Feeding FHIR with LHC-Forms

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What is LHC-Forms and what can it do?
LHC-Forms- how it works and what it can do?

- A fast, web based and MU standards based, open source JavaScript program (300kB) generates live forms from JSON form descriptions on the fly.
- Accommodates nested groups and repeating groups of questions.
- Has all of the usual form functions: Skip logic, rich validation checks, auto complete menus, score calculation, etc.
- Many different layout styles and a responsive design that fits any screen size.
Associated Tools Services

- Form builder for creating new forms and editing old ones
- Clinical table linker provides auto complete look-up for questions whose answers come from external tables
- All LOINC panels are LHC forms (most LHC forms are LOINC panels)
- Implements FHIR questionnaire plus a bit more
- Can store captured data as:
  - FHIR Questionnaire responses
  - FHIR Diagnostic reports
  - HL7 Messages
- Docker for delivering packages
- Units validation and converter package
- See last slide for access to code and demo pages
Secret Sauce in Clinical table linker

- Via the URL, users can specify what fields in the external table are searched, and which answers are returned as part of selection grid, and which are stored in the index value field as hidden variables.
- Other fields in the form can use these hidden variables as answer lists, default values, or help messages.
- Explore the tables we have created so far at: [https://clin-table-search.lhc.nlm.nih.gov/](https://clin-table-search.lhc.nlm.nih.gov/)
- Tables include IDC9, ICD10, genetic tables (ClinVar, dbSNP, etc.), RxTerms, NPI (coming soon), etc.
LHC forms are standards based

- All 2000+ LOINC panels including hundreds of validated surveys. Are LHC forms
- NIH’s Common Data elements can be presented as LHC forms: https://cde.nlm.nih.gov/home
- LHC on FHIR
- Form is also a FHIR questionnaire (plus)
- Can generate FHIR questionnaire responses FHIR Diagnostic reports (mostly but not limited to SMART on FHIR) or HL7 V2 messages,
- UCUM for units of measure
- Tied to many external, MU Standard and genetic standard coding system NPI coming
Lots of rich survey instruments and assessments available as LOINC forms

- Most CMS clinical forms (OASIS, MDS 3.0 nursing home assessments, dialysis reports) are represented as LOINC panels/forms.
  - CMS is unifying all of its assessments as LOINC forms with LOINC codes-some which will use the LOINC codes for existing CMS data items where possible and obtain new ones when needed
- CDC standard forms for birth and death certificates are LOINC forms
- Lots and lots of psychosocial surveys
  - PHQ, PROMIS,
- Lots of clinical test panels and nursing assessment forms
- Ventilator variables, 12 lead EKG, Pulmonary function tests (Mayo), cardiac echoes (DICOM), Lab panels, Ophthalmology measures (NEI), etc., etc.
Examples


- Will show live examples of
  - PHQ-4 form – Demo – Score calculation
  - Surgeon General’s family health history (Demo - repeats of many questions and skip logic)
  - Form for reporting genetic results (represents early draft of HL7 genetic message proposal demo):
  - Using LHC form to implement an application
    - PHR lite
Surgeon Generals family health history as an LHC-Form

Multiple levels of nesting - Proband can have many diagnoses with dates AND many relatives who also have many diagnoses and dates
PHQ-9 Depression survey with score computed on the fly

As an LHC-Form

Secret sauce: Code stored in one field can generate code answer lists for succeeding fields— to be illustrated on the PHR form.

Enter Lasix oral and get selection menu of available pill sizes.
Choices of combo boxes, radio buttons, check boxes and grids when appropriate.
Can enter multiple fields in one field (or as separate fields illustrated with PHR)

- Medications assessed [51963-7]
  - Ampicillin
  - Coumarin

- Gene(s) assessed [48018-6]
  - CFTR
  - AAGAB
  - FDXACB1

Make multiple sections in one field. Remove them by clicking on x.
Secret sauce: record for Id in one field generates defaults for others

Before

After
Responsive design-example from HL7 V2 genetics reporting form

<table>
<thead>
<tr>
<th>Wide screen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full narrative report [51969-4]</strong></td>
</tr>
<tr>
<td><strong>Variant ISCN [81291-7]</strong></td>
</tr>
<tr>
<td><strong>Versions of Coding Systems [divider04t]</strong></td>
</tr>
<tr>
<td><strong>Human reference sequence assembly [62374-4]</strong></td>
</tr>
<tr>
<td>NCBI35, GRCh37, OTHER:</td>
</tr>
<tr>
<td><strong>HGVs version [ID] [81303-0]</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skinny screen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variant ISCN [81291-7]</strong></td>
</tr>
<tr>
<td><strong>Versions of Coding Systems [divider04t]</strong></td>
</tr>
<tr>
<td><strong>Human reference sequence assembly [62374-4]</strong></td>
</tr>
<tr>
<td>NCBI35, GRCh37, OTHER:</td>
</tr>
<tr>
<td><strong>HGVs version [ID] [81303-0]</strong></td>
</tr>
</tbody>
</table>
Lots of options at the top of the LHC demo page to show different features - won’t dwell on them.
Making Applications from forms – Implemented PHR close to what it was in previous Ruby on Rails applications (will demo)

### Personal Health Record

#### Medical Conditions

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Status</th>
<th>Started</th>
<th>Stopped</th>
<th>Description/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>Active</td>
<td>04/20/2016</td>
<td>04/22/2016</td>
<td>Sounds anginal. Worsen with exertion, but young and no family history</td>
</tr>
<tr>
<td>Pneumonia - bronchial</td>
<td>Inactive</td>
<td>03/17/2017</td>
<td>04/22/2016</td>
<td>Treated with Zpack on ambulatory basis</td>
</tr>
<tr>
<td>Hay fever (allergic rhinitis)</td>
<td>Active</td>
<td>03/20/2012</td>
<td>MM/DD/YYYY</td>
<td>Every spring</td>
</tr>
<tr>
<td>bad</td>
<td>Select one or type a value</td>
<td>MM/DD/YYYY</td>
<td>MM/DD/YYYY</td>
<td>Type a value</td>
</tr>
</tbody>
</table>

#### Medications

<table>
<thead>
<tr>
<th>Medication name</th>
<th>Status</th>
<th>Strength</th>
<th>Instructions</th>
<th>Started</th>
<th>Stopped</th>
<th>Why stopped</th>
<th>Resupply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z.PAK (Pack)</td>
<td>Stopped</td>
<td>mixed Pack</td>
<td>take until gone</td>
<td>03/17/2016</td>
<td>04/22/2016</td>
<td>Finished the prescription</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>Beclomethasone (Nasal)</td>
<td>Active</td>
<td>40 mcg puff Metered dose spray</td>
<td>1 puff twice day in season</td>
<td>03/20/2012</td>
<td>MM/DD/YYYY</td>
<td>Select one or type a value</td>
<td>MM/DD/YYYY</td>
</tr>
</tbody>
</table>

#### Allergies and Other Dangerous Reactions

<table>
<thead>
<tr>
<th>Allergy</th>
<th>Reaction</th>
<th>Started</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollen</td>
<td>Sneezing or stuffy nose</td>
<td>03/15/2017</td>
<td>Worse when maple trees bloom</td>
</tr>
<tr>
<td>Select one or type a value</td>
<td>MM/DD/YYYY</td>
<td>Type a value</td>
<td></td>
</tr>
</tbody>
</table>
HL7 message generated from completion of genetics form - only top 2/3ds showing (Hand out)
LHC form producing Diagnostic report JSON and or questionnaire response For delivery to FHIR server (Handout)
Form Builder
After selecting a starter form

- List of all 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 underlies the form.
- Clicked on one variable, BP diastolic
- Shows Controls for managing cardinality
- Input required
- Data type
- Default value
- Formulae
- Show/Hide rules (Skip logic)
The FHIR connection
What is working

- **Using Smart on FHIR**
  - Can pull up form service,
    - 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 if and view it - back in the form
    - Provides an ecosystem for LHC forms and LOINC panels
    - Questionnaire response is other option – But most panel/survey kind of data will have to be converted to a diagnostic study to be usefully absorbed in an EMR
LHC-Forms on FHIR

Author: Lister Hill National Center for Biomedical Communications (LHN CBC)
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 light-weight, 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 (LHN CBC)
No other apps found
LHC-Forms (a.k.a. LForms)

LHC-Forms are part of the SMART on FHIR Initiative that offers open-source forms for Web-based medical applications or to integrate into electronic health records (EHRs), personal health records (PHRs), and mobile health apps.

Select Sample Patient

<table>
<thead>
<tr>
<th>Gender</th>
<th>Name</th>
<th>Family Name</th>
<th>Born</th>
</tr>
</thead>
<tbody>
<tr>
<td>🌸♀</td>
<td>Brittany Ackerman</td>
<td>Ackerman</td>
<td>1942-11-09</td>
</tr>
<tr>
<td>♂♂</td>
<td>Daniel X. Adams</td>
<td>Adams</td>
<td>1925-12-23</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Deborah Adams</td>
<td>Adams</td>
<td>1948-01-09</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Emilie Adams</td>
<td>Adams</td>
<td>1935-09-22</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Aaron Alexis</td>
<td>Alexis</td>
<td>1989-10-26</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Carol G. Allen</td>
<td>Allen</td>
<td>1963-12-26</td>
</tr>
<tr>
<td>♂♂</td>
<td>Beryl Bachmann</td>
<td>Bachmann</td>
<td>1974-02-13</td>
</tr>
<tr>
<td>♂♂</td>
<td>Paulene Bachmann</td>
<td>Bachmann</td>
<td>1985-02-02</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Megda Bachmann</td>
<td>Bachmann</td>
<td>1937-02-15</td>
</tr>
<tr>
<td>🌸♀</td>
<td>Trudy Belson</td>
<td>Belson</td>
<td>1945-08-30</td>
</tr>
</tbody>
</table>

Patients 1 to 10 of 176

1 patient selected

OK  Cancel
SMART on FHIR Demo with LOINC Panels/Forms

Name: Deborah Adams
Gender: female
DoB: 1948-01-09
ID: hca-pat-18

Please select a LOINC Panel/Form from left side.

- 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)
LHC-Forms

- Project page: https://lhncbc.nlm.nih.gov/project/lforms
- Software download and documentation: https://github.com/lhncbc/lforms
- Demo site: https://lhc-forms.lhc.nlm.nih.gov/

Lister Hill Table Connector (aka Autocompleter)

- http://lhncbc.github.io/autocomplete-lhc
- https://github.com/lhncbc/autocomplete-lhc

Form Builder


Units of measure (UCUM) validator and converter

- http://lhncbc.github.io/ucum-lhc/
JSON & Screenshot of genetic form (use Chrome)

- Form as FHIR Questionnaire: [http://lhncbc.github.io/lforms/samples/genetic-panel/fhir-questionnaire.json](http://lhncbc.github.io/lforms/samples/genetic-panel/fhir-questionnaire.json)