Feeding FHIR with LHC-Forms

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Mt. Washington Conference Center
Baltimore, MD
October 19, 2016
What is LHC-forms and what can it do?
LHC-Forms is Powerful

https://lhncbc.nlm.nih.gov/project/lforms

- A fast, web based open source JavaScript program (300kB) generates live forms on-the-fly using JSON form descriptions.

- Accommodates nested groups and repeating groups of questions (e.g. Surgeon General’s Family Health History).

- Has all of the usual form functions -- Skip logic, rich validation checks, auto complete menus, score calculation, other calculations

- Answer lists displayed as columnated grid with autocomplete functions.

- Many different layout styles and responsive design that fits any screen size.

- Some examples follow
LHC-Forms are standards oriented

- All LOINC 2000+ LOINC panels are LHC forms.
  - Same for most of NLM’s Common Data Elements (CDEs) – not all LOINC.
    - NIH Common Data Elements (CDE) Repository: https://cde.nlm.nih.gov/home

- Form questions modeled after to HL7 observations with data types, cardinality, units of measure for quantities and answer lists for ordinal variables.

- Has external (standard) vocabulary tables (e.g. RxNorm, LOINC, ICD, many genomic standards) with auto-complete service.

- LHC-Forms service (https://lhncbc.nlm.nih.gov/project/lforms) generates HL7 v2 messages from entered data.

- Via SMART, can link to patient resource (now), and deliver captured data to FHIR resource(s). (Stay tuned for today’s demo.)
Lots of rich form (questionnaire content) in LOINC

- Most CMS forms (OASIS, MDS, Dialysis) and CMS is organizing all of their assessment instruments around LOINC (e.g. CDC birth and death certificates).
- Lots of psychosocial surveys (e.g. PROMIS, Neuro-QOL), Clinical structures, ventilator variables, 12-lead EKG, Pulmonary function tests (Mayo), cardiac echos (DICOM), Nursing instruments (ANA), Lab panels, Ophthalmology measures (NEI), etc.
Associated Tools Services

- Form builder for creating new forms and editing old ones
- Docker for delivering packages.
- JSON Schema for LHC-Forms.
  - Item: [https://github.com/lhncbc/lforms-validator/blob/master/lforms-item-schema.json](https://github.com/lhncbc/lforms-validator/blob/master/lforms-item-schema.json)
- Clinical table linker- provides machinery for questions whose answers come from external tables
  - “Secret sauce”: via URL, implementer can specify what fields are searched, which are returned as part of columnated grid, and which are stored in the value field as hidden variables
  - Other fields in the form can use these hidden variables as answer lists, default values or help messages -- will demonstrate.
LHC-Forms Demo Screenshots

- Matrix
- Nested and repeating groups
- Score computation
- Auto-complete
- Auto defaults
### Matrix Legend showing PROMIS Social isolation panel

#### PROMIS item bank - social isolation - version 2.0

<table>
<thead>
<tr>
<th>Date Done</th>
<th>Time Done</th>
<th>Where Done</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM/DD/YYYY</td>
<td>Type a value</td>
<td>Select or type a value</td>
<td>Type a value</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>People get the wrong idea about my situation</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Usually</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel isolated even when I am not alone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that people avoid talking to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel detached from other people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that some of my friends avoid me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that some of my family members avoid me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that I am alone in my interests and ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that people barely know me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel like a stranger to those around me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find that friends or relatives have difficulty talking with me about my health</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that people are around me but not with me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel isolated from others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Nested and Repeating Groups

Surgeon General’s family health history as an LHC-Form
Survey Score Computed On-the-Fly (PHQ-4) ©

The form computes the total score as one answers the questions.
Choice menu presented as grid from NCBI’s database of Genetic variations panel

<table>
<thead>
<tr>
<th>Name</th>
<th>Variant ID</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>NM_015713.4(RRM2B):c.322-2A&gt;G</td>
<td>5387</td>
<td>RRM2B-related mitochondrial disease</td>
</tr>
<tr>
<td>NM_000059.3(BRCA2):c.5946delT (p.Ser1982Argfs)</td>
<td>9325</td>
<td>Pancreatic cancer 2</td>
</tr>
<tr>
<td>NM_000059.3(BRCA2):c.6275_6276delTT (p.Leu2092Profs)</td>
<td>9318</td>
<td>Breast-ovarian cancer, familial 2</td>
</tr>
<tr>
<td>NM_000465.3(BARD1):c.1670G&gt;C (p.Cys557Ser)</td>
<td>8045</td>
<td>Familial cancer of breast</td>
</tr>
<tr>
<td>NM_007194.3(CHK2):c.470T&gt;C (p.Ile157Thr)</td>
<td>5591</td>
<td>Li-Fraumeni syndrome 2</td>
</tr>
<tr>
<td>NM_007194.3(CHK2):c.541C&gt;T (p.Arg181Cys)</td>
<td>5597</td>
<td>Familial cancer of breast</td>
</tr>
</tbody>
</table>

[Table continued]
**Automatic details from hidden fields**

**HL7 draft genetic test reporting form**

Describes an approach being explored in HL7 Clinical Genomics work group.
HL7 message generated from completion of genetics form

(only top 2/3ds showing)
Form Builder Demo Screenshots
LHC Form Builder

Editing LOINC: 72513-5 Vital signs with smoking status and pain scale [VSP]
After selecting a starter form

- List of all of the form questions at the start and their hierarchy
- User can add questions or remove levels and re-order questions within a level
- Detailed attributes about the current question: in this case, the first one in the hierarchy. Can edit cardinality, skip logic, validation checks etc.
- Full live form for what has been created so far. Will look just like it would look in real use. This space can also show the JSON output that underlie the form
- Clicked on one variable, BP diastolic
- Shows Controls for managing cardinality
- Input required
- Data type
- Default value
- Formula
- Show/Hide rules (Skip logic)
The FHIR connection
What is working

- Using SMART on FHIR
  - Can pull up form service from https://gallery.smarthealthit.org/
    - Very fast -- all with native FHIR resources.
    - Provides an ecosystem for LOINC.
  - Steps
    - Pick a patient from the sample patient registry file.
    - Pick a form.
    - Enter data.
    - Store it in the Diagnostic report resource -- using related observations as needed to implement that hierarchical – and repeating – group structure
    - Retrieve it and view it back in the form.
    - Inspect V2 message.
    - Inspect FHIR message.
LHC-Forms on FHIR

https://gallery.smarthealthit.org/
https://gallery.smarthealthit.org/

LHC-Forms on FHIR

Author: Lister Hill National Center for Biomedical Communications (LHNCBC)
Website: https://forms-demo.nlm.nih.gov
Last Update: Monday, October 17, 2016
Tags: Clinical Care, Diagnoses, Clinical Data Capture, Featured

App Description

LHC-Forms (a.k.a. LForms) is a lightweight, feature-rich, open-source widget that creates input forms for web-based medical applications or to integrate into electronic health records (EHRs), personal health records (PHRs), and mobile health apps.

Related Apps

Other apps by Lister Hill National Center for Biomedical Communications (LHNCBC)

No other apps found
SMART on FHIR Demo with LOINC Panels/Forms

Name: Deborah Adams  Gender: female  DoB: 1946-01-09  ID: hca-pat-18

Featured LOINC Panels/Forms
- US Surgeon General family health portrait
- Vital signs panel
- Short blood count panel
- HL7 Genetic Variant Reporting Panel
- HL7 Genetic Variant Reporting Panel (table version)

Please select a LOINC Panel/Form from left side.
### SMART on FHIR Demo with LOINC Panels/Forms

**Name:** Deborah Adams  
**Gender:** Female  
**DOB:** 1948-01-09  
**ID:** hca-pat6-18

#### Featured LOINC Panels/Forms
- **US Surgeon General family health portrait**
- Vital signs panel
- Short blood count panel
- HL7 Generic: Variant Reporting Panel
- HL7 Genetic: Variant Reporting Panel (table version)

#### US Surgeon General family health portrait

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMD0YYYYY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>My health history</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Type a value</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Select one</td>
<td></td>
</tr>
<tr>
<td>Birth Date</td>
<td>MMD0YYYYY [mm/dd/yyyy]</td>
<td></td>
</tr>
<tr>
<td>Tnull</td>
<td>Select one</td>
<td></td>
</tr>
<tr>
<td>Adopted</td>
<td>Select one</td>
<td></td>
</tr>
<tr>
<td>Parents related</td>
<td>Select one</td>
<td></td>
</tr>
<tr>
<td>Body height</td>
<td>Type a value</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Type a value</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>Select one or more</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Select one or more</td>
<td></td>
</tr>
</tbody>
</table>

**Diseases history panel**

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of diseases</td>
<td>Search for value</td>
<td></td>
</tr>
<tr>
<td>Age range at onset of disease</td>
<td>Select one</td>
<td></td>
</tr>
</tbody>
</table>

**Add another "Diseases history panel"**

**Family member health history**
Issues and Plans
Issues

- Observations are all packaged in the Diagnostic report resource.
- Too slow to move into observation.
- But currently no option to search by observation ID in that resource.
- To put them in the observation resource requires requesting a new observation instance ID from that resource, then tying it into the diagnostic report and then storing the observation into the observation resource. With current hardware, it can take 2 seconds per observation. Would not be tolerable to user.
Lots of challenges with complicated objects whose attributes are treated as individual fields on most real world forms.

- Date and time usually entered separately not as one big time stamp
- Provider ID entered separately not (usually) as a package with many separate fields.
- Telephones etc. rarely entered with all of the paraphernalia.
- Even quantities present problems -- easier to use string and regular expressions for many cases (Will make a value- and units object soon)
To do

- Link to provider, orders, encounter and depending on which one is chosen pull the other info from that resource.
- Solve the slow observation store problem.
- Provide report date and deal better with effective date.
URLs for exploring
(Ye Wang, Paul Lynch, Ajay Kanduru, Lee Mericle, Clem McDonald)

- Well-connected data input form (LHC-Forms)
  - Project page:  [https://lhncbc.nlm.nih.gov/project/lforms](https://lhncbc.nlm.nih.gov/project/lforms)
  - Software download and documentation:  [https://github.com/lhncbc/lforms](https://github.com/lhncbc/lforms)

- Lister Hill Clinical Table Search Service (aka Autocompleter/Table Connector)
  -  [http://lhncbc.github.io/autocomplete-lhc](http://lhncbc.github.io/autocomplete-lhc)
  -  [https://github.com/lhncbc/autocomplete-lhc](https://github.com/lhncbc/autocomplete-lhc)

- Form Builder

- Units of measure (UCUM) validator and converter
  -  [http://lhncbc.github.io/ucum-lhc](http://lhncbc.github.io/ucum-lhc)

- LHC-Forms on FHIR  [https://gallery.smarthealthit.org/](https://gallery.smarthealthit.org/)