Feeding FHIR with LHC-Forms

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HL7 Partners in Interoperability
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 assement 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 ©	○	○	○	○	○
I feel isolated even when I am not alone ©	○	○	○	○	○
I feel that people avoid talking to me ©	○	○	○	○	○
I feel detached from other people ©	○	○	○	○	○
I feel that some of my friends avoid me ©	○	○	○	○	○
I feel that some of my family members avoid me ©	○	○	○	○	○
I feel that I am alone in my interests and ideas ©	○	○	○	○	○
I feel that people barely know me ©	○	○	○	○	○
I feel like a stranger to those around me ©	○	○	○	○	○
I find that friends or relatives have difficulty talking with me about my health ©	○	○	○	○	○
I feel that people are around me but not with me ©	○	○	○	○	○
I feel isolated from others ©	○	○	○	○	○

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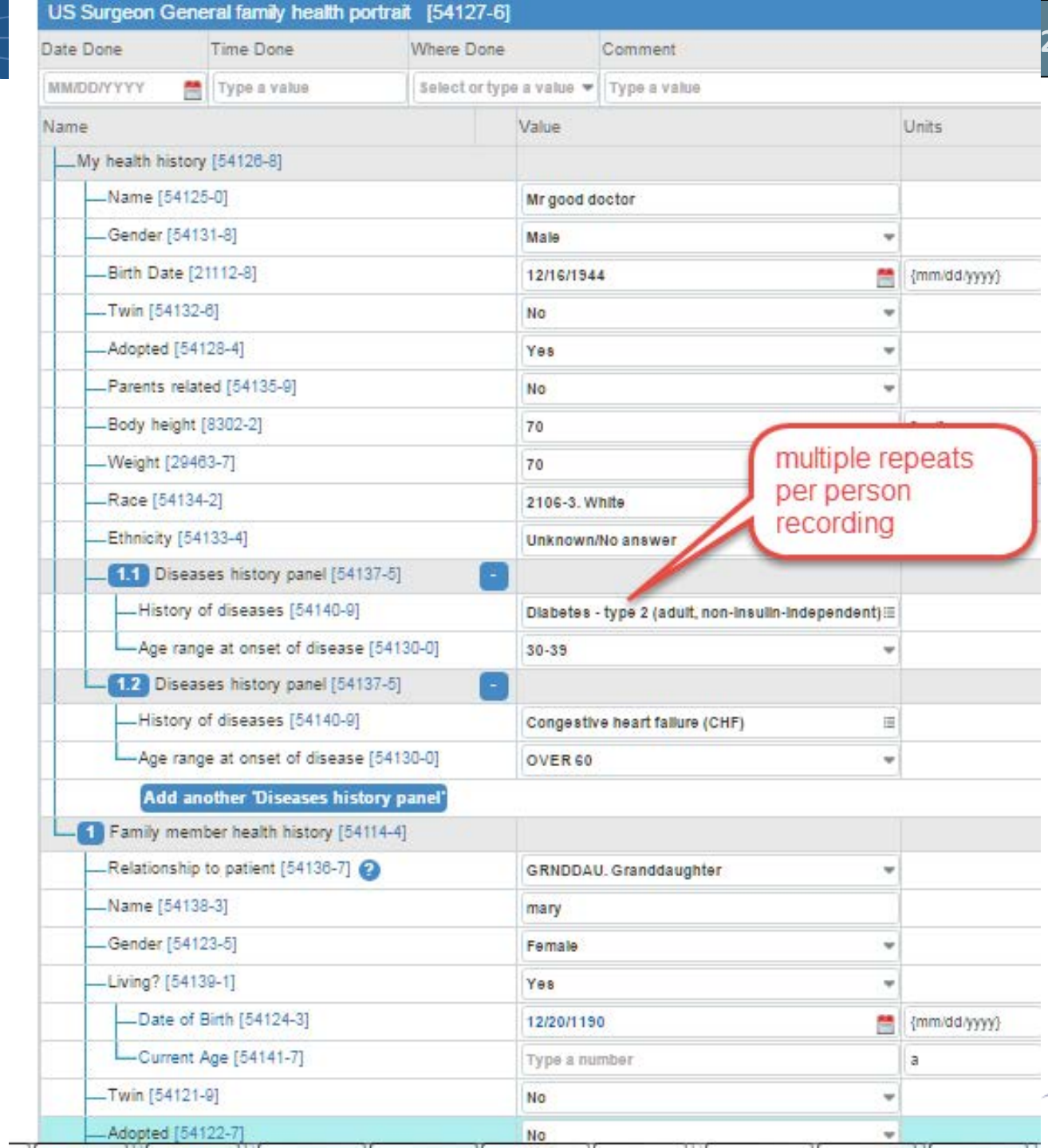
Nested and Repeating Groups

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



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

Use "List" Style | Use "Table" Style | Show HL7 Message

☐ 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.

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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

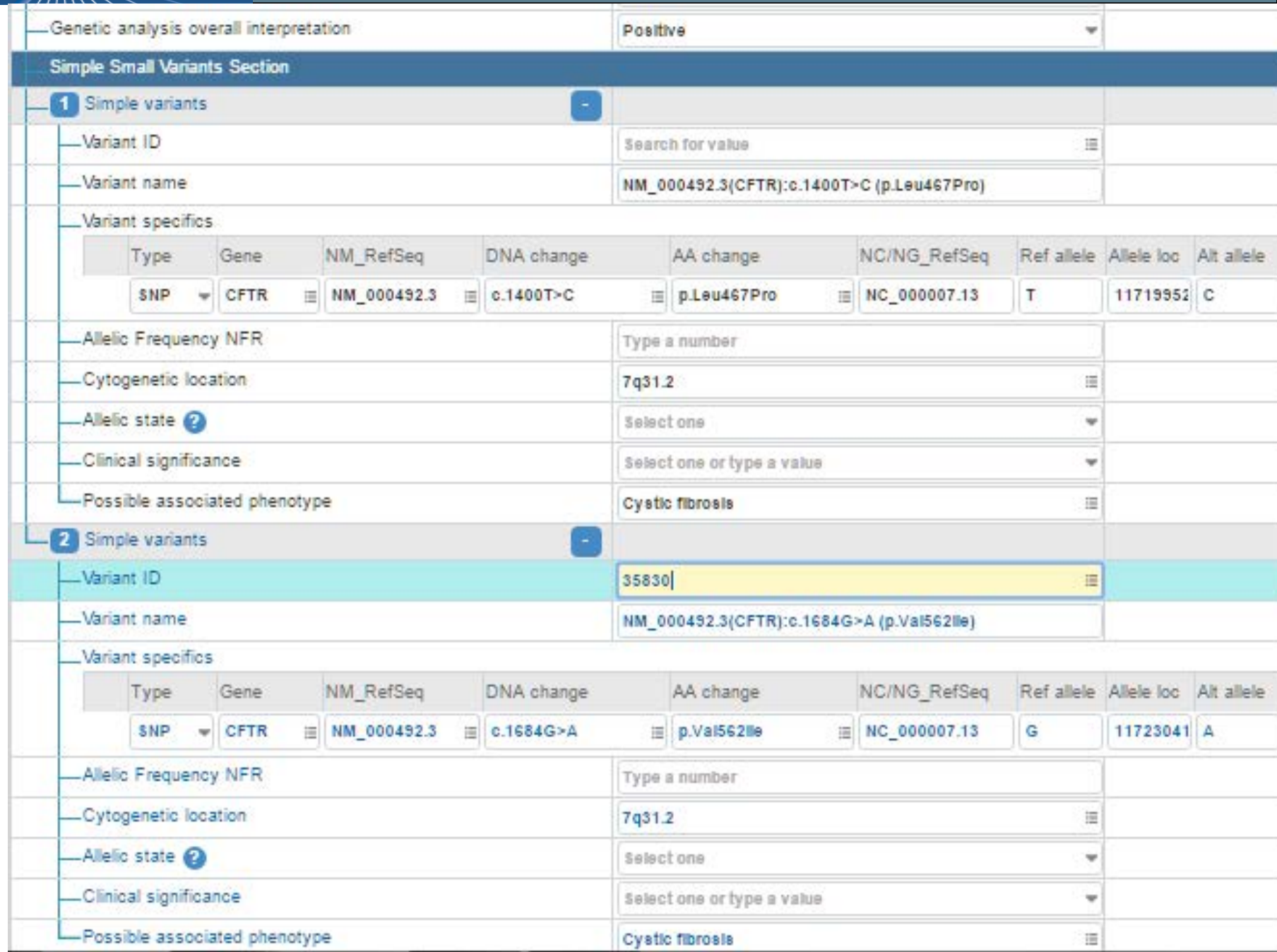
See more items (Ctl Ret)

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



HL7 message generated from completion of genetics form

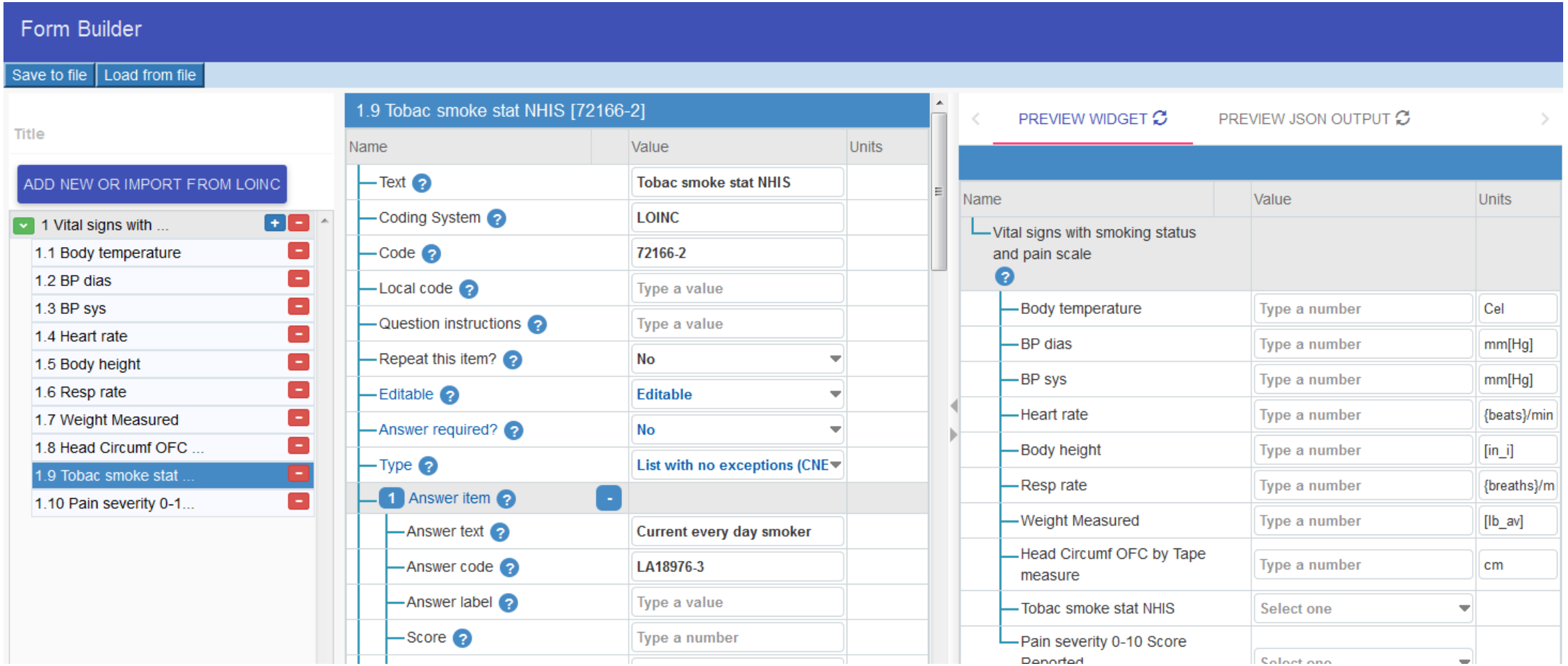
(only top 2/3ds showing)

OBR|1|X1000-0^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|

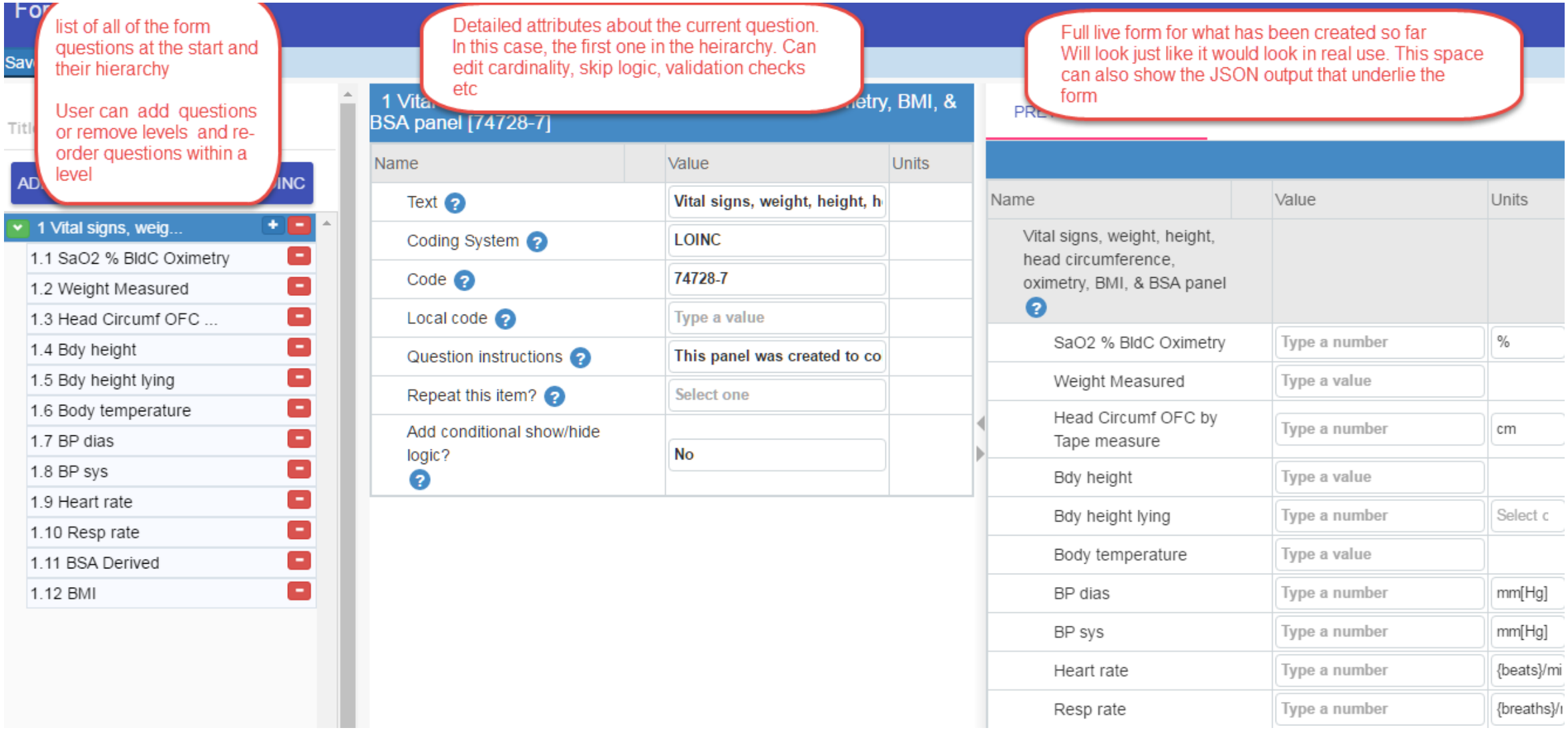
Form Builder Demo Screenshots

LHC Form Builder

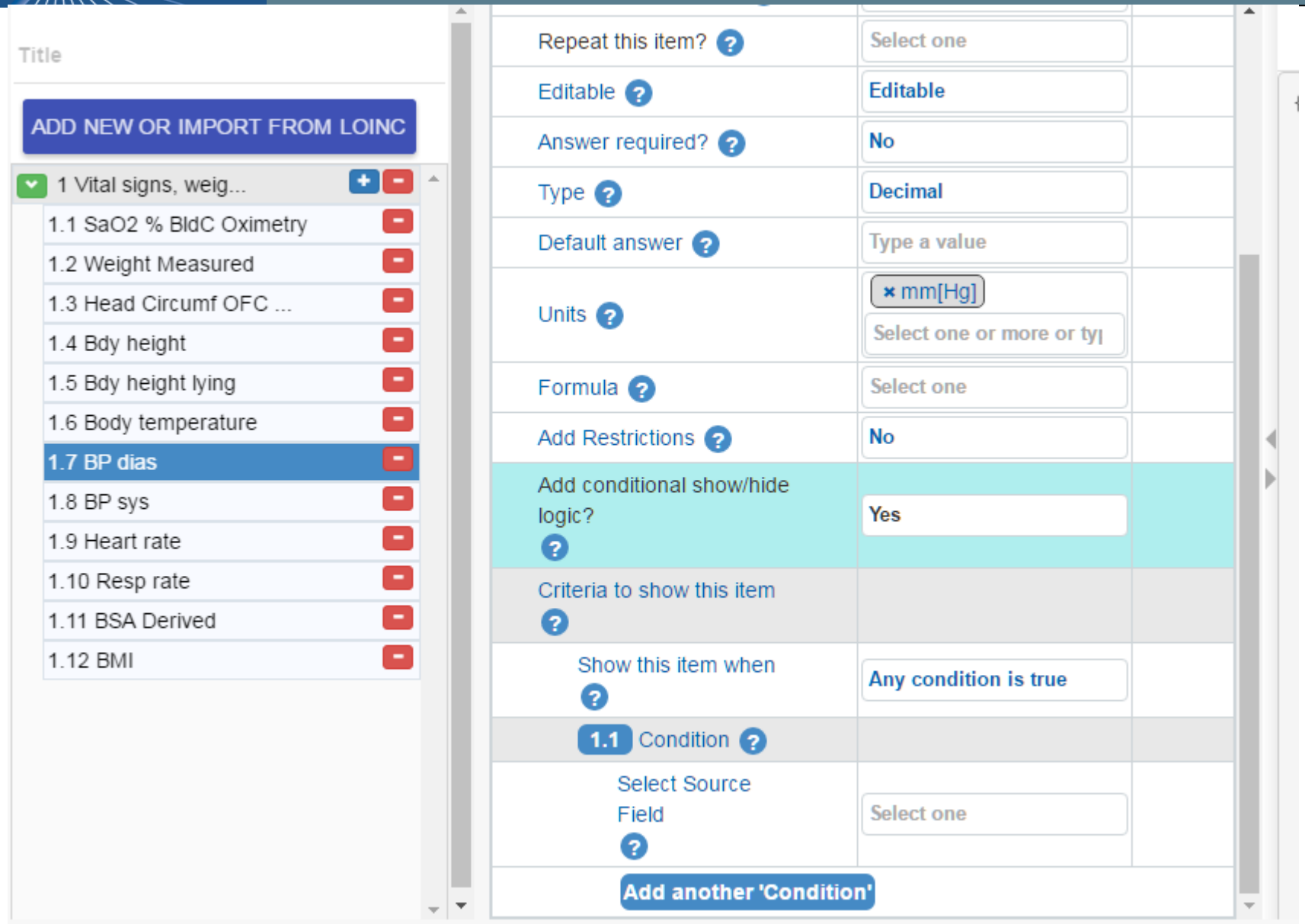
Editing LOINC: 72513-5 Vital signs with smoking status and pain scale [VSP]



After selecting a starter form



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



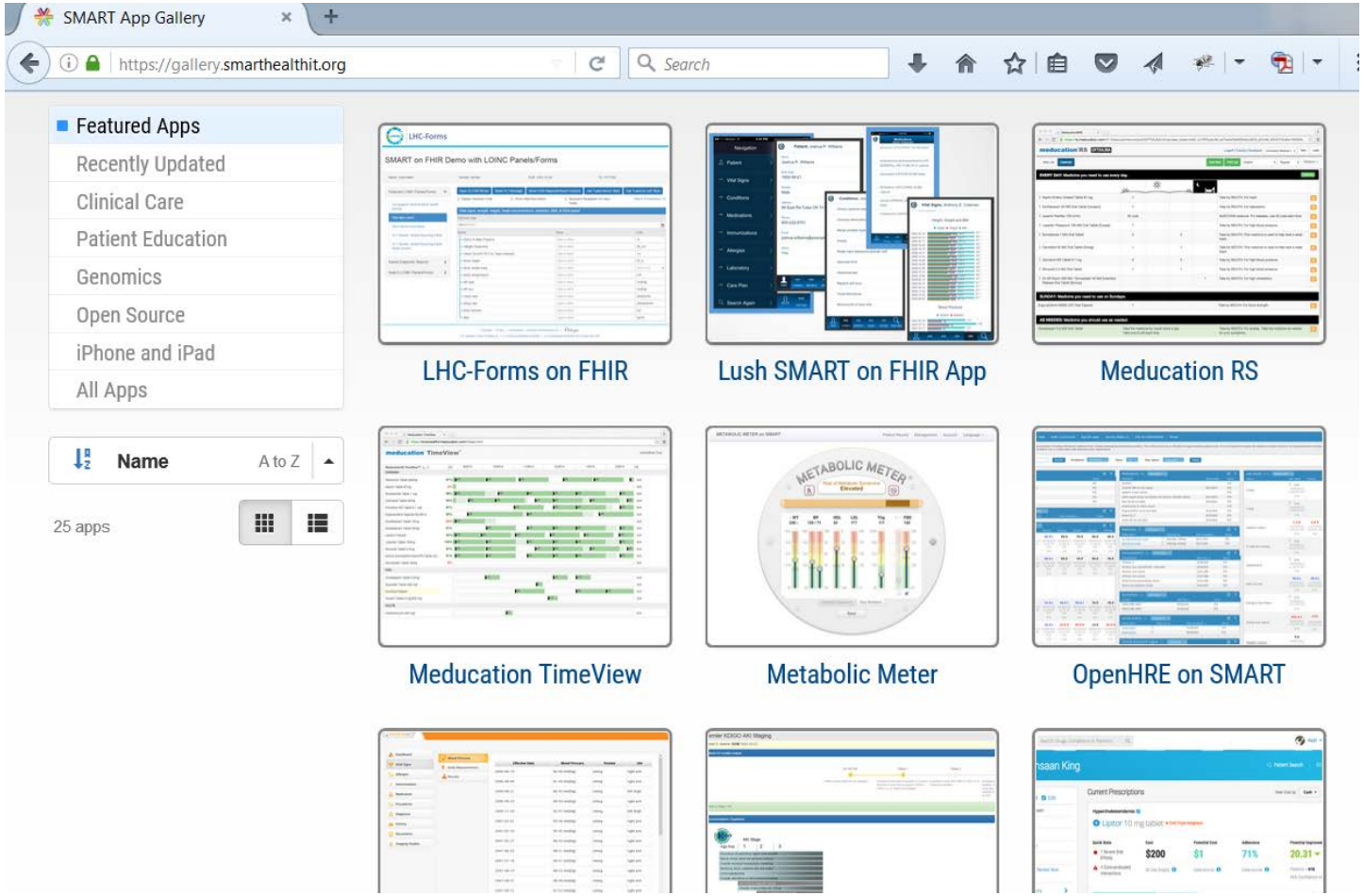
The FHIR connection

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/

SMART App Gallery BETA

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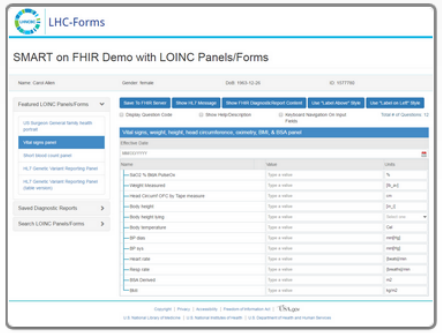
LHC-Forms on FHIR



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

Try It

App Description

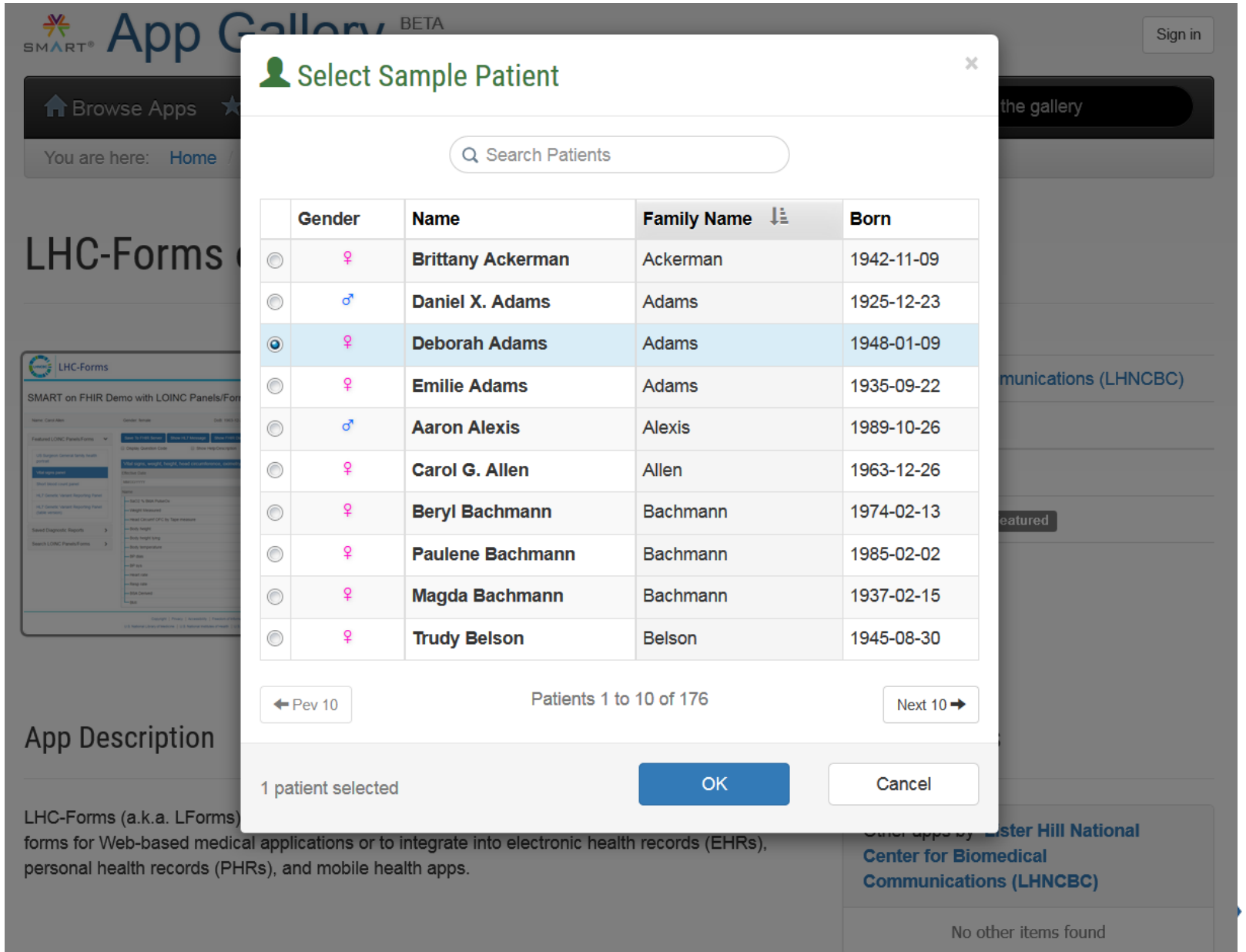
LHC-Forms (a.k.a. LForms) is a light-weight, feature-rich, open-source widget that creates input forms for Web-based medical applications or to integrate into electronic health records (EHRs), personal health records (PHRs), and mobile health apps.

Related Apps

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

No other items found

https://gallery.smarthealthit.org/



LHC-Forms

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

Please select a LOINC Panel/Form from left side.

LHC-Forms

SMART on FHIR Demo with LOINC Panels/Forms

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

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- HL7 Genetic Variant Reporting Panel
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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		

USA.gov

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/