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/
- 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

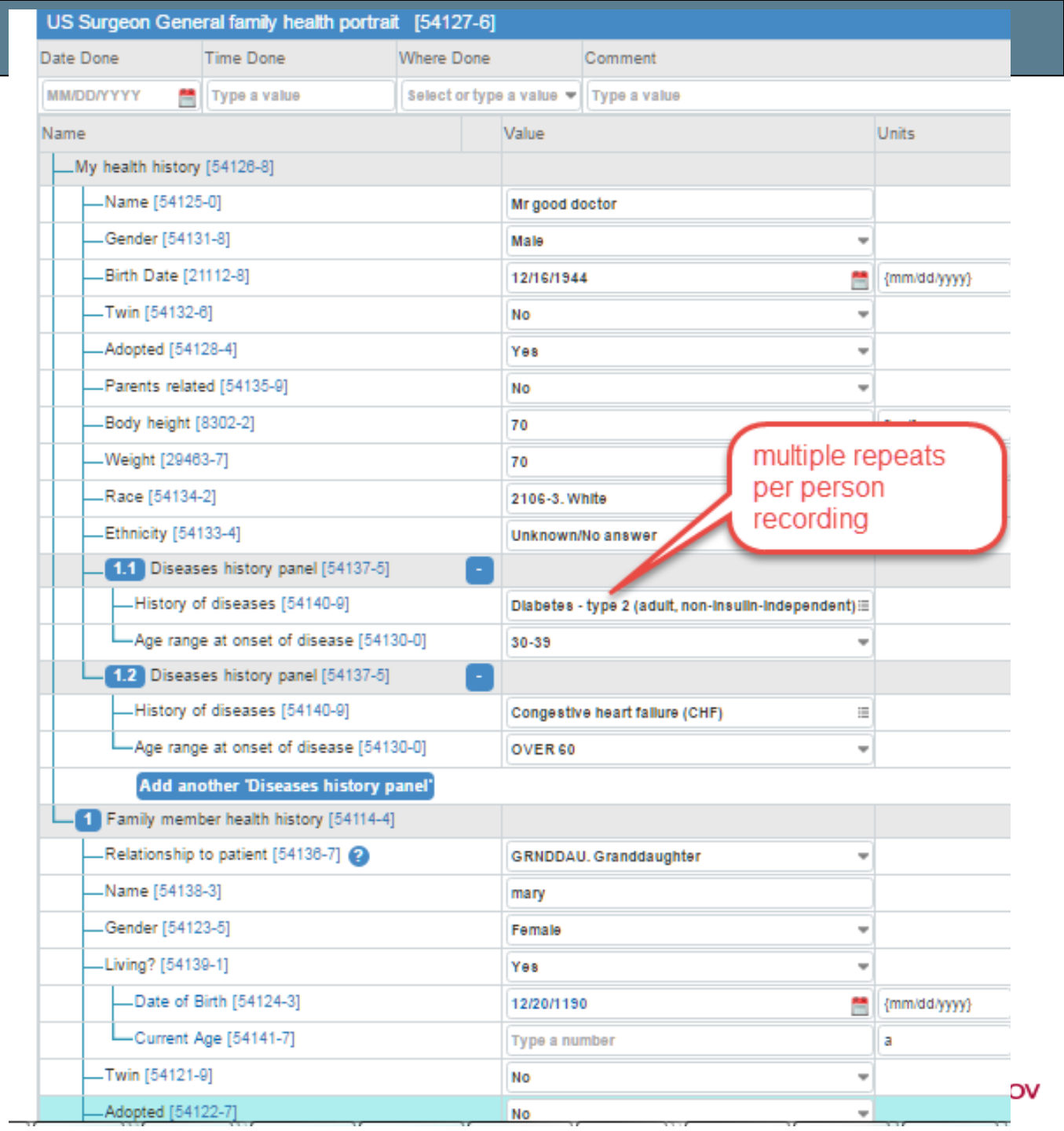
- Most CMS clinical forms (OASIS, MDS 3.0 nursing home assessments, dialysis reports) are represented as LOINC panels/forms.
  - CMS is unifying all of its assessments as LOINC forms with LOINC codes- some which will use the LOINC codes for existing CMS data items where possible and obtain new ones when 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

- https://lhc-forms.lhc.nlm.nih.gov/
- 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

PHQ-9 quick depression assessment panel [44249-1] ©

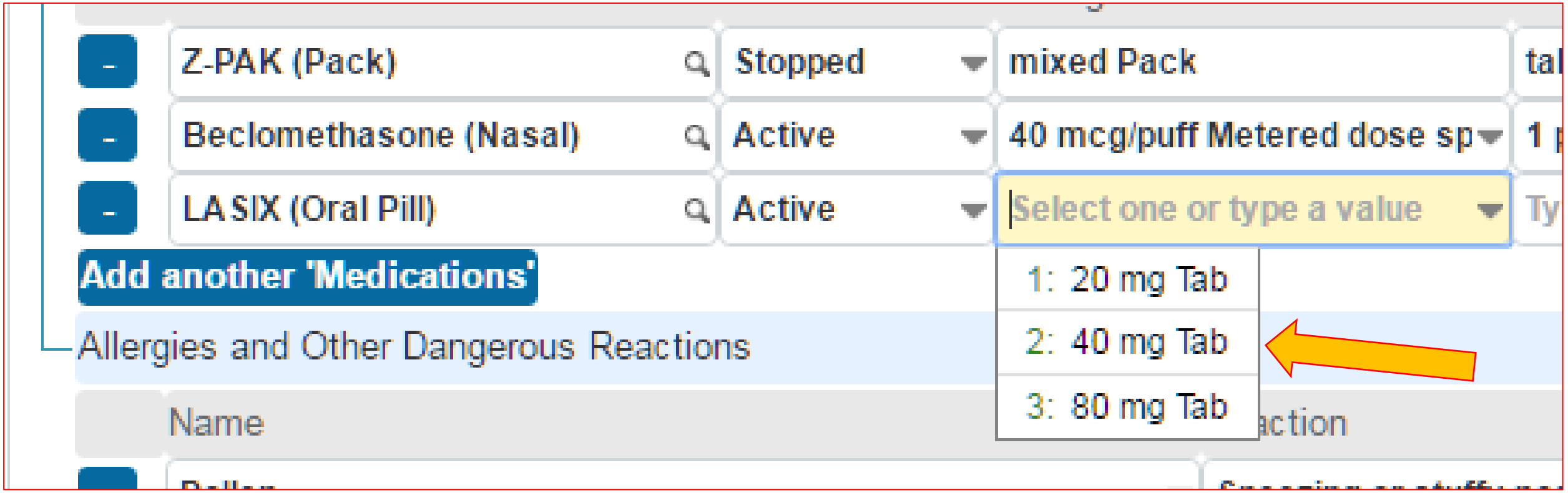
Date Done	Time Done	Where Done	Comment
MM/DD/YYYY	Type a value	Select or type a value	Type a value

Name	Value	Units
Over the last 2 weeks, how often have you been bothered by any of the following problems? [44257-4] ©		
Little interest or pleasure in doing things? [44250-9] ©	1. Several days	
Feeling down, depressed, or hopeless? [44255-8] ©	2. More than half the days	
Trouble falling or staying asleep, or sleeping too much [44259-0] ©	1. Several days	
Feeling tired or having little energy [44254-1] ©	1. Several days	
Poor appetite or overeating [44251-7] ©	1. Several days	
Feeling bad about yourself-or that you are a failure or have let yourself or your family down [44258-2] ©	1. Several days	
Trouble concentrating on things, such as reading the newspaper or watching television [44252-5] ©	0. Not at all	
Moving or speaking so slowly that other people could have noticed. Or the opposite-being so fidgety or restless that you have been moving around a lot more than usual [44253-3] ©	0. Not at all	
Thoughts that you would be better off dead, or of hurting yourself in some way [44260-8] ©	1. Several days	
Patient health questionnaire 9 item total score [44261-6] ? ©	8	{score}
How difficult have these problems made it for you to do your work, take care of things at home, or get along with other people? [69722-7] ? ©	Select one	

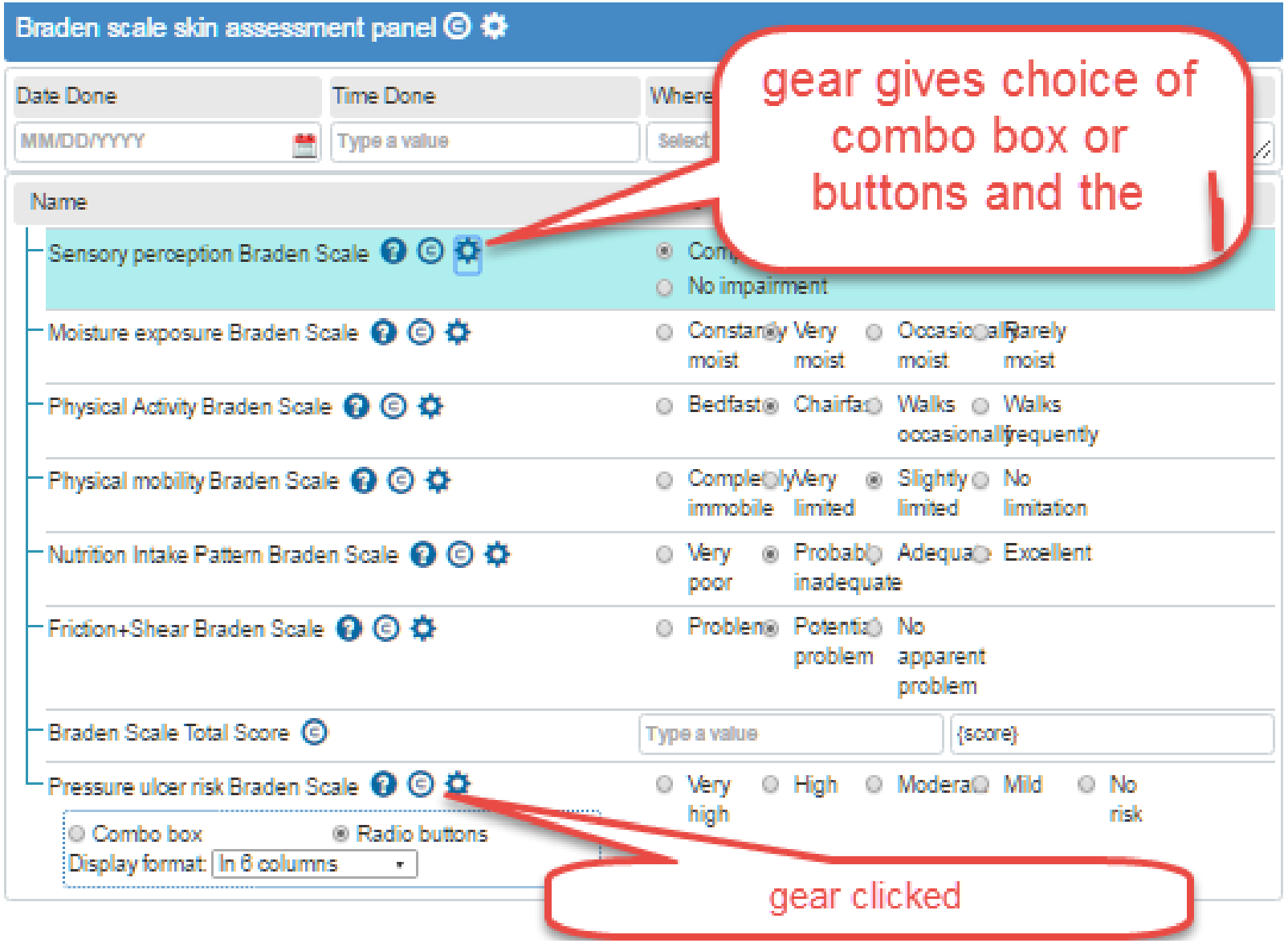
form adds up the score for the answers given

https://lhc-forms.lhc.nlm.nih.gov/

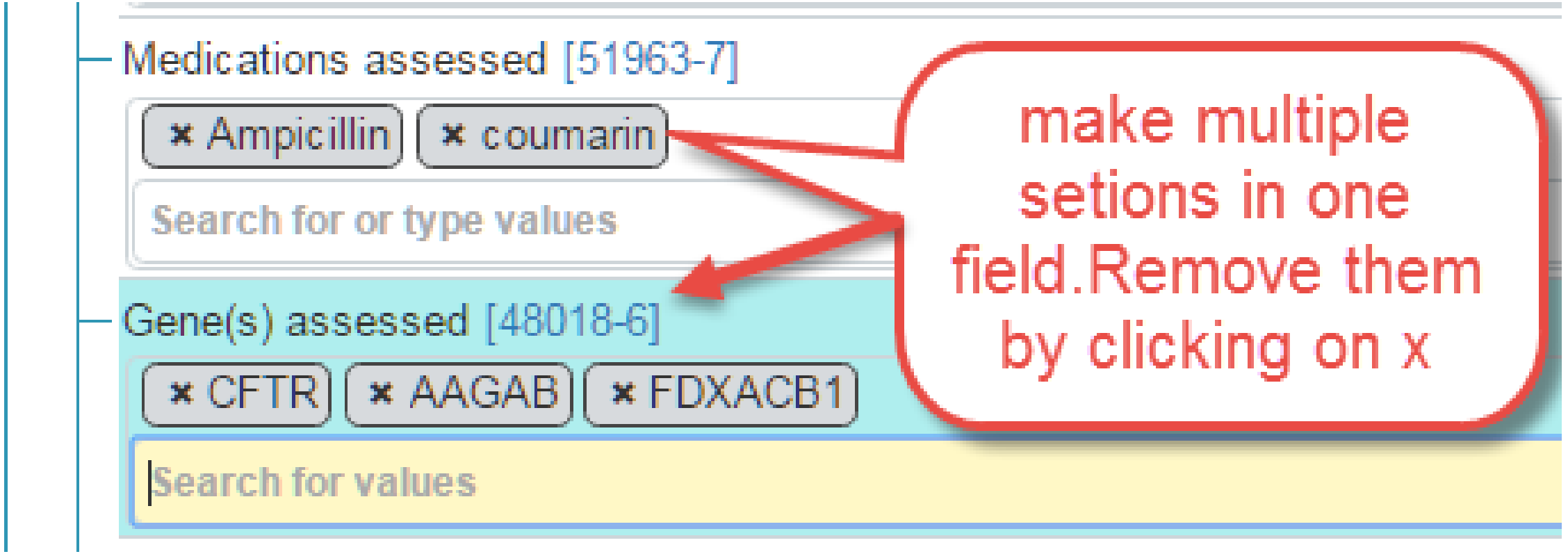
Secret sauce : Code stored in one field can generate code answer lists for succeeding fields- to be illustrated on the PHR form Enter Lasix oral and get selection menu of available pill sizes



Choices of combo boxes, radio buttons, check boxes and grids when appropriate

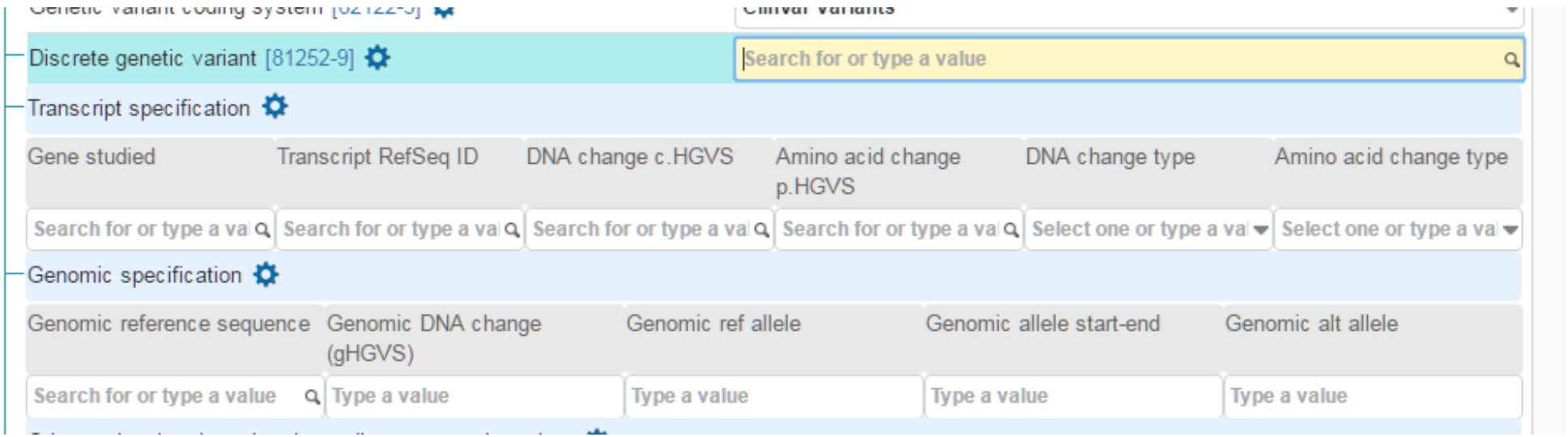


Can enter multiple fields in one field (or as separate fields illustrated with PHR)

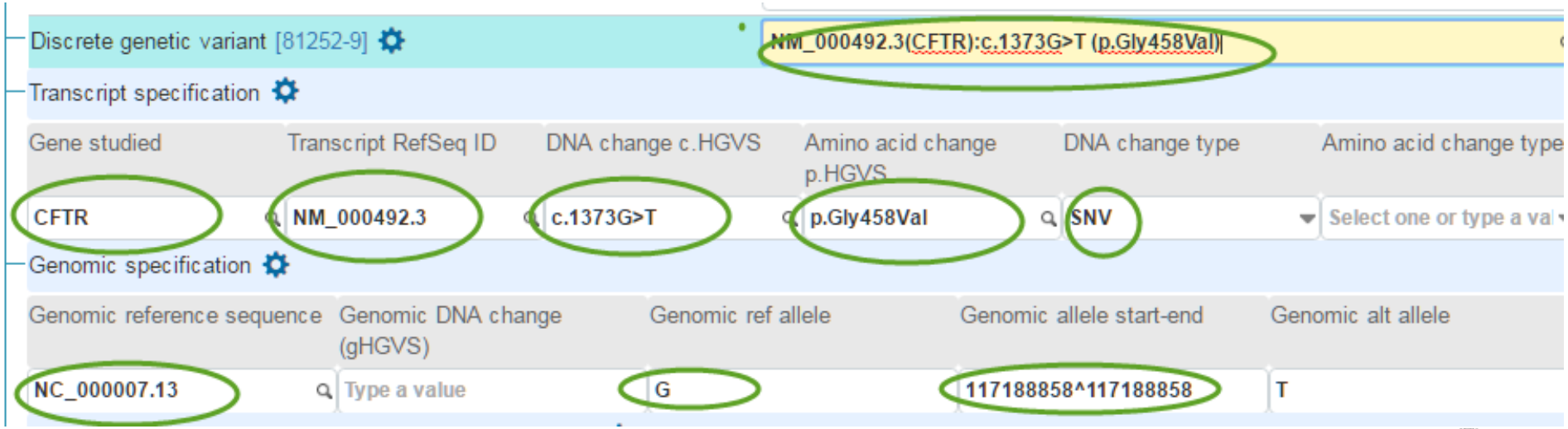


Secret sauce: record for Id in one field generates defaults for others

Before

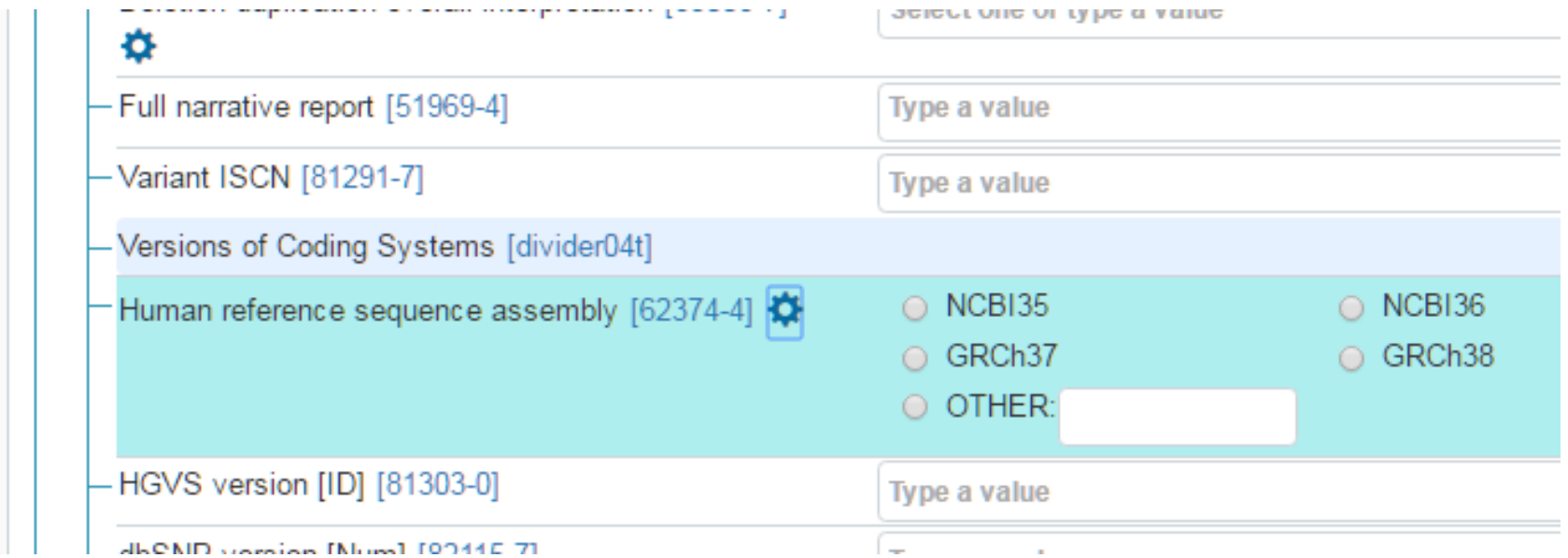


After

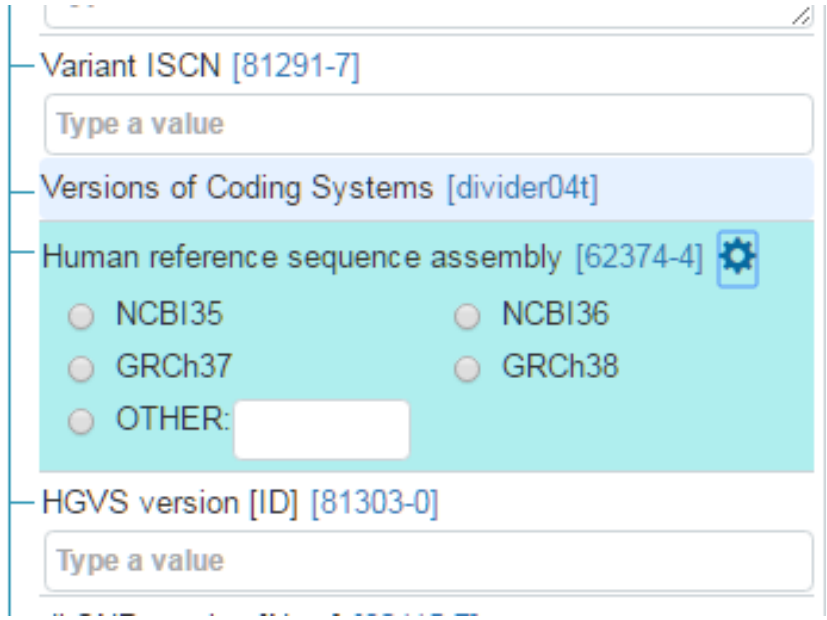


Responsive design-example from HL7 V2 genetics reporting form

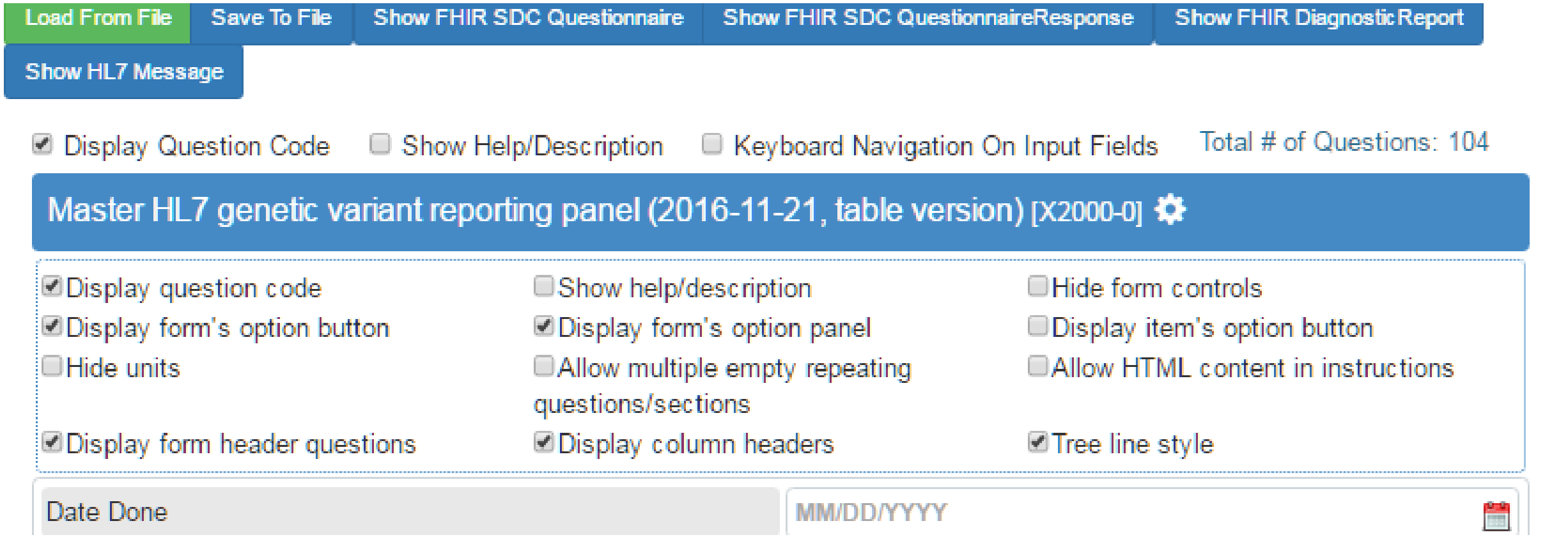
Wide screen



Skinny screen



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)

Save To File | Use "Label Above" Style | Use "Label on Left" Style | Show HL7 Message

☐ Display Question Code ☑ Show Help/Description ☐ Keyboard Navigation On Input Fields Total # of Questions: 44

Personal Health Record

Medical Conditions

Medical condition	Status	Started	Stopped	Description/Comment
Chest pain	Active	04/20/2016	MM/DD/YYYY	Sounds anginal. Worrse with exertion, but young and no family history
Pneumonia - bronchial	Inactive	03/17/2017	04/22/2016	Treated wish Zpack on ambulatorybais
Hay fever (allergic rhinitis)	Active	03/20/2012	MM/DD/YYYY	Every spring
bac	Select one or t	MM/DD/YYYY	MM/DD/YYYY	Type a value

Add another 'Medical Conditions'

Medications

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

Add another 'Medications'

Allergies and Other Dangerous Reactions

Name	Reaction	Started	Comment
Pollen	Sneezing or stuffy nose	03/15/2017	Worse when maple trees bloom
Select one or type a value	Select one or type a value	MM/DD/YYYY	Type a value

Add another 'Allergies and Other Dangerous Reactions'

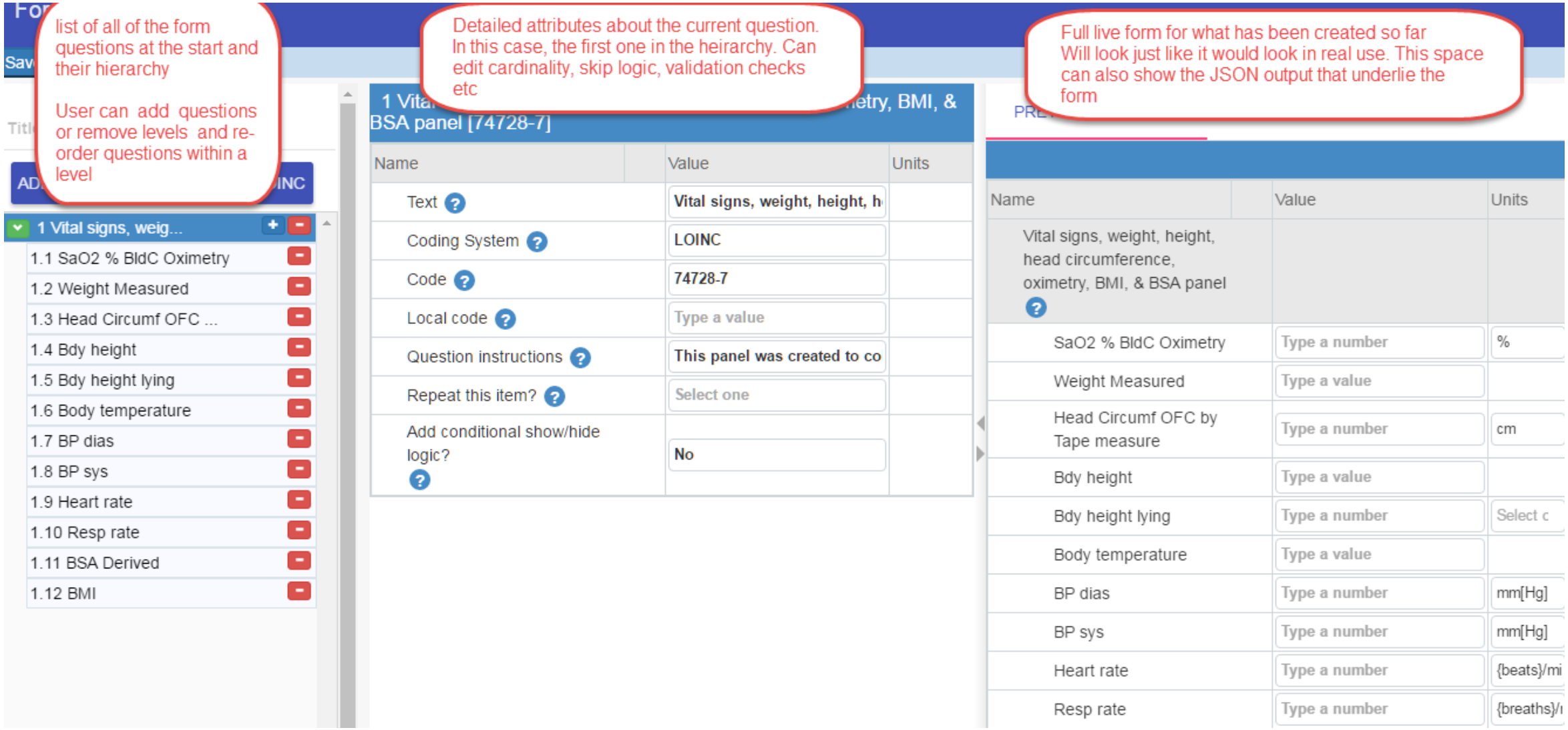
HL7 message generated from completion of genetics form- only top 2/3ds showing (Hand out)

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|

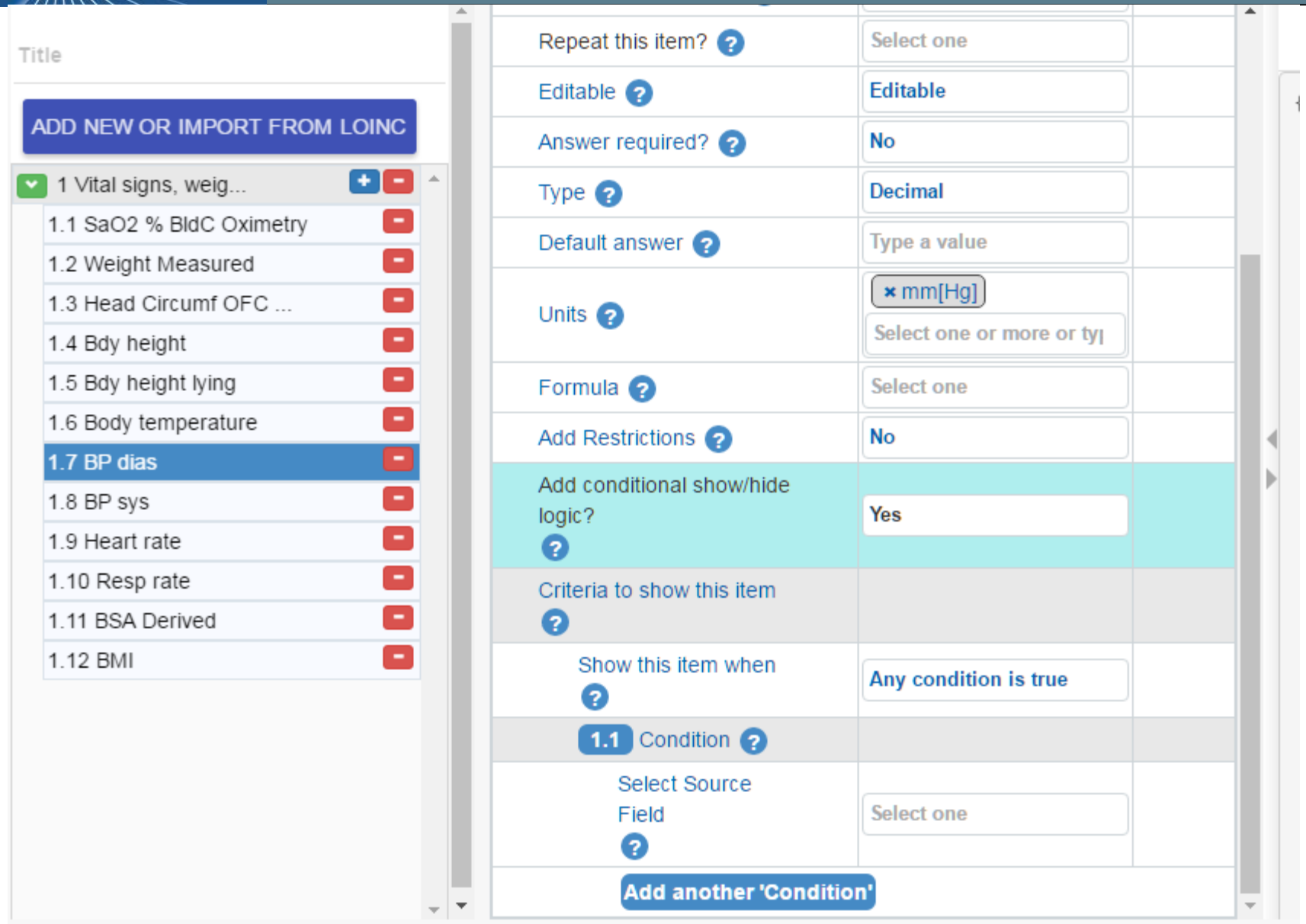
LHC form producing Diagnostic report JSON and or questionnaire response For delivery to FHIR server (Handout)

Form Builder

After selecting a starter 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

SMART App Gallery BETA

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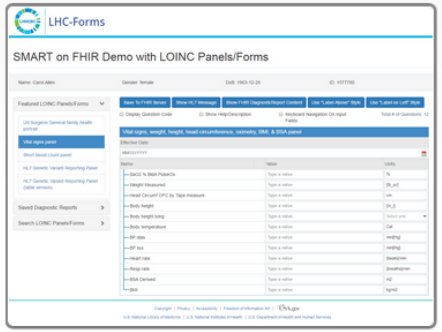
LHC-Forms on FHIR



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

SMART App Gallery BETA

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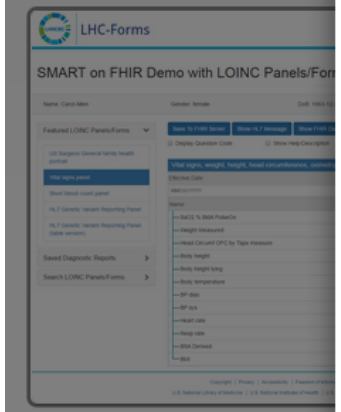

Select Sample Patient

Search Patients

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

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

1 patient selected OK Cancel

munications (LHNCBC)

eatured

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.

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

No other items found

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.

URLS for exploring

(Ye Wang, Paul Lynch, Ajay Kanduru, Lee Mericle, Clem McDonald)

- 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)
  - https://clin-table-search.lhc.nlm.nih.gov/
  - http://lhncbc.github.io/autocomplete-lhc
  - https://github.com/lhncbc/autocomplete-lhc
- Form Builder
  - https://lhc-formbuilder.lhc.nlm.nih.gov/lforms/demo
- Units of measure (UCUM) validator and converter
  - http://lhncbc.github.io/ucum-lhc/

URLS for exploring - cont.

(Ye Wang, Paul Lynch, Ajay Kanduru, Lee Mericle, Clem McDonald)

- JSON & Screenshot of genetic form (use Chrome)
  - Screenshot: http://lhncbc.github.io/lforms/samples/genetic-panel/screenshot.png
  - - Form as FHIR Questionnaire: http://lhncbc.github.io/lforms/samples/genetic-panel/fhir-questionnaire.json
  - - Form response as FHIR QuestionnaireResponse: http://lhncbc.github.io/lforms/samples/genetic-panel/fhir-questionnaire-response.json
  - - Form response as FHIR DiagnosticReport: http://lhncbc.github.io/lforms/samples/genetic-panel/fhir-diagnostic-report.json
  - - LHC-Forms format (with user data): http://lhncbc.github.io/lforms/samples/genetic-panel/lforms-data.json