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Enterprise Imaging
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Using HL7 FHIR to Integrate Structured Reporting Reports into an Open Source Medical Records System

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Background

The radiology report is the core tool of communication between radiologists and ordering clinicians. In the current healthcare delivery model, there is interaction with various departments and across multiple providers requiring interchange of the radiology reports. The MRRT (Management of Radiology Report Templates) profile developed by the Integrating the Healthcare Enterprise (IHE) radiology workgroup defines the format of radiology templates and the mechanism to query, retrieve and store the templates[1-4]. Various studies on the use of MRRT enabled reporting templates postulate a delivery model where there is a central repository of MRRT reports such as the RSNA radiology report template library[1-3] or a specialty focused repository of reports as proposed by the Society of interventional Radiology (SIR)[5]. The MRRT format would be queried by radiologists using a reporting system and loaded as a template that the radiologist can dictate into the fields. The completed report would then be saved into the radiology information system (RIS) and PACS and other applications in the enterprise.

Previous work using the MRRT profile described development of the standard and conversion of available reports from the RSNA report template library to the MRRT profile[6]. Vendors remain in the early phases of adoption of the MRRT standard, and the technical process of how to implement the profile is not documented. Various standards that allow exchange of clinical data include HL7 v1,v2 and v3; CDA (Clinical Document Architecture). FHIR (Fast Health Interoperability Resources) is a standard developed by HL7 to exchange data between clinical applications in a consistent, easy to implement and rigorous mechanism[7].

We describe a technical implementation of MRRT profile that allows exchange of MRRT generated reports with an open-source medical records system (OpenMRS) using actual CT Pulmonary embolism reports.

Case Presentation

We selected the CT Chest Pulmonary Embolism template from the RSNA report template library (http://www.radreport.org/template/0000116) to demonstrate the integration of the MRRT report into the open-source medical records system, OpenMRS. The template library is REST-enabled to support retrieval of reports by any system[8].

CT Chest Pulmonary Embolism
Intravenous contrast (agent and volume): [ ]

Clinical information: [ ]

Comparison: [None.]

Findings
Diagnostic quality: [Adequate | Suboptimal | Nondiagnostic]
Acute pulmonary embolism: [None | Yes]
Right heart strain: [None | Yes]
Pulmonary arteries: [Normal in caliber.]

Lung parenchyma: [Normal.]
Pleural effusion: [None.]
Central airways: [Normal.]

Adenopathy: [None.]
Heart and great vessels: [Normal.]

Upper abdomen: [Normal.]
Bones: [Normal.]

Impression
[No acute or chronic pulmonary embolism.]

Sample format of report

The MRRT report has a metadata section with various concept mappings for form elements, and a second body section with the actual reporting details presented as HTML5.

<!DOCTYPE html>
<html>
<head>
<meta charset="UTF-8"/>.
<meta content="CT Chest Pulmonary Embolism" name="dcterms.title"/>
<meta content="CT Chest Pulmonary Embolism template :: Authored by Heilbrun ME" name="dcterms.description"/>
<meta content="http://www.radreport.org/template/0000116" name="dcterms.identifier"/>
<meta content="en" name="dcterms.language"/>
<meta content="IMAGE_REPORT_TEMPLATE" name="dcterms.type"/>
<meta content="Radiological Society of North America (RSNA)" name="dcterms.publisher"/>
<meta content="May be used gratis, subject to license agreement" name="dcterms.rights"/>
<meta content="http://www.radreport.org/license.pdf" name="dcterms.license"/>
<meta content="2012-03-28" name="dcterms.date"/>
<meta content="Heilbrun ME" name="dcterms.creator"/>
<meta content="Kahn CE Jr [editor]" name="dcterms.contributor"/>
<link rel="stylesheet" type="text/css" href="IHE_Template_Style.css"/>
<!-- The absolute link to the CSS file is http://www.radreport.org/html/IHE_Template_Style.css -->
<script type="text/xml">
<!--
<template_attributes>
<top-level-flag>true</top-level-flag>
<status>ACTIVE</status>
<coding_schemes>
 <coding_scheme name="RadLex" designator="2.16.840.1.113883.6.256" />

```
 <coding_scheme name="SNOMEDCT" designator="2.16.840.1.113883.6.96" />
 <coding_scheme name="LOINC" designator="2.16.840.1.113883.6.1" />
</coding_schemes>
<term>
 <code meaning="computed tomography" value="RID10321" scheme="RadLex">
</term>
<term>
 <code meaning="pulmonary embolism" value="RID4834" scheme="RadLex">
</term>
<term>
 <code meaning="set of pulmonary arteries" value="RID28586" scheme="RadLex">
</term>
<term>
 <code meaning="thorax" value="RID1243" scheme="RadLex">
</term>
<term>
 <code meaning="thromboembolism" value="RID4837" scheme="RadLex">
</term>
<coded_content>
<entry ORIGTXT="T116_3">
 <term>
  <code meaning="contrast agent" value="RID11582" scheme="RadLex">
 </term>
</entry>
<entry ORIGTXT="T116_5">
 <term>
  <code meaning="clinical information" value="RID13166" scheme="RadLex">
 </term>
```

We converted the mapped concepts in the CT Chest PE MRRT template into observations that were composed of the mapping system (e.g. SNOMED or RadLex) , mapped code and the value of the concept. These observations were then populated into a diagnostic report as shown below. A script to automate the conversion of the MRRT template was programmed.

```
{
  "resourceType": "DiagnosticReport",
  "identifier": [{
"system": "http://www.radreport.org/template/0000116",
"value": "0000116"
  }],
  "status": "final",
  "category": {
"coding": [{
  "system": "http://hl7.org/fhir/v2/0074",
  "code": "RAD"
}]
  },
  "code": {
"coding": [
```

```
    {
     "system": "RadLex",
     "code": "RID10321",
     "display": "computed tomography"
    },
    {
     "system": "RadLex",
     "code": "RID4834",
     "display": "pulmonary embolism"
    }
  ],
  "text": "Chest CT for Pulmonary Embolism"
  },
  "subject": {
  "reference": "Patient/ba2674c5-9daa-11e5-b785-52540082e4b4"
  },
  "encounter": {
  "reference": "Encounter/example"
  },
  "effectiveDateTime": "2011-03-04T08:30:00+11:00",
  "issued": "2015-03-04T11:45:33+11:00",
  "performer": {
  "reference": "Practitioner/d5e9d067-998d-4707-b5b1-74a7e6f7214b",
  "display": "Indiana University Physicians group"
  },
  "contained": [
  {
   "resourceType": "Observation",
   "id": "r1",
   "code": {
    "coding": [
     {
      "system": "RadLex",
      "code": "RID12",
      "display": "Diagnostic quality:"
     }
    ],
    "text": "Diagnostic quality:"
   },
   "subject": {
    "reference": "Patient/ba2674c5-9daa-11e5-b785-52540082e4b4"
   },
   "performer": [
    {
     "reference": "Practitioner/d5e9d067-998d-4707-b5b1-74a7e6f7214b",
     "display": "Indiana University Physicians group"
    }
   ],
   "valueQuantity": {
```

```
    "value": "Adequate"
  }
}
],

  "result": [{
"reference": "#r1"
  }]
}
```


To consume the report in the electronic medical records system, we implemented a FHIR RAD profile into the OpenMRS. A concept dictionary with the MRRT coded concepts was implemented and mapped to RadLex[9], SNOMED[10] and LOINC[11].

FHIR handlers were used to process the incoming data, which was created as a new encounter within the patient record. The observations were saved as discrete data elements due to the granular nature of our structured report. A simple reporting tool in the EMR supported analysis of the imported MRRT data.

Outcome

We developed a FHIR-enabled EMR and a script to convert the MRRT template to a FHIR diagnostic report. To test the system, we used sample anonymized MRRT report data from 50 patients who underwent a CT arteriogram of the chest for pulmonary embolism. We then tested the process of data import from the MRRT reports into OpenMRS by performing queries to show number of patients with a positive pulmonary embolism, presence of right heart strain, and adequacy of contrast/diagnostic quality of the study and pulmonary artery size.

Discussion

We demonstrate a use case for implementing MRRT reports within an EMR using FHIR. We have developed a new layer in the proposed MRRT architecture that separates reporting process with the report authorship. The middleware that serves as the transport hub for MRRT report data and is enriched with FHIR profiles, thus providing a mechanism for different practices using different RIS, PACS and reporting software to share data. Such architecture would be useful as groups of specialists work towards a common data set for reporting, and also to make template updates easier by providing versioning of MRRT templates and FHIR reports.

Moreover the structure of MRRT involves concept/terminology mapping that provides discrete data elements that support processing of report elements to generate reports for quality initiatives. For example, our sample import mapped to RadLex terms allows you to establish the occurrence of heart strain and pulmonary artery enlargement in patients with acute pulmonary embolism. Given expansible nature of the MRRT template forms, a user can customize the template to include additional data elements like d-dimer or Wells score to ensure more accurate reports for patient care.

The consumption of the FHIR diagnostic report has a role in populating data registries that consume primarily discrete data elements. We have developed an open-source data registry with the same architecture to consume data reports tracking Y90 treatment patients

Conclusion

Implementation of FHIR-enabled transport middleware can provide a way for vendors to integrate radiology reports based on MRRT templates. The architecture of the health care enterprise in this case would support several REST-enabled MRRT template sources such as the RSNA reporting library (radreport.org) or specific institutional libraries. This would also provide some report authorship tools like terminology mapping, collaborative editing and versioning of report templates. These templates would be imported into reporting software and remain independent of the various software applications. Once the radiologist dictates the report and signs it, the study report generated from the MRRT templates would then be distributed across multiple data recipients including registries, RIS and PACS systems. Given terminology mapping of discrete data elements, the imported data could be analyzed to answer various clinical questions.

References

1. IHE, Management of Radiology Report Templates - IHE. 2013.
2. Committee, I.R.T., Management of Radiology Report Templates (MRRT). Integrating the Healthcare Enterprise, 2013. 11.
3. RadReport.org: Radiology Reporting Templates. 2007; Available from: http://www.radreport.org/.
4. Kahn, C. Information Technology in Radiology (Structured Reporting). 1970. European Congress of Radiology 2015.
5. Durack, J.C., The value proposition of structured reporting in interventional radiology. American Journal of Roentgenology, 2014. 203(4): p. 734-738.
6. Cramer, J.A., et al., Structured and templated reporting: An overview.
7. DSTU. Welcome to FHIR 2014; V0. 0.82:
8. Genereaux, B. and D. Dennison, REST Enabling the Report Template Library. Journal of Digital Imaging, 2014. 27(3): p. 331-336.
9. Langlotz, C.P., RadLex: A New Method for Indexing Online Educational Materials. RadioGraphics, 2006. 26(6): p. 1595-1597.
10. Spackman, K.A., K.E. Campbell, and R.A. Côté, SNOMED RT: a reference terminology for health care. Proceedings of the AMIA Annual Fall Symposium, 1997: p. 640-644.
11. McDonald, C.J., et al., LOINC, a Universal Standard for Identifying Laboratory Observations: A 5-Year Update. Clinical Chemistry, 2003. 49(4): p. 624-633

Keywords

MRRT, FHIR, Open Source, Structured Reporting