DISCLOSURE

In the past 12 months, I have not had any significant financial interest or other relationship with the manufacturers of the products or providers of the services that will be discussed in my presentation.

Any commercial products or vendors mentioned in this presentation are for presentation purposes only.
Captain’s log, stardate 72809.9

• Jim, I am a doctor, not a secretary. I can’t spend all my time and go after every single piece of information I need to do my job! Can’t the federation do something about it?
Table 3. Modified Cyst Fluid Interpretation*

<table>
<thead>
<tr>
<th>Cyst Fluid Analysis</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEA &gt; 800 ng/ml</td>
<td>Mucus-producing pancreatic neoplasia</td>
</tr>
<tr>
<td>CEA &lt; 5 ng/ml</td>
<td>Non-mucus-producing pancreatic neoplasia</td>
</tr>
<tr>
<td>Amylase &lt; 250 U/L</td>
<td>Not a pseudocyst</td>
</tr>
</tbody>
</table>

Abbreviation: CEA, carinoembryonic antigen.

A. Liver, transjugular biopsy:
   - Equivocal CMV immunostain (see COMMENT).
   - Prominent bile duct injury, mild portal inflammation, and early bridging fibrosis (stage 2-3 of 4).
   - Cholestasis, periportal bile ductular proliferation; negative for ductopenia (CK7).
   - Occasional dead hepatocytes.
   - Minimal (<5%) steatosis.
   - Glycogenated nuclei.
   - Iron overload (4+ iron in hepatocytes and macrophages by iron stain).
   - HSV 1&2 and adenovirus immunostains are negative.

Note: The patient's history is noted, including myelodysplastic syndrome (MDS) status post two allogenic stem cell transplants (2/2015 and 6/2016), alcohol use, steatohepatitis, Hepatitis B. Most recent pertinent laboratory data include: 12/13/16, ALT 169, AST 126, TBili 1.3, DBili 0.7. Hepatitis B DNA (12/13/16) is negative. Hepatitis C tests are negative.

Rare equivocal cells are present on CMV immunostain. Correlation with CMV PCR for evaluation of CMV infection is recommended.

The overall findings in the liver biopsy is concerning for graft versus host disease (prominent bile duct epithelial damage without ductopenia). Trichrome and orcein stains demonstrate periportal and early bridging fibrosis. While no diagnostic features of steatohepatitis and hepatitis B are seen, their contribution to the hepatic fibrosis cannot be determined. Other differential diagnosis also includes medication induced liver injury. Please correlate with clinical and laboratory findings.
<table>
<thead>
<tr>
<th></th>
<th>mg/dL</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>0.5-1.4</td>
<td>08-27-2012 07:34</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:09</td>
<td>1.3</td>
</tr>
<tr>
<td>BUN</td>
<td>7-20</td>
<td>08-27-2012 07:34</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:09</td>
<td>23</td>
</tr>
<tr>
<td>eGFR</td>
<td>&gt;59</td>
<td>08-27-2012 07:34</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:09</td>
<td>42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Seconds</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>11.8-14.5</td>
<td>08-27-2012 06:47</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>07-30-2012 06:59</td>
<td>12.9</td>
</tr>
<tr>
<td>PTT</td>
<td>14.0-34.0</td>
<td>08-27-2012 06:47</td>
<td>35.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>07-20-2012 06:02</td>
<td>34.9</td>
</tr>
<tr>
<td>INR</td>
<td>0.9-1.1</td>
<td>08-27-2012 06:47</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>07-30-2012 06:59</td>
<td>1.0</td>
</tr>
<tr>
<td>Platelets</td>
<td>150-450</td>
<td>08-27-2012 07:13</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:16</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>g/dL</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HGB</td>
<td>11.3-13.0</td>
<td>08-27-2012 07:13</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:12</td>
<td>8.9</td>
</tr>
<tr>
<td>HCT</td>
<td>36-47</td>
<td>08-27-2012 07:13</td>
<td>24.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:12</td>
<td>25.6</td>
</tr>
<tr>
<td>WBC</td>
<td>3.5-11</td>
<td>08-27-2012 07:13</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-26-2012 07:12</td>
<td>0.1</td>
</tr>
<tr>
<td>Albumin</td>
<td>g/dL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5-5.0</td>
<td>08-27-2012 07:34</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08-27-2012 07:34</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Borrowed with permission from Paul J. Chang, M.D
Evaluating the Referring Physician’s Clinical History and Indication as a Means for Communicating Chronic Conditions That Are Pertinent at the Point of Radiologic Interpretation

Piotr Obara · Merlijn Sevenster · Adam Travis · Yuechen Qian · Charles Westin · Paul J. Chang

Abstract The clinical history and indication (CHI) provided with a radiological examination are critical components of a quality interpretation by the radiologist. A patient’s chronic conditions offer the context in which acute symptoms and findings can be interpreted more accurately. Seven pertinent (potentially diagnosis altering) chronic conditions, which are fairly prevalent at our institution, were selected. We analyze if and how in 140 CHIs there was mention of a patient’s previously reported chronic condition and if and how the condition was subsequently described in the radiology report using a four-item scheme (Mention/Specialization, Generalization, Common comorbidity, No mention). In 40.7 % of CHIs, the condition was rated Mention/Specialization. Therefore, we reject our first hypothesis that the CHI is a reliable source for obtaining pertinent chronic conditions (>90.0%). Non-oncological conditions were significantly more likely rated No mention in the CHI than oncological conditions (58.7 versus 8.3%, \(P<0.0001\)). Stat cases were significantly more frequently No mention than non-stat cases (60.0 versus 31.3%, \(P=0.0134\)). We accept our second hypothesis that the condition’s rating in the CHI is significantly correlated with its rating of the final radiology report (\(\chi^2\) test, \(P<0.00001\)). Our study demonstrates an alarming lack of communication of pertinent medical information to the radiologist, which may negatively impact interpretation quality.

Lack of appropriate clinical history is a known detriment to radiologic exam interpretation [6, 7]. For example, ground-glass opacities on a chest CT are generally not a specific finding; however, in immunocompromised patients they are suspicious of an atypical infection. Similarly, enlarged axillary lymph nodes on a mammogram could be an ominous finding unless there is history of an inflammatory condition such as lupus. Given the established importance of past medical history in radiological exam interpretation, we evaluated the rates at which chronic conditions are mentioned in the CHI and in the CHR.

We evaluated the trustworthiness of the CHI as a means to communicate pertinent chronic conditions to the radiologist. By pre-selecting patients whom were known to suffer from seven chronic conditions, we could track the rate by which these conditions were successfully communicated. This unique study design sets it apart from earlier studies [6, 10] in which the CHI proper was evaluated without structural reference to the patient’s complete clinical history.
Data Granularity and Standardization

Diagnosis:

No malignant cells identified. ATYPIA OF UNDETERMINED SIGNIFICANCE
Follicular cells with architectural atypia.

Bethesda classification: III

Diagnosis:

Atypical cells present. Follicular lesion of undetermined significance. See comment.

Comment:

ThinPrep slide reveals groups of follicular cells in both macrofollicular and microfollicular arrangements. In some areas, nuclear crowding and enlargement is noted. Although a benign (hyperplastic) nodule is favored, a neoplasm cannot be excluded. Additional sampling is suggested if clinically indicated.
"Okay, just a few more items to add to your EHR. I appreciate your patience..."

"PATIENT-CENTERED CARE"
Chekov comments

• But captain, what is the issue here, doesn't the Federation allow us access to clinical information through a unified interface in the EHR?
Why Do We Have the Federation?

- Data stored on electronically can be used to:
  - Manage patient care
  - Maximization of revenue
  - Enable precision medicine through research from the molecular to population scale
BIG DATA IN HEALTH CARE

- Government agencies
- Patient portals
- Research studies
- Payer records
- Generic databases
- Electronic health records (EHR)
- Smart phones
- Wearable devices
- Public records
- Search engine data
The Three approaches

The Federated Approach

- Uses a software abstraction layer to combine various database sources into a single view
- AKA virtualized database architecture
- The source data is not moved or copied
The Data Lake Approach

• Move all data into a single location
• Structured or unstructured data
• Indexing...what is that?
• Stay tuned to Dr. William’s lecture “Data Lakes, Warehouses and Marts, Oh My!”
The Data Hub Approach

- Data is moved/copied and indexed to a central hub
- Data can be easily queried
- Highest overhead for interoperability
Why do a Federated Approach?

• No need to move or copy data into a central repository
  – Maintain single source of truth
• Real time access of data
• Maybe the only option to realistically to combine heterogeneous data from multiple sources that changes frequently.
  – Which can be institution(s), service(s), and data type(s)
Federated Frameworks

Federated Architecture

Parent

Child

CLUSTER C

Child

CLUSTER B

Child

CLUSTER A

http://www.tefg.com/Structure/support/default.html
Single Source of Truth

- Labs
- Primary Care
- Hospitals
- Specialists
- Public Health
- Long Term Care
- Pharmacies
Why do a Federated Approach?

• No need to move or copy data into a central repository
  – Maintain single source of truth

• **Real time access of data**

• Maybe the only option to realistically to combine heterogeneous data from multiple sources that changes frequently.
  – Which can be institution(s), service(s), and data type(s)
• Jim, I am a doctor, not an archaeologist. I need the federation to give me real time clinical information.

• Or this might happen...
HE'S DEAD, JIM
Why do a Federated Approach?

• No need to move or copy data into a central repository
  – Maintain single source of truth
• Real time access of data
• Maybe the only option to realistically to combine heterogeneous data from multiple sources that changes frequently.
  – Which can be institution(s), service(s), and data type(s)
History of Present Illness

Patient presented in late June 2006 with sudden onset of blurred vision, diplopia, weakness (L arm > R), and L eye ptosis after a C. jejuni GI infection. She was admitted to the hospital and lumbar puncture showed increased protein, an EMG/NCS showed early signs of AIDP. She was treated with IV Ig and had some improvement of her symptoms. Her vital capacities were normal during the hospitalization. She was then transferred to rehab and was discharged on July 20, 2006. Her walking is better but she still has some weakness, blurry vision due abnormal eye movement and some tightness and pain in her mid-back.

Social History
Never A Smoker
Never Drank Alcohol
Occupation: Retired

Current Meds
Fluticasone Propionate 50 MCG/ACT Nasal Suspension; Therapy: (Recorded:24May2013) to
Gabapentin 100 MG Oral Capsule; Therapy: (Recorded:24May2013) to
Glibizide 10 MG Oral Tablet; Therapy: (Recorded:24May2013) to
Insulin Purified NPH (Pork) SUSP; Therapy: (Recorded:24May2013) to
Lasix 20 MG Oral Tablet; TAKE 1 TABLET TWICE DAILY; Therapy: (Recorded:24May2013) to
Norvasc 10 MG Oral Tablet; Therapy: (Recorded:24May2013) to
Percocet 5-325 MG Oral Tablet; Therapy: (Recorded:24May2013) to
Protonix 40 MG Oral Tablet Delayed Release; Therapy: (Recorded:24May2013) to
Toprol XL 50 MG Oral Tablet Extended Release 24 Hour; Therapy: (Recorded:24May2013) to
Zocor 10 MG Oral Tablet; Therapy: (Recorded:24May2013) to

Allergies
Acenofex LOTN
Bactrim DS TABS

<table>
<thead>
<tr>
<th>Patient</th>
<th>Typical Normal Reference Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Male</td>
</tr>
<tr>
<td>WBC</td>
<td>0.6 x10E+9/L</td>
</tr>
<tr>
<td>RBC</td>
<td>1.88 x10E+12/L</td>
</tr>
<tr>
<td>Hgb</td>
<td>6.0 g/dL</td>
</tr>
<tr>
<td>Wct</td>
<td>18.7 %</td>
</tr>
<tr>
<td>MCV</td>
<td>89.4 fL</td>
</tr>
<tr>
<td>MCH</td>
<td>36.3 pg</td>
</tr>
<tr>
<td>MCHC</td>
<td>36.5 %</td>
</tr>
<tr>
<td>RDW</td>
<td>17.1 %</td>
</tr>
<tr>
<td>PLT</td>
<td>54 x10E+9/L</td>
</tr>
</tbody>
</table>
Sample Ophthalmology Note

HPI:
Example: 82 y.o. RF with history of NPDR (non-proliferative diabetic retinopathy) presenting with "blurry vision" in the right eye for the past 3 days. She said she was cleaning her house, and "might have gotten something in my eye" three days ago. Since then, she complains of darkness/blurriness of vision and photophobia. Sore watery but no discharge. No flashes, possibly? New floaters (floaters sound heavier, wave classification, polyopia, vision, weight loss, sight loss, headache, or any other systemic symptoms). There has been no vision changes in her left eye.

V_{oc} < 20/100 (PMH) 20/30-1 P < 5.0 in 3 Ref. oc to EOMI oc

SLE
EXT: uni ou
L/L: mild melomelitis ou
C/S: 1+ red. wat. eye
K: - eye cornea
A/C: deep and quiet ou
Intra: flat, round, no H/O ou
Lens: PCO, 0.6, 0.6 N/D ou
Vit: POD ou, no reflex ou

DFE
Macular mitis eye simnply OD
Vessels, aracterization atid AIH. cracking ou, no NVE
Pharynx: H/P ou, bow out brief heme ou
Disc: G/D ratio = 0.3 ou, no NVD ou

A/P:
1. Corneal abrasion - appears sterile with no infiltrate. Possibly caused by scratch during house cleaning, vs. recurrent erosion, exacerbated by some air. Irritate with erythromycin gel and gels and have pt. tape lid at night. Will see daily until defect healed to ensure it does not become infected.
2. NPDR - radios. Court to follow yearly and consider fundus photos.
3. Return to ophthalmic discharge.
4. Pt. seen and discussed with attending.

Vve (vision with glasses), PHNI (pinhole no improvement), P (pupils), TAP (pressure with application), CF (confrontational fields), EOMI (extramacular movements intact), SLE (slit lamp exam), EXT (external), L/L (lids & lacrimation), C/S (conjunctiva and sclera), K (cornea), A/C (antechamber), Vit (vitreous), DFE (dilated fundus exam), CE (cataract extraction), LOL (laugh out loud)

--- OD (right eye) OS (left eye) OU (both eyes) ---
Table 1. The 2018 Bethesda System

SPECIMEN TYPE:
Indicate conventional smear (Pap smear) vs. liquid-based preparation vs. other

SPECIMEN ADEQUACY
- Satisfactory for evaluation (describe presence or absence of endocervical/extranuclear zone component and any other quality indicators, e.g., partially obscuring blood, inflammation, etc.)
- Unsatisfactory for evaluation (specify reason)
- Specimen rejected/not processed (specify reason)
- Specimen processed and examined, but unsatisfactory for evaluation of epithelial abnormality because of (specify reason)

GENERAL CATEGORIZATION (optional)
- Negative for Intraepithelial Lesion or Malignancy
- Other:
  - See Interpretation/Result (e.g., endometrial cells in a woman ≥45 years of age)
  - Epithelial Cell Abnormality: See Interpretation/Result (specify "squamous" or "glandular" as appropriate)

INTERPRETATION/RESULT
NEGATIVE FOR INTRAEPITHELIAL LESION OR MALIGNANCY
(When there is no cellular evidence of neoplasia, state this in the General Categorization above and/or in the Interpretation/Result section of the report—whether or not there are organ-associated or non-neoplastic findings)

Non-neoplastic Findings (optional to report)
- Non-neoplastic cellular variations
  - Squamous metaplasia
  - Keratinous changes
  - Tubal metaplasia
  - Atrophy
- Pregnancy-associated changes
- Reactive cellular changes associated with:
  - Inflammation (includes typical repair)
  - Lymphocytic (follicular) cervicitis
  - Radiation
  - Intravenous contraceptive device (IUD)
  - Glandular cells status post hysterectomy

Organisms
- Trichomonas vaginalis
- Fungal organisms morphologically consistent with Candida spp.
- Shift in flora suggestive of bacterial vaginitis
- Bacteria morphologically consistent with Actinomyces spp.
- Cellular changes consistent with herpes simplex virus
- Cellular changes consistent with cytomegalovirus

OTHER
- Endometrial cells (in a woman ≥45 years of age)
  - (Specify "negative for squamous intraepithelial lesion")
**BREAST SPECIMEN REPORT**

<table>
<thead>
<tr>
<th>Test name</th>
<th>Type</th>
<th>Path. score</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>% positive</td>
<td>98.13</td>
</tr>
<tr>
<td>PR</td>
<td>% positive</td>
<td>98.96</td>
</tr>
<tr>
<td>HER2</td>
<td>Score</td>
<td>1 +</td>
</tr>
</tbody>
</table>

**00-1 Individual assay findings**

- **Estrogen Receptor (ER) (SP1)**
  - % positive: 98.13
  - Favorable: 1
  - Unfavorable: < 1

- **Progesterone Receptor (PR) (1E2)**
  - % positive: 98.96
  - Favorable: > 1
  - Unfavorable: < 1

- **HER2 (4B5)**
  - Score: 1 +
Federated Approach is Also Excellent for...
Purist approach is not necessary

Learning from Health Information Exchange Technical Architecture and Implementation in Seven Beacon Communities

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4371446/pdf/egems1060.pdf
Figure 1. Continuum of HIE Architecture Models

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4371446/pdf/egems1060.pdf
Figure 1. Hospital and Health System M&A Activity, 2000-2017

Source: Kaufman Hall Transactions Data
M&A Facts

- 70-90% of all mergers fail
- 57% of companies will undertake an acquisition within 1 year
- 34% of firms cite, "the challenges of IT integration" as a reason for deals not meeting expectations
- 49% of organizations have more than 5 deals in the pipeline
- Most companies only have 100 days to deliver integrated data assets

Sources: Harvard Business Review, Ernst and Young
Captain, we are receiving a transmission

• The message is from the Klingons...I am decoding it now.
• The Klingons want to reverse their hostility towards the federation and I need to study their anatomy to save Chancellor Gorkon to achieve peace!
Spock speaks

• Captain, the *federation* rules forbade dealing with outlaws and getting involved in the politics of other cultures
Kirk speaks

• We have *reversed* time and rank before to save people; we will *reverse* this *federation* rule to save one more life and achieve peace. Mr. Spock, can we communicate with the Klingons through the *federation with our* intent?
Spock speaks

• In theory we could interface with the **federation** through a highly agile **SOA** to get to the Klingons.
Kirk speaks

• Excellent Mr. Spock. Take us there Mr. Sulu.
Federated Frameworks

Federated Architecture

CLUSTER C

CLUSTER B

CLUSTER A

ENTERPRISE

http://www.tefg.com/Structure/support/default.html
Reverse Federation

Access of a federated repository in a direction opposite to the normally considered primary/subordinate linkage

- Ulysses Gregory John Balis, M.D.
What about interoperability?
Web 2.0

- User generated content
- Ease of use
- Participatory culture
- Interoperability
Web 2.0

- User generated content
- Ease of use
- Participatory culture
- **Interoperability**
  - JavaScript framework
Service-oriented architecture (SOA)

• An open, agile, extensible, federated, compostable architecture comprised of autonomous, Quality of Service (QoS)-capable, vendor diverse, interoperable, discoverable, and potentially reusable services, implemented as Web services
Service-oriented architecture (SOA)

• An open, agile, extensible, federated, compostable architecture comprised of autonomous, Quality of Service (QoS)-capable, vendor diverse, interoperable, discoverable, and potentially reusable services, implemented as Web services
SOA, the Approach

- SOA = architecture/concept
- Web Service = implementation strategy
Interface Strategies

• HL7
  – 2.x
  – Web API/HL7 FHIR

• Data Repository / Data Warehouse

• Middleware/Interface Engine/Enterprise Service Bus (ESB)
Order Interface

Result Interface

Figure from: A. Carter, MD
HL7 2.X

PID||PATID1234|^M11|^AN||JONES^WILLIAM^A^III||19610615|M||2106-3|677 DELAWARE
EVN|A01|198808181123

<table>
<thead>
<tr>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code> </code></td>
<td>Field Separator</td>
</tr>
<tr>
<td>~</td>
<td>Component Separator</td>
</tr>
<tr>
<td>&amp;</td>
<td>Sub-Component Separator</td>
</tr>
<tr>
<td>~</td>
<td>Field Repeat Separator</td>
</tr>
<tr>
<td>\</td>
<td>Escape Character</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSH</td>
<td>Message Header</td>
</tr>
<tr>
<td>EVN</td>
<td>Event Type</td>
</tr>
<tr>
<td>PID</td>
<td>Patient Identification</td>
</tr>
<tr>
<td>NK1</td>
<td>Next of Kin</td>
</tr>
<tr>
<td>PV1</td>
<td>Patient Visit</td>
</tr>
<tr>
<td>CBR</td>
<td>Observation Request</td>
</tr>
<tr>
<td>OBX</td>
<td>Observation Result</td>
</tr>
<tr>
<td>CRC</td>
<td>Common Order</td>
</tr>
<tr>
<td>NTE</td>
<td>Notes</td>
</tr>
<tr>
<td>IN1</td>
<td>Insurance</td>
</tr>
<tr>
<td>GT1</td>
<td>Guarantor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01</td>
<td>Admit patient</td>
</tr>
<tr>
<td>A02</td>
<td>Transfer patient</td>
</tr>
<tr>
<td>A03</td>
<td>Discharge patient</td>
</tr>
<tr>
<td>A04</td>
<td>Register patient</td>
</tr>
<tr>
<td>A05</td>
<td>Pre-admit patient</td>
</tr>
<tr>
<td>A06</td>
<td>Transfer outpatient to inpatient</td>
</tr>
<tr>
<td>A07</td>
<td>Transfer Inpatient to outpatient</td>
</tr>
<tr>
<td>A08</td>
<td>Update patient</td>
</tr>
<tr>
<td>A11</td>
<td>Cancel admit</td>
</tr>
<tr>
<td>A12</td>
<td>Cancel transfer</td>
</tr>
<tr>
<td>A13</td>
<td>Cancel discharge</td>
</tr>
<tr>
<td>A17</td>
<td>Bed swap</td>
</tr>
<tr>
<td>A18</td>
<td>Merge patient</td>
</tr>
</tbody>
</table>
SUPPLEMENTAL SURGICAL PATHOLOGY REPORT

Order Number: SU-100164 Date Completed: 4/27/2018 6:00 PM
Date Received: 4/27/2018 8:40 AM

Date Collected: 4/27/2018 4:00 PM

REASON FOR SUPPLEMENTAL REPORT: ADDITIONAL INFORMATION

Order Number: SU-100164 Date Completed: 4/27/2018 6:00 PM
Date Received: 4/27/2018 8:40 AM

Supplemental:

For clarification, HER2 IHC was repeated on the patient’s resection specimen (SU-16-41704) and is negative (1+). As such, fluorescence in-situ hybridization (FISH) for HER2 gene amplification will not be performed on the core biopsy material.

Electronically Signed By:

I, the above named pathologist, have personally examined and interpreted the slides from this case.

Michigan Medicine Pathology and Clinical Laboratories

Supplemental:

For clarification, HER2 IHC was repeated on the patient’s resection specimen (SU-16-41704) and is negative (1+). As such, fluorescence in-situ hybridization (FISH) for HER2 gene amplification will not be performed on the core biopsy material.

Electronically Signed By:

I, the above named pathologist, have personally examined and interpreted the slides from this case.

Michigan Medicine Pathology and Clinical Laboratories
The Data Hub Approach

• Data is moved/copied and indexed to a central hub
• Data can be easily queried
• Highest overhead for interoperability
HL7 2.X

**Figure 2: Data Workflow Using an Integration Engine**

AKA middleware

Source: https://corepointhealth.com/thank-you/future-interoperability-web-apis-fhir/
Enterprise Service Bus

• Data transformation
  – XML
  – Binary
  – Text
  – CSV
  – Swift
  – HL7
  – CDA
  – DICOM
  – EDI
Enterprise Service Bus

• Protocol Conversion
  – TCP/IP
  – HTTP
  – MLLP
  – Web service (SOAP/REST)
  – Database
  – FTP/SFTP
  – Email
  – File System
  – Message Queue (JMS, MSMQ, Websphere MQ and etc.)
  – DICOM
Enterprise Service Bus

• Data Routing
• Data enhancement
• Data administration/monitoring
• Security
• Scalability and cost effective
• SOA friendly
University of Chicago SOA Architecture

Data Sources

Data Ingestion (ETL)

Data Persistence / Storage (“Data Warehouse”)

“Focused” Data Storage (“DataMarts”)

Data Delivery and Analysis (HIE, datamining BIA, CEP, Predictive Analytics)

Data Consumption and Presentation (Portals, Visualization, Scorecards, Dashboards)

SOA Enterprise Service Bus (ESB)

Borrowed with permission from Paul J. Chang, M.D
Web 2.0

- User generated content
- Ease of use
- Participatory culture
- **Interoperability**
  - JavaScript framework
68 packages found

Sort Packages
Optimal
Popularity
Quality
Maintenance

Who's Hiring?
Hired, Apply Digital, Voxer and lots of other companies are hiring Javascript developers.

See all 19 companies

hl7
Parsing HL7 into JSON

@hl7 json parser

austundag published 1.1.1 • 10 months ago

simple-hl7
Simple library for creating and parsing hl7 messages

@hl7

rupp.io published 3.1.0 • a month ago

nodengine-hl7
HL7 parser

@hl7 parser

evanlucas published 4.1.8 • 3 years ago

hl7parser
HL7 2.x parser and generator.

@hl7 parser generator
Web Application Programming Interface (API)

- HTTP
  - Representational state transfer (REST)
  - Simple Object Access Protocol (SOAP)
- Payload data
  - Extensive Markup Language (XML)
  - JavaScript Object Notation (JSON)
  - HyperText Markup Language (HTML)
- Websocket
  - Industry lag
Web API

- Fast Healthcare Interoperability Resources (FHIR)
- Modeled after web application programming interface (API)

```javascript
axios({
  method: 'get',
  url: 'https://######.med.umich.edu/######/###/###.#####.########/#####/Patient/Medications',
  params: {
    patientId: req.body.MRN,
    patientIdType: 'MRN',
    userId: '####',
    userIdType: '#####',
    profileView: '3',
    numberDaysToIncludeDiscontinuedAndEndedOrders: '30',
  },
  headers: {
    'Accept': 'application/json',
    'Content-Type': 'application/json',
    'Authorization': 'Bearer [token]'  
  }
});
```

REST

JSON

- Name: "aspirin 81 mg chewable tablet"
  key: "1"
- Name: "omeprazole (PriLOSEC) 20 mg delayed release capsule"
  key: "2"
- Name: "NUM00008269 atorvastatin 2,318 mg in sodium chloride 8.9 % 432.72 ml infusion"
<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Reference Range</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>7.0</td>
<td>6.0 - 8.3</td>
<td></td>
</tr>
<tr>
<td>Albumin</td>
<td>4.6</td>
<td>3.5 - 4.9</td>
<td></td>
</tr>
<tr>
<td>AST</td>
<td>34</td>
<td>8 - 30</td>
<td></td>
</tr>
<tr>
<td>ALT</td>
<td>46</td>
<td>&lt;= 35</td>
<td></td>
</tr>
<tr>
<td>Alkaline Phosphatase</td>
<td>105</td>
<td>40 - 116</td>
<td></td>
</tr>
<tr>
<td>Bilirubin, Direct</td>
<td>0.4</td>
<td>0.0 - 0.3</td>
<td></td>
</tr>
<tr>
<td>Bilirubin, Total</td>
<td>1.1</td>
<td>0.2 - 1.2</td>
<td></td>
</tr>
</tbody>
</table>
Progress Notes

Flared: 1/4/2019 4:50 PM
Encounter Date: 1/2/2019 Status: Addendum

Encounter Date: 1/2/2019
Supervising Physician:

Subjective:

Hyper tension/Volume
Regarding hypertension, he is currently taking carvedilol 6.25 mg twice daily, eplerenone 50 mg daily, Losartan (brand name) 40 mg twice daily, hydralazine 10 mg twice daily, and metolazone 5 mg on Mon/Weds/Fri. He sees an outside cardiologist. Patient does not take medications that may worsen hypertension. He states he checks home BP infrequently as he goes to the doctor 3-4 times a month and readings have always been on the low side. He reports that generic torasemide resulted in previous hospitalization and is only able to take brand name medications. He denies any light-headedness, chest pain.

Hyper lipidaemia/CV Risk
Regarding hyperlipidaemia, he is currently taking atorvastatin 40 mg daily. Patient denies muscle aches or pains that are changed from baseline (chronic back pain).

Diabetes
Regarding diabetes, he is currently taking insulin glargine (Lantus) 35 units in the morning and insulin aspart three times a day using a sliding scale. He reports 2-3 episodes of symptomatic hypoglycemia in the past month. They all occurred overnight, and he is woken up due to cold sweats, dizziness. Hypoglycemia is treated by eating a peanut butter & jelly sandwich. He checks home blood sugars four times daily and recalls readings 99-114 in the mornings with pre-meal readings in the 100-200s. He states the 200s is infrequent.

Lifestyle
Not discussed in detail today.

Medication Management
Patient reports excellent adherence to prescribed medications with missed doses occurring rarely ever. Patient does use a pill box when on vacation. Otherwise, he uses a reminder method of storing his pills bottles above the refrigerator in a cabinet. Insurance is the primary source of paying for medications with some difficulty affording medications reported at this time (~$200-$400/month). Specifically, his insulin ($150/3 months) and some of his brand name medications. He is not interested in 30-day supplies of medications as he prefers the convenience fewer trips to the pharmacy of 90-day supplies.

Current Medication List
Outpatient Medications Prior to Visit
Medication Sig Dispense Refill
- amiodarone (CORVADONE, PACERONE) 200 mg tablet Take 200 mg by mouth two times daily.
- amlodipine (ELIQUIS) 5 mg tablet Take 5 mg by mouth two times daily.
- aprocin acid (VITAMIN C) 1,000 mg tablet Take 1 Tablet by mouth Daily tablet
- aspirin (ECOTRIN LOW STRENGTH) 81 mg delayed release tablet Take 1 Tablet. Delayed Release (E.C.) by mouth Daily
- atorvastatin (LIPITOR) 40 mg tablet Take 40 mg by mouth at bedtime.
- carvedilol (COREG) 6.25 mg tablet Take 6.25 mg by mouth two times daily.


date
Encounter Date: 1/2/2019
Supervising Physician: Dr. ############

Subjective:
### is a 67 y.o. male seen for Chronic kidney disease (CKD) Stage III and medication management.

- **Hypertension/Volume**: He is currently taking carvedilol 6.25 mg tw ice daily, eplerenone 50 mg daily, Lasix (brand name) 40 mg tw ice daily, hydralazine 10 mg tw ice daily, and metolazone 5 mg on Mon/Weds/Fri. He sees an outside cardiologist. Patient does not take medications that may worsen hypertension. He states he checks home BP infrequently as he goes to the doctor 3-4 times a month and readings have always been on the low side. He reports that generic furosemide resulted in a previous hospitalization and is only able to take brand name medications. He denies any light-headedness, chest pain.

- **Hyperlipidemia/CV Risk**: He is currently taking atorvastatin 40 mg daily. Patient denies muscle aches or pains that are changed from baseline (chronic back pain).

- **Diabetes**: He is currently taking insulin glargine (Lantus) 35 units in the morning and insulin aspart three times a day using a sliding scale. He reports 2-3 episodes of symptomatic hypoglycemia in the past month. They all occurred overnight, and he is woken up due to cold sweats, dizziness. Hypoglycemia is treated by eating a peanut butter & jelly sandwich. He checks home blood sugars four times daily and recalls readings 99-114 in the mornings with pre-meal readings in the 100-200s. He states the 200s are infrequent.

Lifestyle:
Not discussed in detail today.

Medication Management:
Patient reports excellent adherence to prescribed medications with missed doses occurring rarely ever. Patient does use a pill box when on vacation. Otherwise, he uses a reminder method of storing his pill bottles above the refrigerator in a cabinet. Insurance is the primary source of paying for medications with some difficulty affording medications reported at this time (~$200-400/month). Specifically, his insulin ($150/3 months) and some of his brand name medications. He is not interested in 30-day supplies of medications as he prefers the convenience (fewer trips to the pharmacy) of 90-day supplies.

Current Medication List:

**Outpatient Medications Prior to Visit**

- **amiodarone (CORDARONE, PACERONE)**: 200 mg tablet. Take 200 mg by mouth tw o times daily.
- **apixaban (ELIQUIS)**: 5 mg tablet. Take 5 mg by mouth tw o times daily.
- **ascorbic acid (VITAMIN C)**: 1,000 mg Tablet. Take 1 Tablet by mouth Daily tablet.
- **aspirin (ECOTRIN LOW STRENGTH)**: 81 mg delayed release tablet. Take 1 Tablet, Delayed Release (E.C.) by mouth Daily.
- **atorvastatin (LIPITOR)**: 40 mg tablet. Take 40 mg by mouth at bedtime.
- **carvedilol (COREG)**: 6.25 mg tablet. Take 6.25 mg by mouth tw o times daily. 0
- **cholecalciferol (VITAMIN D3)**: 400 unit capsule. Take 1 Capsule by mouth Daily capsule.
- **dipipanone 65.25 mg Tablet. Take 62.5 mg by mouth every other day.
- **eplerenone (INSPIRAN)**: 25 mg tablet. Take 2 tablets (50 mg) by mouth once daily. 180 tablet 4
- **fluticasone (FLONASE)**: 50 mcg/actuation nasal spray. Spray 1 spray into the nose tw o times daily.
- **furosemide (LASIX)**: 40 mg tablet. Take 1 Tablet by mouth Daily (Patient taking differently: Take 1 tablet by mouth every morning.).
- **hydrALAZINE (APRESOLINE)**: 10 mg tablet. Take 10 mg by mouth tw o times daily.
- **insulin aspart (NovoLOG)**: 100 unit/mL. Injection inject into the skin 3 times daily with meals. Use as directed per sliding scale. Maximum 40 units daily.
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>title</title>
  <link rel="stylesheet" href="style.css">
  <script src="script.js"></script>
</head>
<body>
  <!-- page content -->
</body>
</html>
Summary

• Federated database architecture
  – A popular strategy for healthcare information integration/exchange in addition to data lake and data hub
  – Unified view for child/subordinate database(s)
  – Real time data access
  – Single source of truth
  – Source data is not copied or moved

• Reverse Federation
  – Access of a federated repository in a direction opposite to the normally considered primary/subordinate linkage
  – An information integration/exchange strategy for SOA
Tuesday, May 7, 8:30 am in Grand Ballroom 1
Acknowledgement

• University of Michigan
  – Ulysses Balis MD
  – David McClintock MD
  – Christopher Williams MD

• University of Chicago
  – Paul Chang MD
Questions?
References


• https://www.himss.org/library/interoperability-health-information-exchange/environmental-scan/care-everywhere

• https://revcycleintelligence.com/features/how-hospital-merger-and-acquisition-activity-is-changing-healthcare


• https://corepointhealth.com/thank-you/future-interoperability-web-apis-fhir/


• www.ncbi.nlm.nih.gov/pmc/articles/PMC4371446/pdf/egems1060.pdf