

Feeding FHIR with LHC-Forms

Clement J. McDonald, MD
Director, Lister Hill Center

Ye Wang, Paul Lynch, and Ajay Kanduru
LHC-Forms software engineers

National Library of Medicine, NIH

HL7 Partners in Interoperability
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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.
 - ❖ Form: <https://github.com/lhncbc/lforms-validator/blob/master/lforms-form-schema.json>
 - ❖ Item: <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
<https://clin-table-search.lhc.nlm.nih.gov/>
 - ❖ 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 ©					
Date Done	Time Done	Where Done	Comment		
MM/DD/YYYY	Type a value	Select or type a value ▼	Type a value		
	Never	Rarely	Sometimes	Usually	Always
People get the wrong idea about my situation ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel isolated even when I am not alone ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that people avoid talking to me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel detached from other people ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that some of my friends avoid me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that some of my family members avoid me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I am alone in my interests and ideas ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that people barely know me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel like a stranger to those around me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find that friends or relatives have difficulty talking with me about my health ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that people are around me but not with me ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel isolated from others ©	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Nested and Repeating Groups

Surgeon General's family health history as an LHC-Form

Date Done	Time Done	Where Done	Comment
MM/DD/YYYY	Type a value	Select or type a value	Type a value
Name		Value	Units
My health history [54128-8]			
Name [54125-0]		Mr good doctor	
Gender [54131-8]		Male	
Birth Date [21112-8]		12/16/1944	{mm/dd/yyyy}
Twin [54132-8]		No	
Adopted [54128-4]		Yes	
Parents related [54135-9]		No	
Body height [8302-2]		70	
Weight [29463-7]		70	
Race [54134-2]		2106-3. White	
Ethnicity [54133-4]		Unknown/No answer	
1.1 Diseases history panel [54137-5] -			
History of diseases [54140-9]		Diabetes - type 2 (adult, non-insulin-independent)	
Age range at onset of disease [54130-0]		30-39	
1.2 Diseases history panel [54137-5] -			
History of diseases [54140-9]		Congestive heart failure (CHF)	
Age range at onset of disease [54130-0]		OVER 60	
Add another 'Diseases history panel'			
1 Family member health history [54114-4]			
Relationship to patient [54138-7] ?		GRNDDAU. Granddaughter	
Name [54138-3]		Mary	
Gender [54123-5]		Female	
Living? [54139-1]		Yes	
Date of Birth [54124-3]		12/20/1190	{mm/dd/yyyy}
Current Age [54141-7]		Type a number	a
Twin [54121-9]		No	
Adopted [54122-7]		No	

multiple repeats per person recording

Survey Score Computed On-the-Fly (PHQ-4) ©

Display Question Code
 Show Help/Description
 Keyboard Navigation On Input Fields
 Total # of Questions: 5

Patient health questionnaire 4 item ©			
Date Done	Time Done	Where Done	Comment
MM/DD/YYYY	Type a value	Select or type a value ▼	Type a value
Name	Value		Units
— Feeling nervous, anxious or on edge ©	2. More than half the days		
— Over the past 2 weeks have you not been able to stop or control worrying	Not at all		
— Little interest or pleasure in doing things? ©	2. More than half the days		
— Feeling down, depressed, or hopeless? ©	2. More than half the days		
— Patient health questionnaire 4 item total score ? ©	6		

the form computes the total score as one answers the questions.

Choice menu presented as grid from NCBI's database of Genetic variations panel

Simple Small Variants Section

1 Simple genetic variant panel

Simple variant

Transcript specification

Gene studied

Transcript RefSeq ID

DNA change c.HGVS

Amino acid change p.HGVS

DNA change type

Amino acid change type

Genomic specification

Genomic reference sequence

bre| ☰

Name	Variant ID	Phenotype
NM_015713.4(RRM2B):c.322-2A>G	5387	RRM2B-related mitochondrial disease
NM_000059.3(BRCA2):c.5946delT (p.Ser1982Argfs)	9325	Pancreatic cancer 2
NM_000059.3(BRCA2):c.6275_6276delTT (p.Leu2092Profs)	9318	Breast-ovarian cancer, familial 2
NM_000465.3(BARD1):c.1670G>C (p.Cys557Ser)	8045	Familial cancer of breast
NM_007194.3(CHEK2):c.470T>C (p.Ile157Thr)	5591	Li-Fraumeni syndrome 2
NM_007194.3(CHEK2):c.541C>T (p.Arg181Cys)	5597	Familial cancer of breast
NM_015713.4(RRM2B):c.329G>A (p.Arg110His)	5393	RRM2B-related mitochondrial disease

[See more items \(Ctl Ret\)](#)

7 of 8692 total; 2685 bytes in 14 ms

Automatic details from hidden fields

HL7 draft genetic test reporting form

Describes an approach being explored in HL7 Clinical Genomics work group

Genetic analysis overall interpretation: Positive

Simple Small Variants Section

1 Simple variants

Variant ID: Search for value

Variant name: NM_000492.3(CFTR):c.1400T>C (p.Leu467Pro)

Variant specifics

Type	Gene	NM_RefSeq	DNA change	AA change	NC/NG_RefSeq	Ref allele	Allele loc	Alt allele
SNP	CFTR	NM_000492.3	c.1400T>C	p.Leu467Pro	NC_000007.13	T	11719952	C

Allelic Frequency NFR: Type a number

Cytogenetic location: 7q31.2

Allelic state: Select one

Clinical significance: Select one or type a value

Possible associated phenotype: Cystic fibrosis

2 Simple variants

Variant ID: 35830

Variant name: NM_000492.3(CFTR):c.1684G>A (p.Val562Ile)

Variant specifics

Type	Gene	NM_RefSeq	DNA change	AA change	NC/NG_RefSeq	Ref allele	Allele loc	Alt allele
SNP	CFTR	NM_000492.3	c.1684G>A	p.Val562Ile	NC_000007.13	G	11723041	A

Allelic Frequency NFR: Type a number

Cytogenetic location: 7q31.2

Allelic state: Select one

Clinical significance: Select one or type a value

Possible associated phenotype: Cystic fibrosis

HL7 message generated from completion of genetics form

(only top 2/3ds
showing)

```
OBR|1|X1000-U^HL7 Genetic Test Panel for Variants - 20160322^LN|
OBX|1|CNE|XXXXX-12^Choose kind of mutations targeted^LN|1|C01^Simple variants^LN~C02^Complex
variants^LN|
OBX|2|CNE|XXXXX-10^Choose region of interest specification^LN|1|C01^Specific targeted mutations^LN|
OBX|3|CWE|51967-8^Genetic disease assessed^LN|1|C0010674^Cystic fibrosis^LN|
OBX|4|CNE|48002-0^Genomic source class^LN|1|LA6683-2^Germline^LN|
OBX|5|CNE|48018-6^Gene(s) examined^LN|1|1884^CFTR^LN|
OBX|6|CNE|51968-6^Genetic analysis overall interpretation^LN|1|LA6576-8^Positive^LN|
OBR|2|XXXXX-9^Simple variants^LN|
OBX|1|CNE|XXXXX-5^Variant ID^LN|1.1|44487^35823^LN|
OBX|2|ST|XXXXX-13^Variant name^LN|1.1|NM_000492.3(CFTR):c.1400T>C (p.Leu467Pro)|
OBR|3|XXXX1-1^Variant specifics^LN|
OBX|1|CNE|XXXXX-19^Type^LN|1.1.1|SNP^SNP^LN|
OBX|2|CNE|48018-6^Gene^LN|1.1.1|44487^CFTR^LN|
OBX|3|CNE|48013-7^NM_RefSeq^LN|1.1.1|44487^NM_000492.3^LN|
OBX|4|CNE|41103-3^DNA change^LN|1.1.1|44487^c.1400T>C^LN|
OBX|5|CNE|48005-3^AA change^LN|1.1.1|44487^p.Leu467Pro^LN|
OBX|6|ST|XXXXX-17^NC/NG_RefSeq^LN|1.1.1|NC_000007.13|
OBX|7|ST|69547-8^Ref allele^LN|1.1.1|T|
OBX|8|ST|X0029^Allele loc^LN|1.1.1|117199525|
OBX|9|ST|69551-0^Alt allele^LN|1.1.1|C|
OBX|3|CWE|X1001-0^Cytogenetic location^LN|1.1|44487^7q31.2^LN|
OBX|4|CWE|X1002-0^Possible associated phenotype^LN|1.1|C0010674^Cystic fibrosis^LN|
OBR|4|XXXXX-9^Simple variants^LN|
OBX|1|CNE|XXXXX-5^Variant ID^LN|2.1|44494^35830^LN|
OBX|2|ST|XXXXX-13^Variant name^LN|2.1|NM_000492.3(CFTR):c.1684G>A (p.Val562Ile)|
OBR|5|XXXX1-1^Variant specifics^LN|
OBX|1|CNE|XXXXX-19^Type^LN|2.1.1|SNP^SNP^LN|
OBX|2|CNE|48018-6^Gene^LN|2.1.1|44494^CFTR^LN|
OBX|3|CNE|48013-7^NM_RefSeq^LN|2.1.1|44494^NM_000492.3^LN|
OBX|4|CNE|41103-3^DNA change^LN|2.1.1|44494^c.1684G>A^LN|
OBX|5|CNE|48005-3^AA change^LN|2.1.1|44494^p.Val562Ile^LN|
OBX|6|ST|XXXXX-17^NC/NG_RefSeq^LN|2.1.1|NC_000007.13|
```

Form Builder Demo Screenshots

LHC Form Builder

Editing LOINC: 72513-5 Vital signs with smoking status and pain scale [VSP]

Form Builder

Save to file | Load from file

Title

ADD NEW OR IMPORT FROM LOINC

1 Vital signs with ...

- 1.1 Body temperature
- 1.2 BP dias
- 1.3 BP sys
- 1.4 Heart rate
- 1.5 Body height
- 1.6 Resp rate
- 1.7 Weight Measured
- 1.8 Head Circumf OFC ...
- 1.9 Tobac smoke stat ...
- 1.10 Pain severity 0-1...

1.9 Tobac smoke stat NHIS [72166-2]

Name	Value	Units
Text	Tobac smoke stat NHIS	
Coding System	LOINC	
Code	72166-2	
Local code	Type a value	
Question instructions	Type a value	
Repeat this item?	No	
Editable	Editable	
Answer required?	No	
Type	List with no exceptions (CNE	
1 Answer item		
Answer text	Current every day smoker	
Answer code	LA18976-3	
Answer label	Type a value	
Score	Type a number	

PREVIEW WIDGET

Name	Value	Units
Vital signs with smoking status and pain scale		
Body temperature	Type a number	Cel
BP dias	Type a number	mm[Hg]
BP sys	Type a number	mm[Hg]
Heart rate	Type a number	{beats}/min
Body height	Type a number	[in_i]
Resp rate	Type a number	{breaths}/m
Weight Measured	Type a number	[lb_av]
Head Circumf OFC by Tape measure	Type a number	cm
Tobac smoke stat NHIS	Select one	
Pain severity 0-10 Score Reported	Select one	

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 heirarchy. 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

For

Save

Title

AD

INC

- 1 Vital signs, weig...
- 1.1 SaO2 % BldC Oximetry
- 1.2 Weight Measured
- 1.3 Head Circumf OFC ...
- 1.4 Bdy height
- 1.5 Bdy height lying
- 1.6 Body temperature
- 1.7 BP dias
- 1.8 BP sys
- 1.9 Heart rate
- 1.10 Resp rate
- 1.11 BSA Derived
- 1.12 BMI

Name	Value	Units
Text ?	Vital signs, weight, height, h	
Coding System ?	LOINC	
Code ?	74728-7	
Local code ?	Type a value	
Question instructions ?	This panel was created to co	
Repeat this item? ?	Select one	
Add conditional show/hide logic? ?	No	

Name	Value	Units
Vital signs, weight, height, head circumference, oximetry, BMI, & BSA panel ?		
SaO2 % BldC Oximetry	Type a number	%
Weight Measured	Type a value	
Head Circumf OFC by Tape measure	Type a number	cm
Bdy height	Type a value	
Bdy height lying	Type a number	Select c
Body temperature	Type a value	
BP dias	Type a number	mm[Hg]
BP sys	Type a number	mm[Hg]
Heart rate	Type a number	{beats}/mi
Resp rate	Type a number	{breaths}/i

- Clicked on one variable, BP diastolic
- Shows Controls for managing cardinality
- Input required
- Data type
- Default value
- Formula
- Show/Hide rules (Skip logic)

Title

ADD NEW OR IMPORT FROM LOINC

1 Vital signs, weig...	+ -
1.1 SaO2 % BldC Oximetry	-
1.2 Weight Measured	-
1.3 Head Circumf OFC ...	-
1.4 Bdy height	-
1.5 Bdy height lying	-
1.6 Body temperature	-
1.7 BP dias	-
1.8 BP sys	-
1.9 Heart rate	-
1.10 Resp rate	-
1.11 BSA Derived	-
1.12 BMI	-

Repeat this item? ?	Select one
Editable ?	Editable
Answer required? ?	No
Type ?	Decimal
Default answer ?	Type a value
Units ?	<input style="width: 100%;" type="text" value="x mm[Hg]"/> Select one or more or tyj
Formula ?	Select one
Add Restrictions ?	No
Add conditional show/hide logic? ?	<input style="width: 100%;" type="text" value="Yes"/>
Criteria to show this item ?	
Show this item when ? <input style="width: 100%;" type="text" value="Any condition is true"/>	
<input style="width: 100%;" type="text" value="1.1 Condition"/> ?	
Select Source Field ? <input style="width: 100%;" type="text" value="Select one"/>	
<input style="width: 100%;" type="button" value="Add another 'Condition'"/>	

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/>

The screenshot shows the SMART App Gallery interface. On the left, there is a sidebar with a 'Featured Apps' section containing a list of categories: Recently Updated, Clinical Care, Patient Education, Genomics, Open Source, iPhone and iPad, and All Apps. Below this is a search bar with the text 'Name' and 'A to Z', and a '25 apps' indicator. The main area displays a grid of application thumbnails. Each thumbnail includes a preview of the app's interface and a caption below it. The visible captions are: 'LHC-Forms on FHIR', 'Lush SMART on FHIR App', 'Medication RS', 'Medication TimeView', 'Metabolic Meter', 'OpenHRE on SMART', and 'Isaan King'. The thumbnails show various data visualizations, including tables, charts, and patient information screens.

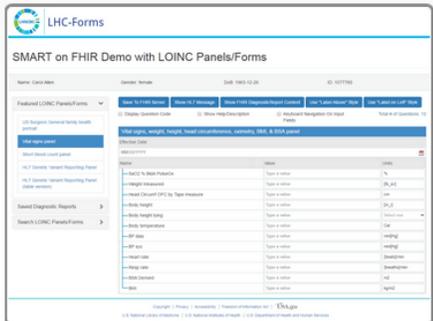
<https://gallery.smarthealthit.org/>


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🔗 About SMART

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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	<div style="display: flex; gap: 5px;"> Clinical Care Diagnosis Clinical Data Capture Featured </div>

Try It

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 \(LHNCBC\)](#)

No other items found





<https://gallery.smarthealthit.org/>

SMART® App Gallery BETA
Sign in

Home

LHC-Forms

App Description

LHC-Forms (a.k.a. LForms) forms for Web-based medical applications or to integrate into electronic health records (EHRs), personal health records (PHRs), and mobile health apps.

1 patient selected
OK
Cancel

Select Sample Patient

✕

	Gender	Name	Family Name	Born
<input type="radio"/>	♀	Brittany Ackerman	Ackerman	1942-11-09
<input type="radio"/>	♂	Daniel X. Adams	Adams	1925-12-23
<input checked="" type="radio"/>	♀	Deborah Adams	Adams	1948-01-09
<input type="radio"/>	♀	Emilie Adams	Adams	1935-09-22
<input type="radio"/>	♂	Aaron Alexis	Alexis	1989-10-26
<input type="radio"/>	♀	Carol G. Allen	Allen	1963-12-26
<input type="radio"/>	♀	Beryl Bachmann	Bachmann	1974-02-13
<input type="radio"/>	♀	Paulene Bachmann	Bachmann	1985-02-02
<input type="radio"/>	♀	Magda Bachmann	Bachmann	1937-02-15
<input type="radio"/>	♀	Trudy Belson	Belson	1945-08-30

← Prev 10
Patients 1 to 10 of 176
Next 10 →



SMART on FHIR Demo with LOINC Panels/Forms

Name: Deborah Adams

Gender: female

DoB: 1948-01-09

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 PanelHL7 Genetic Variant
Reporting Panel (table
version)

Saved Diagnostic Reports

Search LOINC Panels/Forms

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-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)

Saved Diagnostic Reports

Search LOINC Panels/Forms

Save To FHIR Server

Show HL7 Message

Show FHIR DiagnosticReport Content

Use "Label Above" Style

Use "Label on Left" Style

Display Question Code

Show Help/Description

Keyboard Navigation On Input Fields

Total # of Questions: 27

US Surgeon General family health portrait

Effective Date

MM/DD/YYYY

Name	Value	Units
My health history		
Name	Type a value	
Gender	Select one	
Birth Date	MM/DD/YYYY	{mm/dd/yyyy}
Twin	Select one	
Adopted	Select one	
Parents related	Select one	
Body height	Type a value	[in_i]
Weight	Type a value	kg
Race	Select one or more	
Ethnicity	Select one or more	
1.1 Diseases history panel		
History of diseases	Search for value	
Age range at onset of disease	Select one	
Add another 'Diseases history panel'		
1 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.

Issues (2)

- ❑ 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>
 - ❖ Software download and documentation: <https://github.com/lhncbc/lforms>
 - ❖ Demo site: <https://lhc-forms.lhc.nlm.nih.gov/>
- ❑ Lister Hill Clinical Table Search Service (aka Autocompleter/Table Connector)
 - ❖ <https://clin-table-search.lhc.nlm.nih.gov/>
 - ❖ <http://lhncbc.github.io/autocomplete-lhc>
 - ❖ <https://github.com/lhncbc/autocomplete-lhc>
- ❑ Form Builder
 - ❖ <https://lforms-formbuilder.nlm.nih.gov> (lforms/demo)
- ❑ Units of measure (UCUM) validator and converter
 - ❖ <http://lhncbc.github.io/ucum-lhc/>
- ❑ LHC-Forms on FHIR <https://gallery.smarthealthit.org/>