

# Closed-Loop Clinical Documentation

An Alternative Approach to Achieving  
Meaningful Use of EHRs

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# Presenters



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Chief Scientist  
M\*Modal

# INTRODUCTION

# Meaningful Use?



# Meaningful Use!!



*“The patient is a 20-year-old man with a history of sickle cell disease who was on a chronic transfusion program with hydroxyurea 500 mg twice a day and penicillin 500 mg occasional nonsteroidal anti-inflammatory drugs.*

*Prior to admission he was on*

```
<text>  
>penicillin 500 mg a day.</content>  
</text>  
<value>  
</value>  
<conceptProperty name="quantity" value="500mg"/>  
</Observation>
```

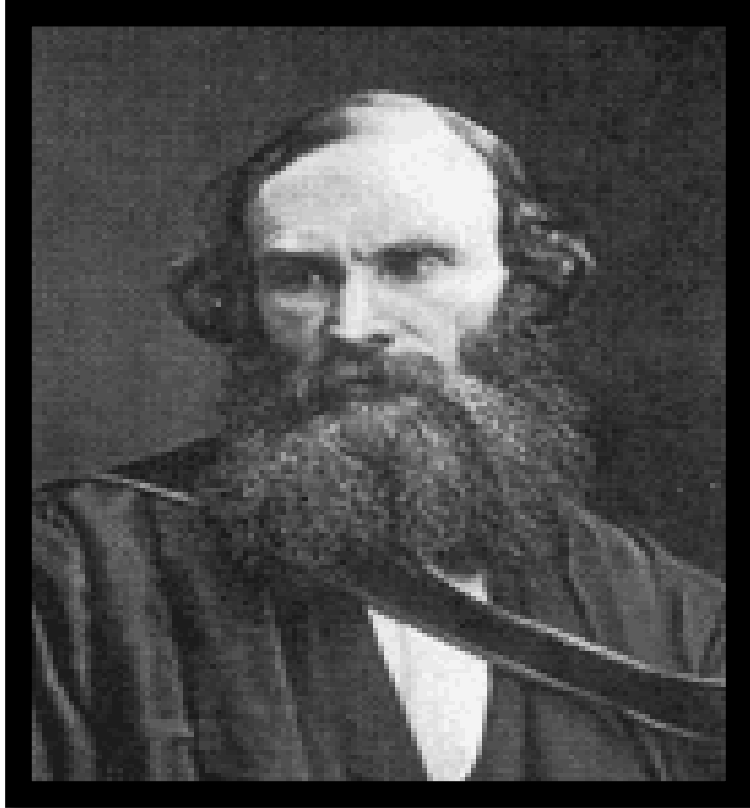
# Standards are a Prerequisite to Functionality

“Well, then,” said Milo, not understanding why each one said the same thing in a slightly different way, “wouldn’t it be simpler to use just one? It certainly would make more sense.”



The Phantom Tollbooth  
Norton Juster

# Standards are a Prerequisite to Functionality



“If you cannot measure it,  
you cannot improve it.”

Lord Kelvin (1824-1907)

“If you cannot standardize  
it, you cannot measure it.”

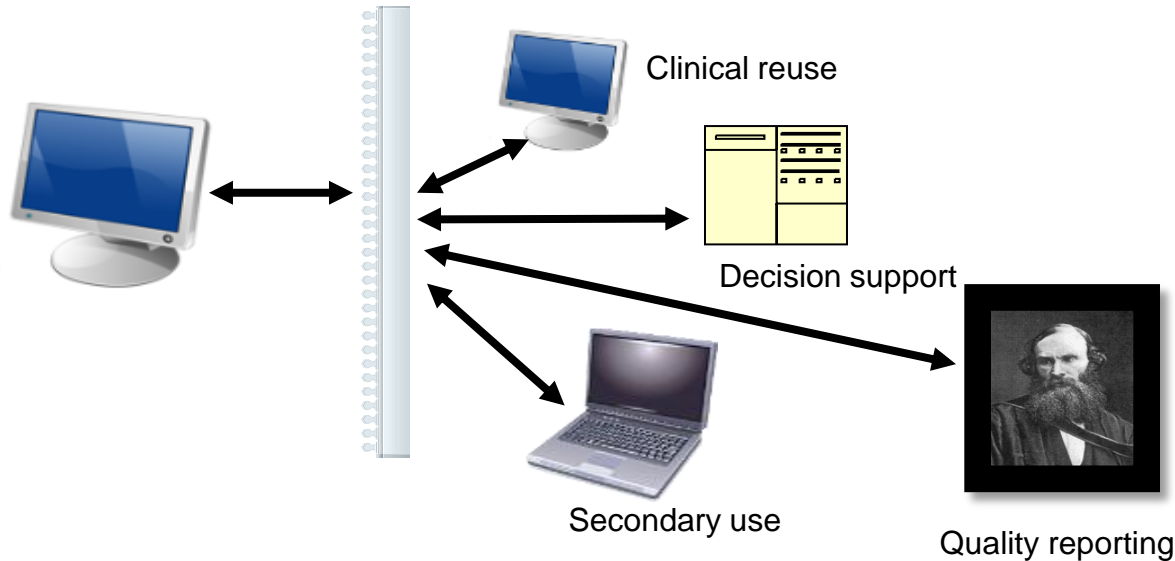
Bob Dolin (2011)



# Meaningful Use Stage 2: Big Picture View

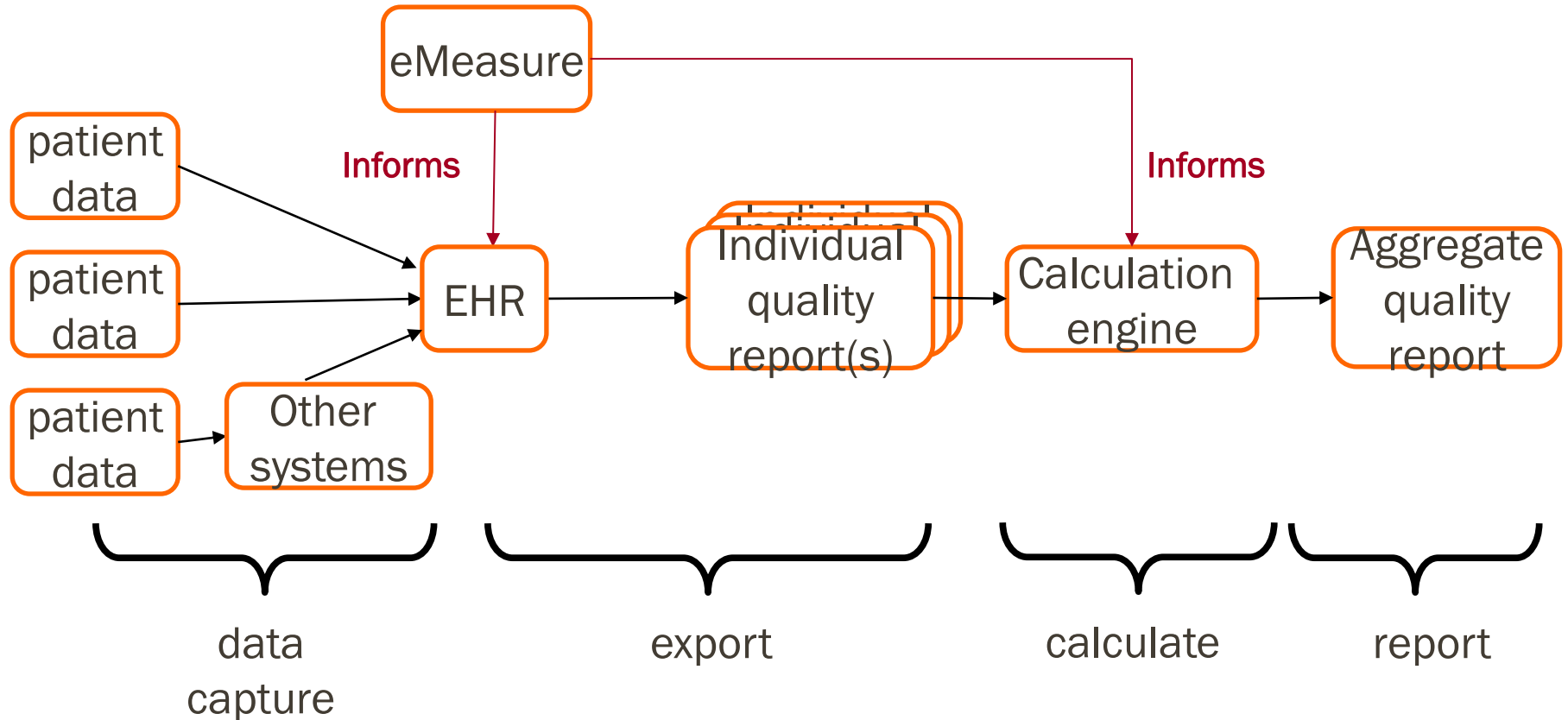
MU-Certified EHR

Meaningful Use of EHR Data





# MU2 and Quality Reporting



# MU2 and HL7

- **Health Level Seven, International** – develop standards cited under MU2
- Key standards include:
  - **HL7 Lab, Immunization Messages**
  - **HL7 Clinical Document Architecture (CDA)**
    - Standardized representation of clinical documents
  - **HL7 Consolidated CDA Implementation Guide**
    - A CDA-based representation of common clinical documents (Consultation Note, H&P, Progress Note, Discharge Summary, Operative Note, Procedure Note, Diagnostic Imaging Report)
  - **HL7 Quality Reporting Document Architecture**
    - A CDA-based representation of individual patient quality data (QRDA Category I) and aggregate patient quality data (QRDA Category III)



# Big Data, Incrementally Structured



# There is Structure in All Clinical Notes

Discharge Summary	
Patient	Ned Nuclear
Date of birth	Novemb
Contact info	6666 Ho Ann Arb Tel: (78
Document Id	999021
Document Created:	March 3
Author	Henry S
Contact info	1002 H Ann Arb Tel: (66

## Hospital Course

The patient was admitted and ruled out for myocardial infarction on the Cardiolite scan. The patient has been ambulated. The patient has been hemodynamically stable. Will discharge.

## Hospital Discharge Diagnosis

Unspecified chest pain

## Hospital Discharge Medications

### Medications

Lisinopril 5 mg

Atenolol 25 mg

1 Tablet once a day

I note that this patient has been on Prednisone for adrenal insufficiency in the past.

```
*****
Hospital Course - Required
*****
-->
- <component>
- <section>
  <templateId root="1.3.6.1.4.1.19376.1.5.3.1.3.5" />
  <code code="8648-8" displayName="HOSPITAL COURSE"
    codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC" />
  <title>Hospital Course</title>
  <text>The patient was admitted and started on Lovenox and
nitroglycerin paste. The patient had serial cardiac enzymes and
was ruled out for myocardial infarction. The patient underwent a
dual isotope stress test. There was no evidence of reversible
ischemia on the Cardiolite scan. The patient has been ambulated.
The patient had a Holter monitor placed but the report is not
available at this time. The patient has remained hemodynamically
stable. Will discharge.</text>
- <entry>
- <observation classCode="OBS" moodCode="EVN">
  <code nullFlavor="NI" />
```

# Incrementalism Works for the Internet

The Google logo is centered on the slide. It features the word "Google" in its signature multi-colored font: blue 'G', red 'o', yellow 'o', blue 'g', green 'l', and red 'e'. The letters have a slight 3D effect with shadows.





# Consolidated CDA

- Continuity of Care Document
- Consultation Note
- Diagnostic Imaging Report
- Discharge Summary
- H&P
- Operative Note
- Procedure Note
- Progress Note
- Unstructured Document





# Consolidated CDA → Meaningful Use

Meaningful Use	“Big Data, Incrementally Structured” Interoperability Strategy
✓	Delivers common clinical documents to the point of care
✓	Standardizing document types and sections today makes it easier to agree on data elements tomorrow
✓	Incrementally adding key data elements into narrative is attractive to clinicians
✓	Partial structuring facilitates natural language processing

## Path to Meaningful Use

- Hit the ground running with basic CDA, to meet the needs of front line clinicians
- Incrementally layer discrete data elements into CDA documents

# Health Story Project

- Approximately 1.2 billion narrative clinical documents are produced in the US each year.
- These documents comprise around 60% of clinical information captured in electronic health records.
- This tremendous source of clinical information is completely underutilized



Care Theme: Transitions of Care

## Health Story: Leveraging C-CDA to Get the Full Story on Cancer Care

**HiMSS**  
Interoperability Showcase  
*In collaboration with IHE*

Use Case 17

# CLOSED-LOOP CLINICAL DOCUMENTATION

# The Current Situation

MRN: 000000  
DOS: 09/11/2009

## CHIEF COMPLAINT:

Patient is a 25 year old woman complaining of feeling frequently fatigued. She reported also occasional dizziness, sleeping difficulties and morning headaches.

## OBJECTIVE:

Recent bout with the flu.

## PHYSICAL EXAMINATION:

Vital signs are normal with a blood pressure of 120/80, pulse 62, temperature 98.6 degrees, weight 108 pounds.

## ASSESSMENT:

Although flu symptoms were in remission, patient has not fully recovered yet.

## PLAN:

Place patient on Biaxin for the next two weeks. The patient will call us if there is no improvement, any worsened or new symptoms.

The screenshot shows a medical charting interface. At the top, it displays 'Last Visit: 01/11/2001' and 'Date of Visit: 11/11/2001'. The doctor is identified as 'DR. JEN MCKOY, MD'. The 'Complaint' is 'Fatigue'. The 'Subjective' section contains the text: 'Patient complained of feeling fatigued. Occasional dizziness. Sleeping difficulties and morning headaches.' The 'Objective' section contains: 'Recent bout with the flu.' The 'Assessment' section contains: 'Although flu symptoms were in remission, patient has not fully recovered.' The 'Problem' is 'INFLUENZA' and the 'Plan' is 'Place patient on antibiotics.' The 'Medications Prescribed' section lists 'BIAxin' with dates '11/11/2001' and '25/11/2001'. On the right side, vital signs are listed: Blood Pressure 120 over 80, Pulse 62, Temp 37.0 C (98.6 F), Height 171.45 cm (67.50 in), Weight 49.09 kg (108.00 lbs), BMI 16.70 kg/m<sup>2</sup> (Moderate). The ICD code is 'SEPTICEMIA DUE TO HE 03841'. At the bottom, there are navigation buttons: Prev, Next, Spell, Print, Patient, Add, Delete, Save, and Exit.

## Dictation

Fast and easy, expressive

- Transcription can be expensive
- Longer turn-around times
- Documents are neither structured nor encoded.

## Direct Data Entry

Structured and encoded information

- Tedious manual process
- Documentation lacks expressiveness of natural language

# Speech Understanding

MRN: 000000  
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The screenshot shows an EMR interface for a patient visit. At the top, it displays 'Last Visit: 01/11/2001' and 'Date of Visit: 11/11/2001'. The doctor is identified as 'DR. JEN MCKOY, MD'. The 'Complaint' field is 'Fatigue'. The 'Subjective' field contains the text: 'Patient complained of feeling fatigued. Occasional dizziness. Sleeping difficulties and morning headaches.' The 'Objective' field contains: 'Recent bout with the flu.' The 'Assessment' field contains: 'Although flu symptoms were in remission, patient has not fully recovered.' The 'Problem' field is 'INFLUENZA' with a severity of 'Acute'. The 'Plan' field contains: 'Place patient on antibiotics.' The 'Medications Prescribed' field shows 'BIAXIN' with dates '11/11/2001' and '25/11/2001'. On the right side, there is a summary of vital signs: Blood Pressure 120 over 80, Pulse 62, Temp 37.0 °C / 98.6 °F, Height 171.45 cm / 67.50 in, Weight 49.09 kg / 108.00 lbs, BMI 16.70 kg/m<sup>2</sup> (Moderate). Below this, it shows 'Recommended Weight Loss 0.00 kg / 0.00 lbs' and 'ICD SEPTICEMIA DUE TO HE 03841'. At the bottom, there are navigation buttons: Prev, Next, Spell, Print, Patient, Add, Delete, Save, and Exit.

## Incrementally Structured & Encoded Clinical Data Within Clinical Narrative

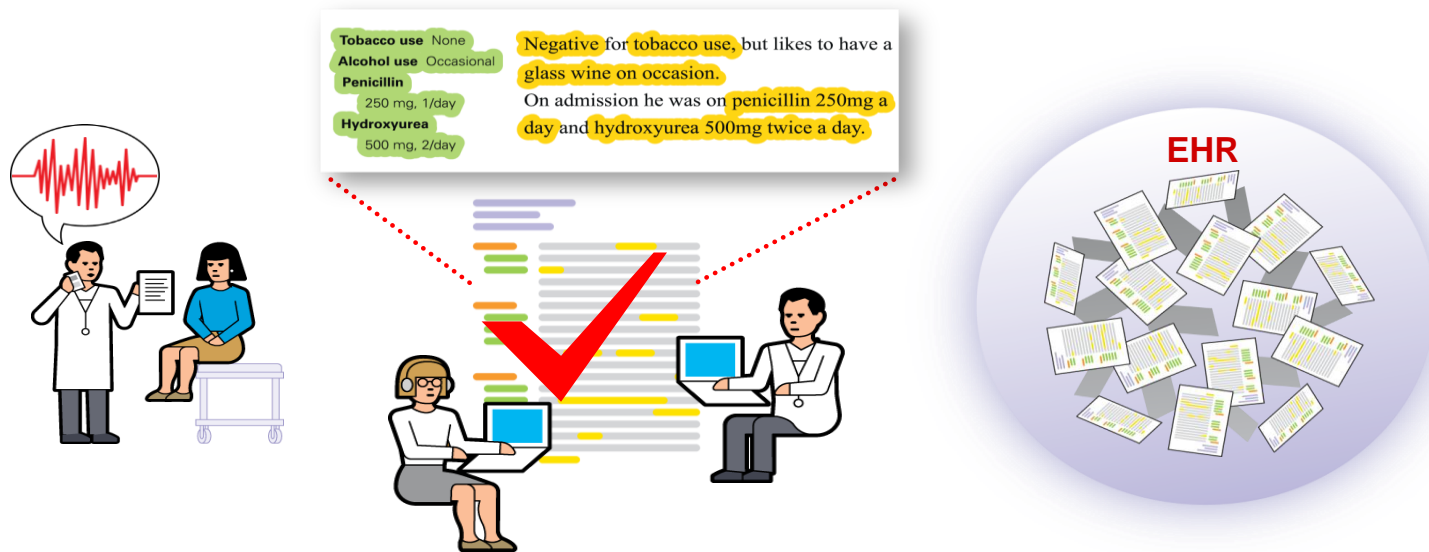
Speech Understanding bridges the gap between dictation & EMRs

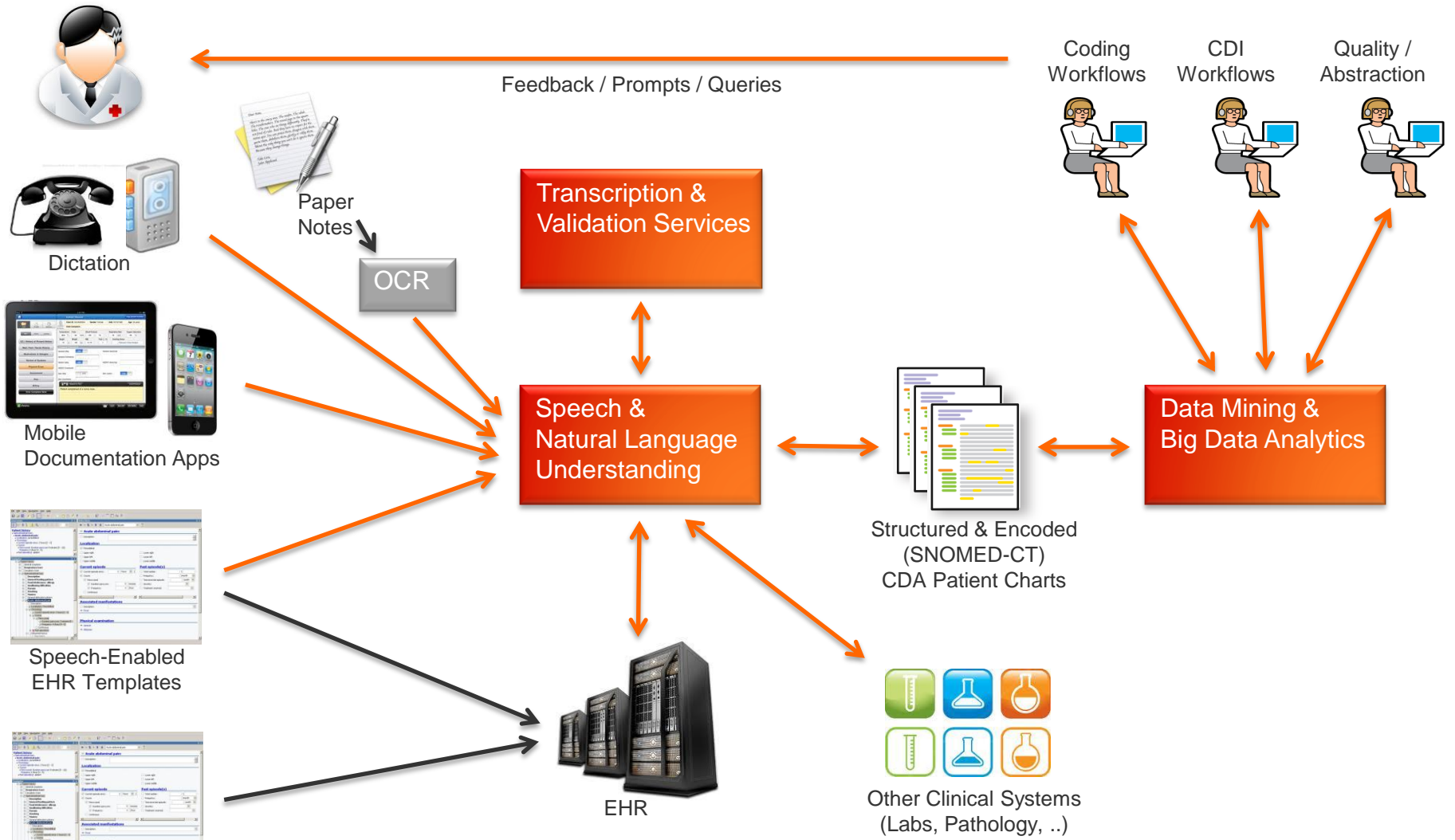
Transforms dictation directly into structured clinical documents in HL7 CDA format

Encoding variety of clinical facts using Controlled Medical Vocabularies such as SNOMED-CT

# Closed-Loop Clinical Documentation

...enables the transformation of dictation **directly** into structured CDA documents while incrementally encoding data depending on the care givers and organizations needs





# Closed Loop Clinical Documentation

- Need feedback mechanism to inform & shape physician behavior **during** the documentation process, in real-time
- To improve clinical documentation quality
- To capture data elements required for Meaningful Use
- To drive accuracy and completeness of charts for billing purposes
- Requires understanding of meaning of clinical statements in narrative reports



# Relevant Technologies

- **Natural Language Understanding (NLU):**

Technology that enables computers to derive meaning from natural human language as found in medical documentation

- **Semantic Reasoning:**

Technology to infer useful consequences ('actions') from asserted clinical facts

Neither technology is perfect, so any useful solution requires humans in the loop

# Natural Language Understanding (NLU)

- Syntax – grammatical structure of sentences
- Semantics – word meanings and relations
- Pragmatics – context contributing to meaning

<b>SUBJ</b>	<b>V-PT</b>	<b>NEG</b>	<b>ANATOMY</b>	<b>SYMPT</b>	<b>TIME</b>
<i>she</i>	<i>has</i>	<i>no</i>	<i>chest</i>	<i>pain</i>	<i>today</i>



# Natural Language Understanding (NLU)

- Word sense disambiguation:
  - “Patient suffers from severe **depression**”.
  - “Electrocardiogram shows ST **depression** in lead 5”.
- Expressions of certainty:
  - “diagnosis of pneumonia **doubtful** at this point”
  - “nausea and vomiting **possibly** indicating concussion”

→ Controlled Medical Vocabularies

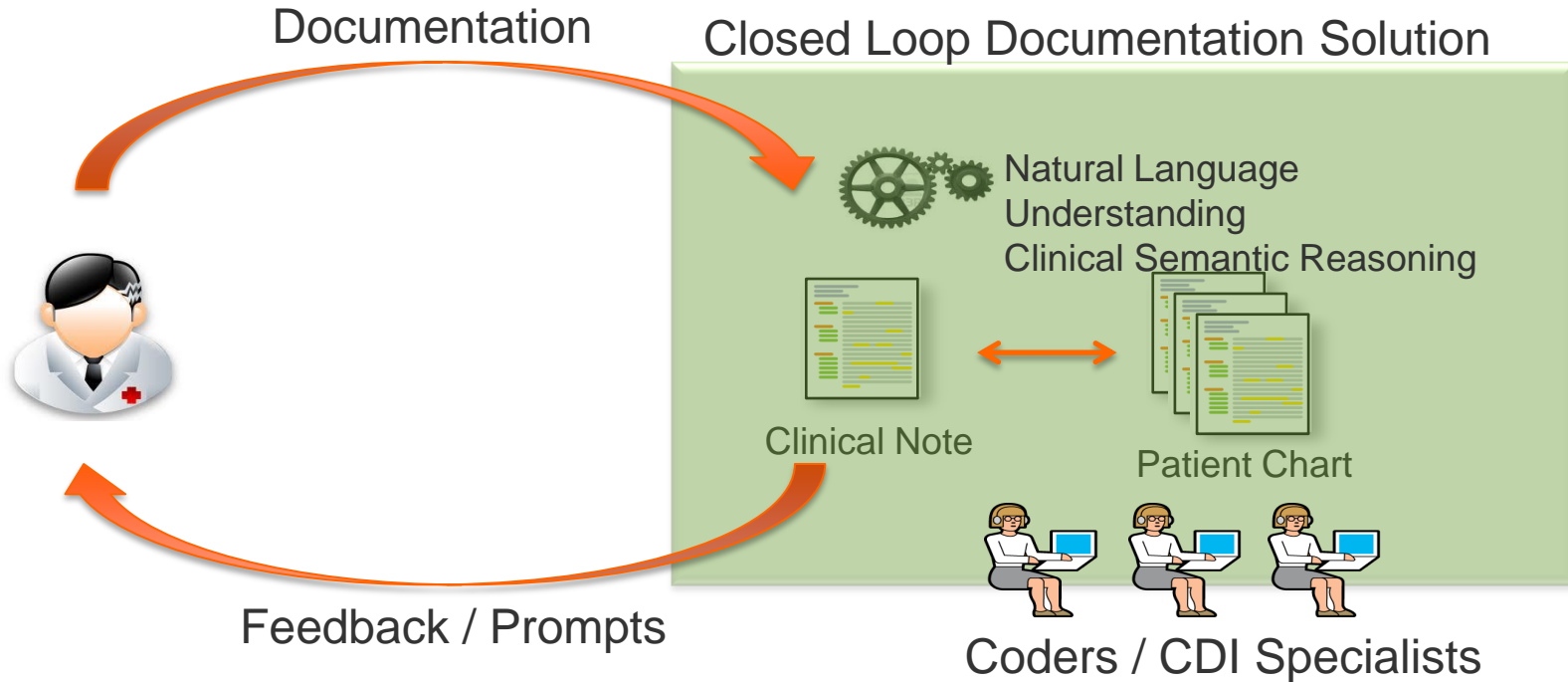
→ Taxonomies

→ Ontologies (SNOMED-CT)

# Natural Language Understanding (NLU)

- Healthcare Applications
  - Computer Assisted Coding (CAC)
  - Closed Loop Clinical Documentation
  - Data Mining of unstructured clinical notes
    - Clinical Documentation Improvement
    - Meaningful Use / Quality Measures
    - ICD-10 Readiness Assessment
    - Predictive Analytics (e.g. readmission risk)
    - Population Health Analytics

# Closed Loop Clinical Documentation



# Data Drives Action

- Gaps/deficiencies can be addressed immediately by the physician
- Once-and-done workflow
- Resulting documentation is more complete, more specific and/or more compliant with regulatory requirements and best practices
- Improves quality of documentation and potentially quality of care

Meritt, Gena  
Nephrology

- Hypertension.
- Renal Insufficiency.

**Allergies**

No known drug allergies

**Medications**

- Lantus 14 units subcu at bedtime.
- Metformin 1000 mg p.o. b.i.d.
- Prinivil 10 mg p.o. q. day.

**Lab Results**

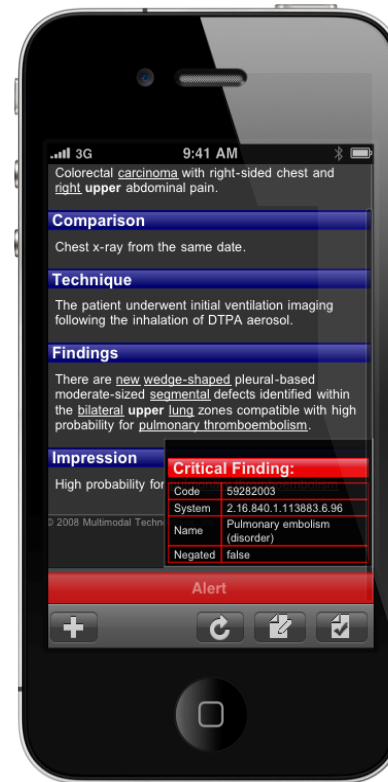
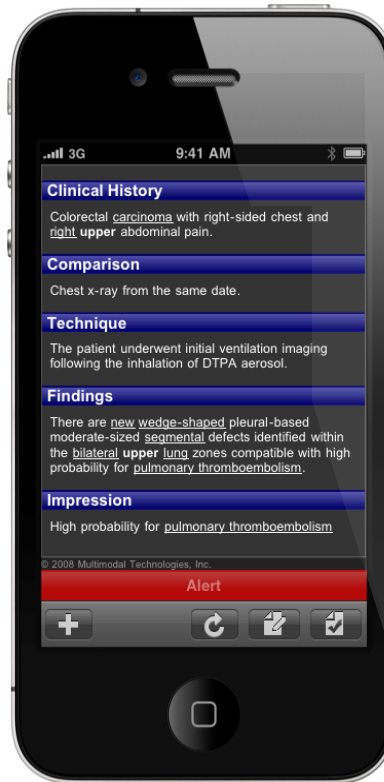
	October	November	December	Normal Range	Interpretation
Sodium (mmol/L)	136	140	138	135-145	Within Range
Potassium (mmol/L)	4.2	4.1	4.5	3.5-5.0	Within Range
Chloride (mmol/L)	105	110	109	100-110	Within Range
Bicarbonate (mmol/L)	23	23	27	18/23	High
BUN (mg/dL)	15	26	32	7-21	High****
Creatinine (mg/dL)	.95	1.3	1.8	.7-1.0	High****
GFR (mls/min/1.73m2)	90	85	62	Higher than 90	Low****

**Assessment and Plan**

The patient was recently admitted for diabetic complications and recent ultrasound showed echogenic kidneys bilaterally. Chronic kidney disease stage 2.

Stop Dictation

# Computer-Assisted Physician Documentation



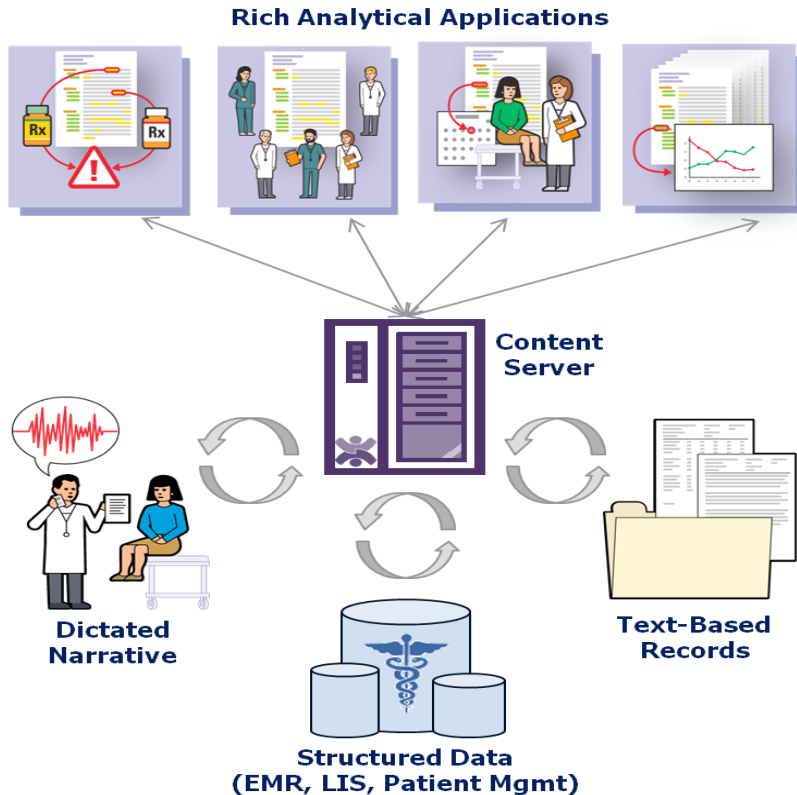
# Information-Enabled Workflows

Provide the appropriate information at the appropriate time...





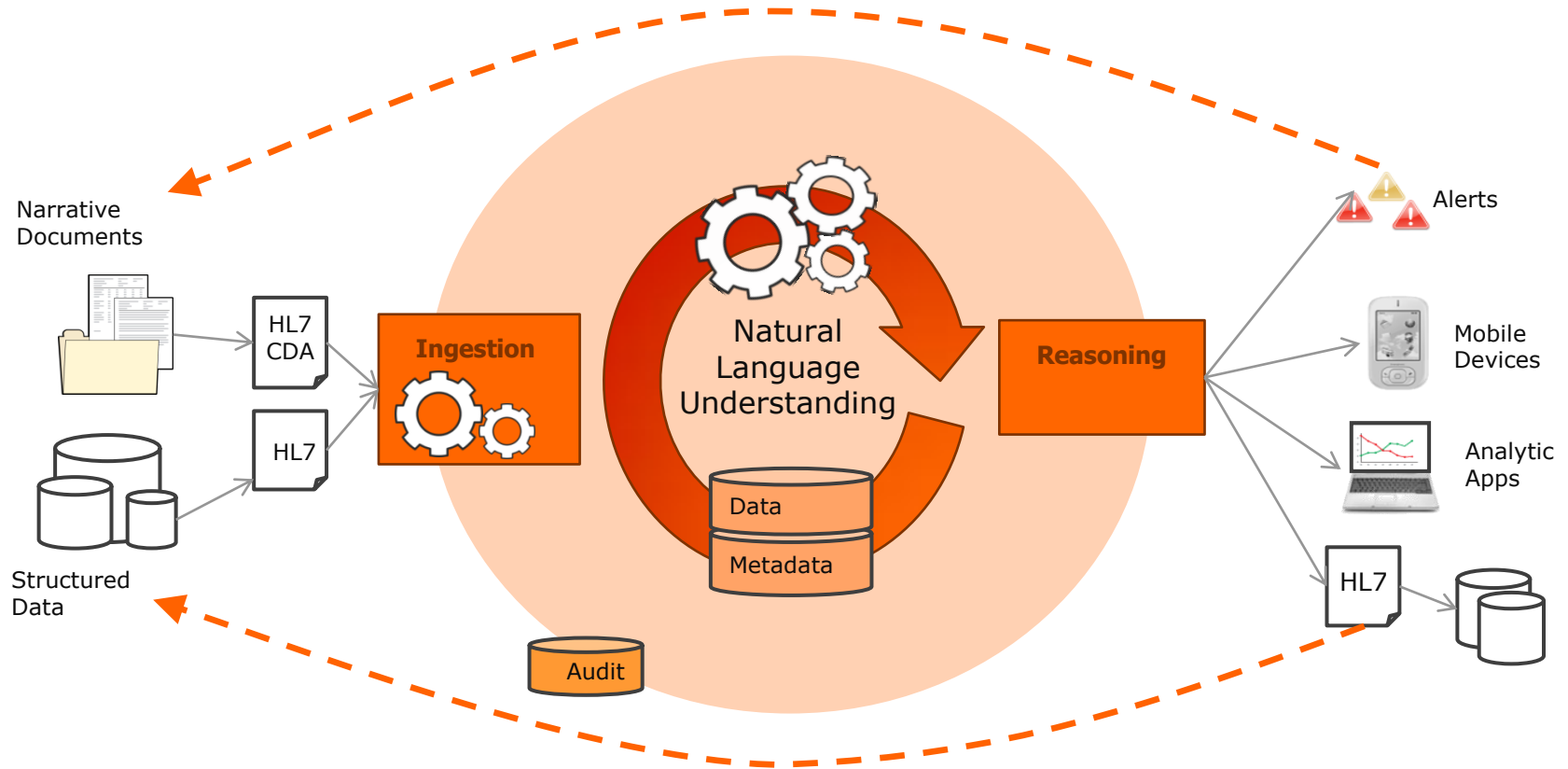
# Mining your Structured & Unstructured Data



## Semantic Reasoning Platform

- Collects and indexes *narrative* and structured patient data
- Applies Natural Language Understanding and Clinical Vocabularies/Ontologies tailored to specific needs
- Tags and preserves clinical data in context of the relevant narrative patient story
- Makes resulting insights & information available in real-time

# Closing the Loop



# Clinical Documentation Improvement



Home



Search



Patients



Admin

Recent Documents



mModal

Aaron.Brauser@HIMDemo



- [-] sandbox
  - [-] Summary Dashboard
    - [-] CDI
      - Acute Respiratory Distress
      - Debridement
      - Hypercapnic Resp Failure**
      - Hypoxic Resp Failure
      - Respiratory Failure
      - Noncompliance
    - Hypertension
    - Shock
    - Pneumonia
    - Syncope
    - Chronic Kidney Disease
    - Congestive Heart Failure
  - [-] QUALITY REPORTING
    - PQRS
    - CLINICAL QUALITY MEASURES
    - Dangerous Abbreviations
    - PRESENT ON ADMISSION
    - MISC
- Integrator
  - Default
  - [-] My Cases

## Hypercapnic Resp Failure

### HYPERCAPNIC RESPIRATORY FAILURE

	Acute	Chronic	Acute on Chronic
Jul 2011	7	4	30
Aug 2011	0	3	15
Sep 2011	0	0	4
Oct 2011	0	0	2

### DOCUMENTS REPORTING HYPERCAPNIC FAILURE, BY PHYSICIAN



### DOCUMENTS REPORTING HYPERCAPNIC FAILURE FAILURE, BY MONTH



### ACUTE

7 total results.  
Displaying reports 1-7

#### Inpatient Progress

Date: Jul 06, 2011 (9 months ago) Physician: BIRDIE MACH

Acute hypercapnic respiratory failure.

DARRIN MCCANN

#### Discharge Summary

Date: Jul 05, 2011 (9 months ago) Physician: ALVA DOWLING

Hypercapnic respiratory failure.

LORENE DANIELS

#### Inpatient Progress

Date: Jul 31, 2011 (8 months ago) Physician: NELLIE NICHOLSON

Acute hypoxic hypercapnic respiratory failure.

WALTERS MCROBERTS

### CHRONIC

7 total results.  
Displaying reports 1-7

#### Output Clinic Note

Date: Aug 24, 2011 (7 months ago) Physician: DOWNS GARTON

previous hypercapnic respiratory failure.

RODRIGO SINGH

#### Inpatient Progress

Date: Aug 29, 2011 (7 months ago) Physician: CATHY WALTON

# Clinical Data Abstraction (Meaningful Use)



**FILTERS**

▼ Radiology Findings Graph List

▼ Date Range  
All

▼ Narrow

▼ Responsible Provider

- Chambers Barrette 2
- Lillie Richard 2
- Vickie Larson 2
- Ford Hamilton 2
- Francisca Hampton 1
- Dr Phillips 1
- Janelle Joesph 1
- Benner Byrne 1
- Pamala Downey 0
- Josephine Black 0
- Dinah Molina 0
- more

▼ Work Type

- Admit Hp Subsections 3
- Inpatient Progress 3
- Initial Inpt Consult 2
- Abdominal Ultrasound Radiology\_demo 1
- Consultation Nephrology 1
- Discharge Summary 1
- Output Clinic Note 1
- Scott & White Output Clinic Note 0
- Procedure Note 0

APPLY RESET

Positive Negative Both Show time gaps

	29 JUL 2011	30 JUL 2011	24 AUG 2011	26 AUG 2011	27 AUG 2011	28 AUG 2011
urinary tract infection						
kidney injury						
kidney pathophysiologic						
urinary tract pneumonia						
heart pneumonia						
heart pathophysiologic						
thorax pain						
head hemorrhage						
head injury						
abdomen pain						

**PROBLEM LIST** REMOVE VERIFY MERGE

Problem	Last Activity	Status	Verification
<input type="checkbox"/> Dyslipidemia (disorder)	7 months ago	active   inactive	Verify
<input type="checkbox"/> Cataract (morphologic abnormality)	7 months ago	active   inactive	Verify
<input type="checkbox"/> Abscess of bladder	8 months ago	active   inactive	Verify
<input type="checkbox"/> Plaque	7 months ago	active   inactive	Verify
<input type="checkbox"/> Failure to thrive (disorder)	8 months ago	active   inactive	Verify
<input checked="" type="checkbox"/> Chronic kidney disease stage 3 (disorder)	7 months ago	active   inactive	
<input type="checkbox"/> Diabetic complication (disorder)	8 months ago	active   inactive	Verify
<input type="checkbox"/> Congestive heart failure (disorder)	7 months ago	active   inactive	Verify
<input type="checkbox"/> Diabetes mellitus with neuropathy	7 months ago	active   inactive	Verify
<input type="checkbox"/> Diastolic heart failure (disorder)	7 months ago	active   inactive	Verify
<input type="checkbox"/> Injury of kidney (disorder)	7 months ago	active   inactive	Verify

**MEDICATIONS** REMOVE VERIFY MERGE

Medication	Effective As Of	Verification
<input type="checkbox"/> NOVLOG unknown 1 dose	7 months ago	Verify
<input type="checkbox"/> TRAMADOL ORAL SUSPENSION Swallow, oral 0 dose	7 months ago	Verify
<input type="checkbox"/> TRAMADOL unknown 1 dose	7 months ago	Verify
<input type="checkbox"/> AZTREONAM unknown 1 dose	7 months ago	Verify
<input type="checkbox"/> DOXYCYCLINE Swallow, oral 0 dose	7 months ago	Verify
<input type="checkbox"/> VITAMIN D unknown 1 dose	7 months ago	Verify
<input type="checkbox"/> CLINDAMYCIN unknown 1 dose	7 months ago	Verify
<input type="checkbox"/> AT 10 Swallow, oral 1 dose	7 months ago	Verify

**ALLERGIES**

Codeine

# Big Data & Population Health Analytics

- Default
- Demo
  - Summary Dashboard
  - CDI
    - Debridement
    - Heart Failure
    - Potential CKD
    - Unspecified CKD
    - Angina
    - Sepsis
    - Pneumonia
    - Anemia
  - QUALITY REPORTING
    - PQRS
      - #51 COPD Spirometry Evaluation
    - CLINICAL QUALITY MEASURES
      - Stroke2: Anti-Thrombolytic Therapy
      - Stroke4: Thrombolytic Therapy
      - VTE5: Discharge Instructions
  - DANGEROUS ABBREVIATIONS
    - cc
    - qd
    - qod
    - iu
    - SC or SQ
  - POPULATION ANALYSIS
    - Hypertension
    - Pneumonia
    - Noncompliance
    - CKD Stages**

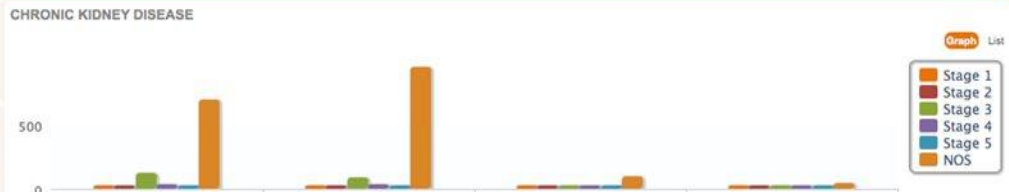
My Cases

CKD

## CKD Stages

CHRONIC KIDNEY DISEASE

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	NOS
Jul 2011	3	18	130	37	20	699
Aug 2011	2	16	95	39	28	951
Sep 2011	0	1	7	2	3	97
Oct 2011	0	0	6	3	0	49



CKD BY PHYSICIAN

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	NOS
CANDACE BLANCHARD	0	0	0	0	0	1
PATRICK GALLOWAY	0	0	0	0	0	1
YOUNG HERNANDEZ	0	0	0	0	0	3
GUADALUPE PACHECO	0	0	0	0	0	3
FISHER MUELLER	0	0	0	0	0	1
SISK BRENT	0	0	0	0	0	1
BROWN DAVIS	0	0	0	0	0	2
STEPHEN GILLIAM	0	0	0	0	0	3
CHRIS RFFSE	0	0	0	0	0	1

STAGE1

5 total results. Displaying reports 1-5

**Output Clinic Note**  
Date: Aug 30, 2011 (7 months ago)  
Physician: LINDA JOHNSON  
chronic kidney disease, stage 1

**Output Clinic Note**  
Date: Aug 22, 2011 (7 months ago)  
Physician: LINDA JOHNSON  
Chronic kidney disease, stage 1, stable....

**Output Clinic Note**  
Date: Jul 06, 2011 (8 months ago)  
Physician: LINDA JOHNSON  
Stage 1 chronic kidney disease - stable

STAGE2

35 total results. Displaying reports 1-10

**Consultation**  
Date: Jul 29, 2011 (8 months ago) Physician: DR PHILLIPS  
Chronic kidney disease stage 2.

**Output Clinic Note**  
Date: Jul 06, 2011 (8 months ago)  
Physician: TAINA BOSLEY  
Chronic kidney disease stage 2

**Output Clinic Note**  
Date: Jul 20, 2011 (8 months ago)  
Physician: LINDA JOHNSON  
Chronic kidney disease, stage 2

STAGE 3

238 total results. Displaying reports 1-10

**Output Clinic Note**  
Date: Jul 28, 2011 (8 months ago)  
Physician: DESTINY COSTA  
CKD, stage 3,

**Output Clinic Note**  
Date: Jul 28, 2011 (8 months ago) Physician: WANG SPELL  
diagnosis chronic kidney disease stage 3

**Output Clinic Note**  
Date: Aug 26, 2011 (7 months ago)  
Physician: BILLS RUNION  
stage 3 chronic kidney disease.

NOS

1,796 total results. Displaying reports 1-10

**Undefined**  
Date: Sep 22, 2011 (6 months ago) Physician: JOEL ARREY  
History of chronic kidney disease.

**Output Clinic Note**  
Date: Aug 29, 2011 (7 months ago) Physician: DEVIN OLIVA  
limited chronic kidney disease.

**Undefined**  
Date: Aug 08, 2011 (7 months ago) Physician: MAJOR KEEL  
sees Dr. BRYCE for chronic kidney disease.

**Output Clinic Note**  
Date: Jul 06, 2011 (8 months ago)

# Conclusions

- Increasing regulatory requirements – including Meaningful Use – demand more specific, complete & compliant clinical documentation
- Narrative clinical documentation is more meaningful and more useful than structured data entry via EHR templates
- Technologies such as **NLU and Semantic Reasoning** are increasingly being used to
- Build **Closed-Loop Clinical Documentation** workflows to prompt & guide physicians
- Resulting narrative can be incrementally tagged and mined for relevant clinical data to drive **information-enabled** clinical workflows
- Augmenting Meaningful Use compliance & increasing physician adoption of EHRs through better clinical documentation workflows

# Thank You!

## Questions?