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Lab Interoperability
More than just LOINC mapping

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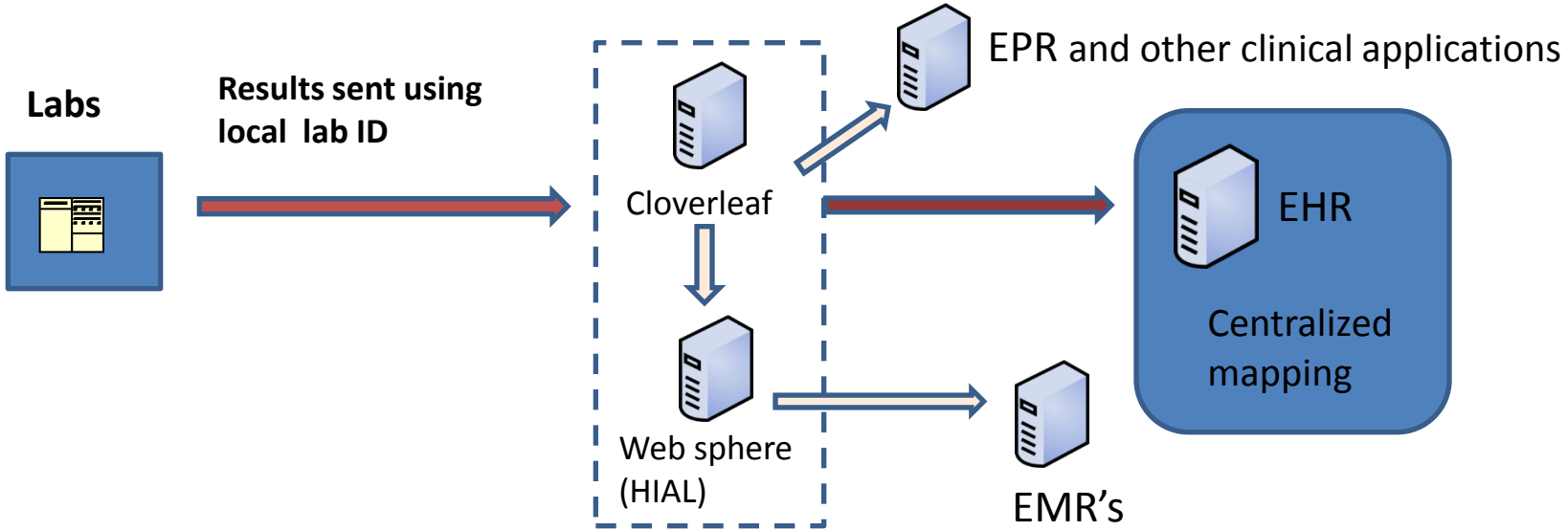
eChart Manitoba

- Is a secure electronic health record that allows authorized health-care providers access to health information when needed
- In use in 436 sites, 43 of these are hospitals with over 5,700 users in the month of April 2016
- Displays: medications, lab results, immunizations, X-ray reports and encounters

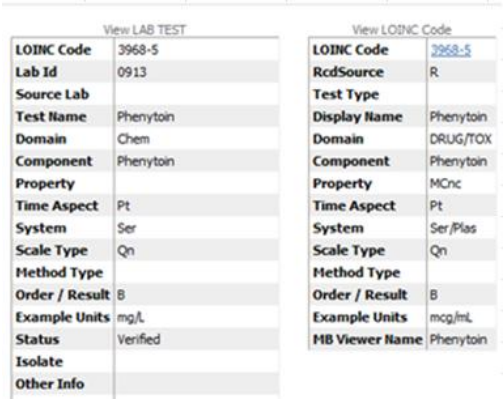
Flow of Lab Results



Mapping of lab tests in eChart Manitoba (EHR)

Up until recently when mapping labs we would look only at…

- Name of test
- Method
- Reported value
- Specimen type



View LAB TEST

LOINC Code	3968-5
Lab Id	0913
Source Lab	
Test Name	Phenytoin
Domain	Chem
Component	Phenytoin
Property	
Time Aspect	Pt
System	Ser
Scale Type	Qn
Method Type	
Order / Result	B
Example Units	mg/L
Status	Verified
Isolate	
Other Info	

View LOINC Code

LOINC Code	3968-5
RcdSource	R
Test Type	
Display Name	Phenytoin
Domain	DRUG/TOX
Component	Phenytoin
Property	MCnc
Time Aspect	Pt
System	Ser/Plas
Scale Type	Qn
Method Type	
Order / Result	B
Example Units	mcg/mL
MB Viewer Name	Phenytoin

What about other factors?

Lab Interoperability Working Group (LIWG)

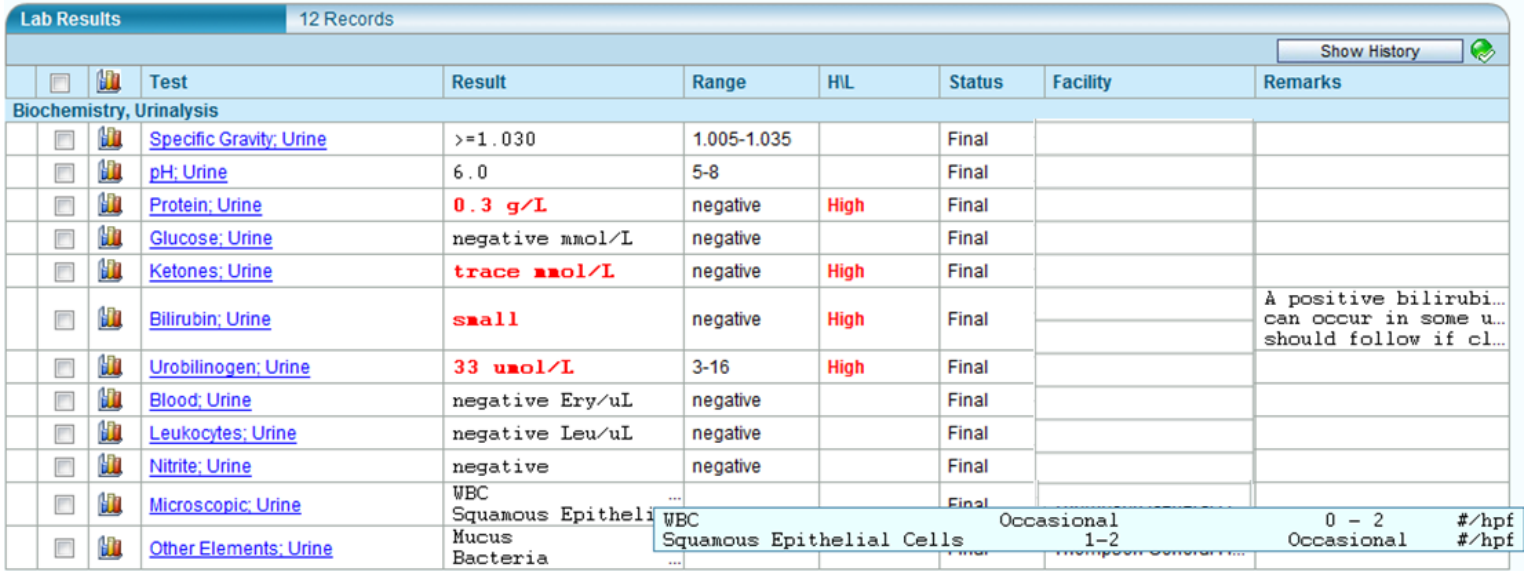
- Comprised of medical lab directors/scientists, lab SME's and Manitoba eHealth representatives
- The goal is to review test types that are shared between the labs and look at standardizing lab tests when applicable
- To meet the needs of clinicians

Overview of tests reviewed by LIWG

- Urinalysis
- Lipoprotein tests
- Cortisol tests
- Serum Electrolyte and renal function tests

Example 1: Urinalysis

Lab 1:



Lab Results — 12 Records

Show History

	Test	Result	Range	H\L	Status	Facility	Remarks
Biochemistry, Urinalysis							
	Specific Gravity; Urine	>=1.030	1.005-1.035		Final		
	pH; Urine	6.0	5-8		Final		
	Protein; Urine	0.3 g/L	negative	High	Final		
	Glucose; Urine	negative mmol/L	negative		Final		
	Ketones; Urine	trace mmol/L	negative	High	Final		
	Bilirubin; Urine	small	negative	High	Final		A positive bilirubi... can occur in some u... should follow if cl...
	Urobilinogen; Urine	33 umol/L	3-16	High	Final		
	Blood; Urine	negative Ery/uL	negative		Final		
	Leukocytes; Urine	negative Leu/uL	negative		Final		
	Nitrite; Urine	negative	negative		Final		
	Microscopic; Urine	WBC Squamous Epitheli...			Final		
	Other Elements; Urine	Mucus Bacteria					

WBC	Occasional	0 - 2	#/hpf
Squamous Epithelial Cells	1-2	Occasional	#/hpf

Example 1: Urinalysis

Lab 2:

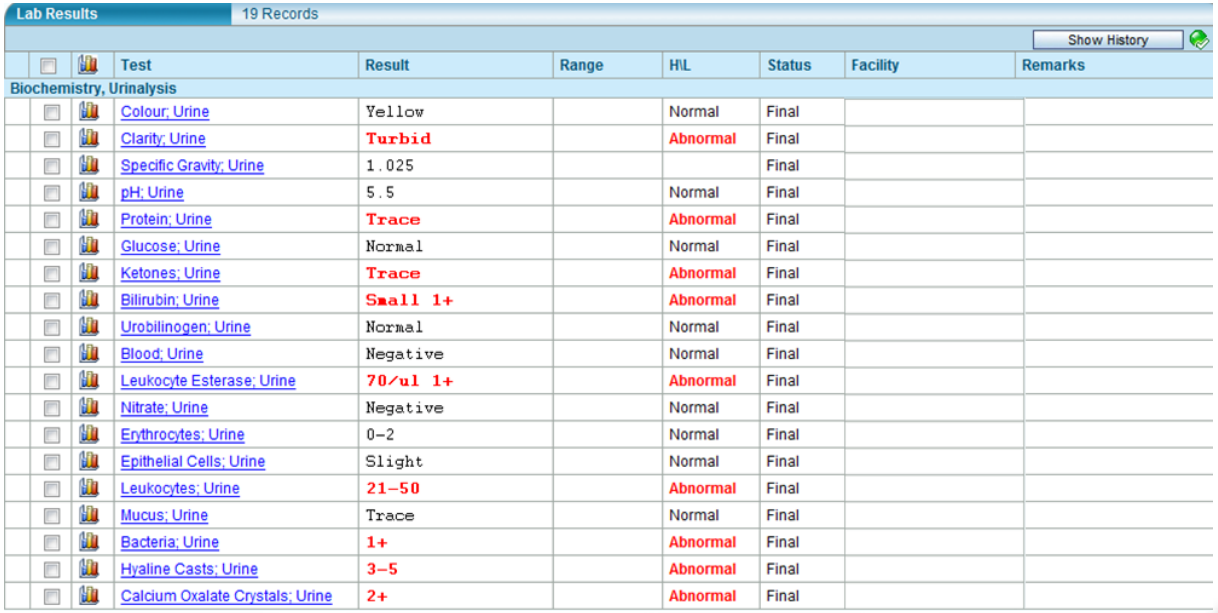
Lab Results — 17 Records

Show History

Test	Result	Range	H\L	Status	Facility	Remarks
Biochemistry, Urinalysis						
Specific Gravity; Urine	1.020	1.005-1.035		Final		
pH; Urine	5.0 pH	5.0-8.0		Final		
Protein; Urine	>= 3.0 g/L	NEGATIVE	Abnormal	Final		
Glucose; Urine	28 mmol/L	NEGATIVE	Abnormal	Final		
Ketones; Urine	NEGATIVE mmol/L	NEGATIVE		Final		
Bilirubin; Urine	NEGATIVE	NEGATIVE		Final		
Urobilinogen; Urine	3.2 umol/L	3-16		Final		
Blood; Urine	NEGATIVE Ery/uL	NEGATIVE		Final		
Leukocyte Esterase; Urine	NEGATIVE Leu/uL	NEGATIVE		Final		
Nitrite; Urine	NEGATIVE	NEGATIVE		Final		
Erythrocytes; Urine	0-2 #/HPF	0-2		Final		
Epithelial Cells; Urine	0-2 #/HPF	0-2		Final		
Leukocytes; Urine	0-2 #/HPF	0-2		Final		
Mucus; Urine	Heavy	NEGATIVE	Abnormal	Final		
Bacteria; Urine	NEGATIVE	NEGATIVE		Final		
Crystals; Urine	NONE PRESENT	NONE PRES...		Final		
Casts; Urine	3-5 #/HPF	NONE PRES...	Abnormal	Final		CASTS: HYALINE CASTS

Example 1: Urinalysis

Lab 3:



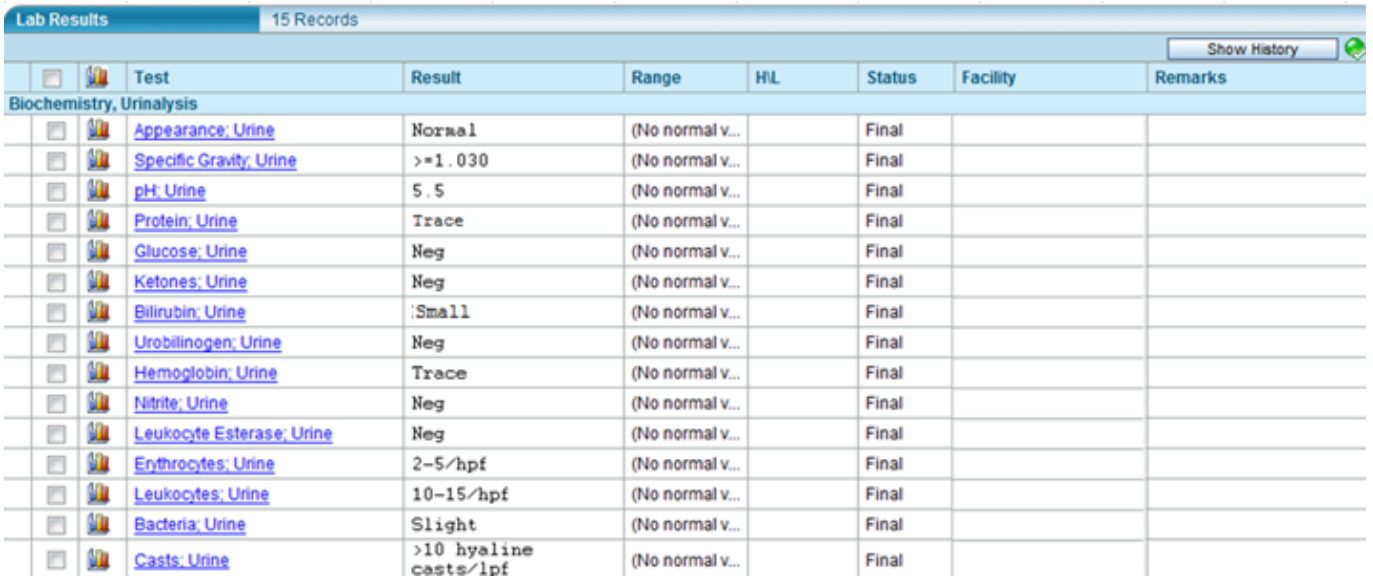
Lab Results — 19 Records

Show History

Test	Result	Range	H\L	Status	Facility	Remarks
Biochemistry, Urinalysis						
Colour; Urine	Yellow		Normal	Final		
Clarity; Urine	Turbid		Abnormal	Final		
Specific Gravity; Urine	1.025			Final		
pH; Urine	5.5		Normal	Final		
Protein; Urine	Trace		Abnormal	Final		
Glucose; Urine	Normal		Normal	Final		
Ketones; Urine	Trace		Abnormal	Final		
Bilirubin; Urine	Small 1+		Abnormal	Final		
Urobilinogen; Urine	Normal		Normal	Final		
Blood; Urine	Negative		Normal	Final		
Leukocyte Esterase; Urine	70/ul 1+		Abnormal	Final		
Nitrate; Urine	Negative		Normal	Final		
Erythrocytes; Urine	0-2		Normal	Final		
Epithelial Cells; Urine	Slight		Normal	Final		
Leukocytes; Urine	21-50		Abnormal	Final		
Mucus; Urine	Trace		Normal	Final		
Bacteria; Urine	1+		Abnormal	Final		
Hyaline Casts; Urine	3-5		Abnormal	Final		
Calcium Oxalate Crystals; Urine	2+		Abnormal	Final		

Example 1: Urinalysis

Lab 4:



Lab Results — 15 Records

Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Urinalysis						
Appearance; Urine	Normal	(No normal v...		Final		
Specific Gravity; Urine	>=1.030	(No normal v...		Final		
pH; Urine	5.5	(No normal v...		Final		
Protein; Urine	Trace	(No normal v...		Final		
Glucose; Urine	Neg	(No normal v...		Final		
Ketones; Urine	Neg	(No normal v...		Final		
Bilirubin; Urine	Small	(No normal v...		Final		
Urobilinogen; Urine	Neg	(No normal v...		Final		
Hemoglobin; Urine	Trace	(No normal v...		Final		
Nitrite; Urine	Neg	(No normal v...		Final		
Leukocyte Esterase; Urine	Neg	(No normal v...		Final		
Erythrocytes; Urine	2-5/hpf	(No normal v...		Final		
Leukocytes; Urine	10-15/hpf	(No normal v...		Final		
Bacteria; Urine	Slight	(No normal v...		Final		
Casts; Urine	>10 hyaline casts/lpf	(No normal v...		Final		

Example 1: Urinalysis

LIWG Standardization:

- All the labs have moved to reporting in SI for the dipstick results
- Minor vocabulary changes for some of the labs
- The labs are moving towards discreet reporting of their Microscopic Urinalysis – 3 out of 4 are currently doing this with the last lab implementing this change on the LIS this fall
- Reference values will be standardized and flagging will displayed

Example 2: Lipoprotein tests

Lab 1:

Lab Results | 8 Records

Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Appearance: Plasma	Not done when triglycerides <4.5 mmol/L.			Final		
Cholesterol	10.9 mmol/L	0-4.6	High	Final		
Triglyceride	2.0 mmol/L	<1.7	High	Final		
Cholesterol In HDL	1.1 mmol/L	>1.0		Final		
Cholesterol In LDL	8.9 mmol/L	0-3.0	High	Final		
Lipoprotein Profile Comment	As this testing va... unknown) this l... repeat lipid pr... Total choleste...			Final		
Cholesterol/Cholesterol In HDL	9.7 mmol/L	0-4.5	High	Final		
Cholesterol In LDL/Cholesterol In ...	7.8 mmol/L	0-3.5	High	Final		

Example 2: Lipoprotein tests

Lab 2:

Lab Results | 6 Records

Show History

	Test	Result	Range	H\L	Status	Facility	Remarks
Biochemistry, Plasma/Serum							
	Fasting Status	FASTING			Final		
	Cholesterol	5.3 mmol/L	3.6-5.2	High	Final		BORDERLINE CHOLESTEROL ELEVATION: 5.2 TO 6.2
	Triglyceride	1.7 mmol/L	< 1.7	High	Final		
	Cholesterol In HDL	1.4 mmol/L	0.9-2.6		Final		
	Cholesterol In LDL	3.1 mmol/L	0.0-3.4		Final		DESIRABLE LDL-CHOL FOR ADULTS: LESS THAN 3.40
	Cholesterol/Cholesterol In HDL	3.91 Ratio	< 4.50		Final		

Example 2: Lipoprotein tests

Lab 3:

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol In HDL	0.9 mmol/L	> 1.0	Abnormal	Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol In LDL	3.09 mmol/L	< 3.0	Abnormal	Final		IDL calculation is invalid if triglycerides > 4.8 mmol/l 2

IDL calculation is invalid if triglycerides > 4.8 mmol/l 2

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Triglyceride	6.65 mmol/L	< 2.3	Abnormal	Final		

Lab Results 1 Records — Show History

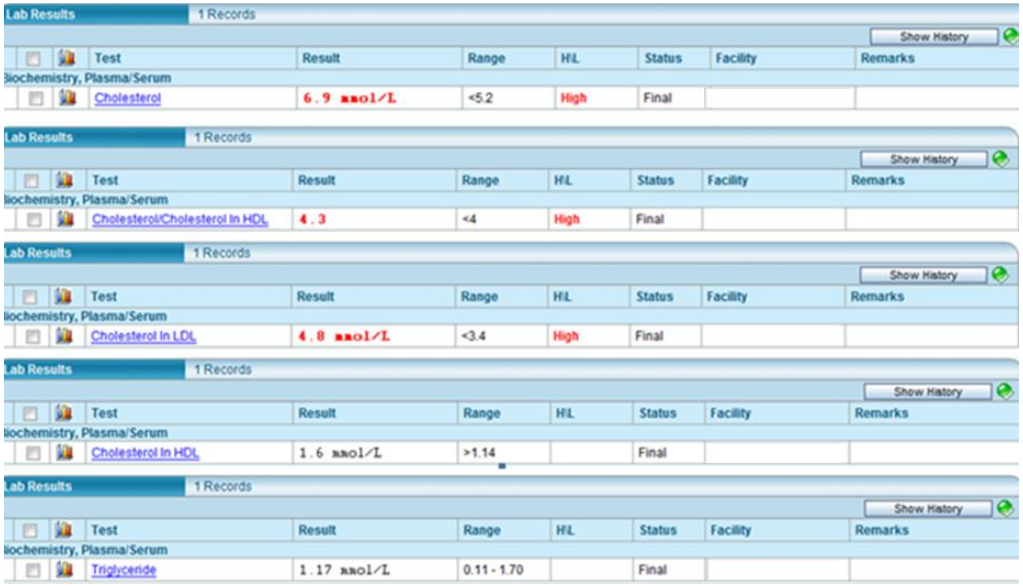
Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol Fasting	7.0 mmol/L	< 5.2	Abnormal	Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol/Cholesterol In HDL	7.8	< 3.5	Abnormal	Final		

Example 2: Lipoprotein tests

Lab 4:



Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol	6.9 mmol/L	<5.2	High	Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol/Cholesterol In HDL	4.3	<4	High	Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol In LDL	4.8 mmol/L	<3.4	High	Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Cholesterol In HDL	1.6 mmol/L	>1.14		Final		

Lab Results 1 Records — Show History

Test	Result	Range	H/L	Status	Facility	Remarks
Biochemistry, Plasma/Serum						
Triglyceride	1.17 mmol/L	0.11 - 1.70		Final		

Example 2: Lipoprotein tests

LIWG Review:

- Lab 1 and 2 report as a profile/panel. The other labs report the tests individually
- The fasting status is either reported as a comment or it is associated with the test or not at all
- 1 lab is reporting the Cholesterol LDL/HDL and Appearance;

  the others are not

Example 2: Lipoprotein tests

LIWG Review:

Adult Reference/therapeutic ranges

	Lab 1	Lab 2	Lab 3	Lab 4
Cholesterol Fasting			< 5.2	
Cholesterol Random			< 5.2	
Total Cholesterol	0-5.2	3.6 -5.2	N/A	< 5.2
Triglycerides	<1.7	<1.7	< 2.3	0.11 - 1.7
HDL Cholesterol	M >1.0, F>1.1	0.9 -3.4	M > 1.0, F > 1.3	F > 1.14, M > 0.9
LDL Cholesterol	0 - 3.4	0 -3.4	< 3.0	< 3.4
Cholesterol/HDL Ratio	0 - 4.5	< 4.50	< 3.5	< 4.0
LDL Cholesterol/HDL Cholesterol	0 - 3.5	N/A	N/A	N/A

Pediatric Reference/therapeutic ranges

	Lab 1		Lab 2		Lab 3	
	Age	Reference Interval	Age	Reference Interval	Age	Reference Interval
Cholesterol: Male	=<29 years	<4.6 mmol/L		N/A	All	< 5.2 mmol/L
Cholesterol: Female	=>30 years	<5.2 mmol/L		N/A	All	< 5.2 mmol/L
Fasting Cholesterol: Male			< 17 years	< 4.6 mmol/L		
Fasting Cholesterol: Female			< 17 years	< 4.6 mmol/L		
Random Cholesterol: Male			< 17 years	< 4.4 mmol/L		
Radnom Cholesterol: Female			< 17 years	< 4.4 mmol/L		
Trigylceride	All	<1.7 mmol/L	<19 years	<1.20 mmol/L	All	0.11 - 1.7 mmol/L
HDL Cholesterol: Male	All	1.0 – 10.0 mmol/L	All	> 1.0 mmol/L	All	> 0.9 mmol/L
HDL Cholesterol: Female	All	1.1 – 10.0 mmol/L	All	> 1.3 mmol/L	All	> 1.14 mmol/L
LDL Chlesterol: Male	=<29 years	<3.0 mmol/L	2-17 years	1.6-2.8 mmol/L	All	< 3.4 mmol/L
LDL Chlesterol: Female	=>30 years	<3.4 mmol/L	2-17 years	1.6-2.8 mmol/L	All	< 3.4 mmol/L
Total Cholesterol/HDL Cholesterol	All	<4.5		< 3.5	All	< 4
LDL Cholesterol/HDL Cholesterol	All	<3.5		N/A		
Non-HDL Cholesterol					All	< 4.3 mmol/L

Example 2: Lipoprotein tests

LIWG Standardization:

- Using the current recommended Canadian Cardiovascular guidelines
- Working with the Endocrinologists to help define some if these parameters
  - Standardizing the tests reported
  - Report the same reference/therapeutic ranges
  - Define if gender and fasting status should be reported
  - Age cutoffs for Pediatrics
- Standardizing the display and format of the results reported; in a panel/group format
- Move to a common LOINC across all the labs to enable trending

Example 3: Cortisol tests

LIWG Review:

- Community and hospital based labs have a different patient population and use a different reference range.

Adult Cortisol Reference Range Review			
	Cortisol AM	Cortisol PM	Cortisol Random
Lab 1	140-690 nmol/L	80-440 nmol/L	80-690 nmol/L
Lab 2	140-690 nmol/L	80-440 nmol/L	not reported
Lab 3	130-540 nmol/L	65-330 nmol/L	65-540 nmol/L
Lab 4	170-700 nmol/L	50-350 nmol/L	not reported

Example 3: Cortisol tests

LIWG Standardization:

- 2 different populations: inpatients and outpatients
- Separate LOINCs for each Cortisol test were given based on these different populations so they cannot be trended together.
- The community based labs have aligned their reference ranges to support their populations

Example 4: Electrolytes/Renal Tests

In progress but reviewing tests that we can standardize.

Adult Reference Values

Test	Lab 1 and 2				Lab 3	Lab 4
	Winnipeg	Rural (P or S)	Rural (WB)	Brandon (P or S)		
Sodium mmol/L	135 - 147 (P)	135-147	138 - 146 (*WB)	135-147	136 - 146 (S)	135-147 (S)
Potassium mmol/L	3.5 - 5.1 (P)	3.5-5.1	3.5 - 4.9 (*WB)	3.5-5.1	3.7 - 5.4 (S)	3.5-5.3 (S)
Chloride mmol/L	97 - 106 (P)	97-106	98 - 109 (*WB)	97-106	95 - 108 (S)	95 - 110 (S)
CO2 mmol/L	22-30 (P)	22-30		22-30	20 - 30 (S)	22 - 29 (S)
Calcium mmol/L	2.10-2.60 (P)	2.10-2.60		2.10-2.60	2.1 - 2.65 (S)	2.10 - 2.60 (S)
Corrected Calcium	2.10-2.60	2.10-2.60		2.10-2.60	no range supplied	2.10 - 2.60 (S)
Magnesium mmol/L - M	0.63 -0.94 (P)	0.63 -0.94		0.63 -0.94	N/A	0.65 - 1.05 (S)
Magnesium mmol/L - F	0.70-0.96 (P)	0.70-0.96		0.70-0.96		
Magnesium mmol/L					0.65 - 1.05 (S)	
Phosphate mmol/L	0.81-1.45 (P)	0.81-1.45		0.81-1.45	0.8 - 1.45 (S)	0.80 - 1.50 (S)
Anion Gap mmol/L	8-16	8-16		8-16		
Glucose mmol/L	3.6 - 6.0 (P)	3.6-6.0	3.9 - 5.8 (*WB)	3.6 - 6.0	3.6 - 7 (S)	3.6 - 6.0 (S)
Fasting Glucose * *	3.6 - 6.0 (P)	3.6-6.0	3.6 - 6.0 (*WB)	3.6 - 6.0	3.6 - 6 (S)	3.6 - 6.0 (S)
Urea mmol/L	2.8 - 7.1 (P)	12.8-7.1	2.9 - 9.4 (*WB)	2.8-7.1	2.5 - 8.1 (S)	2.8 - 8.1 (S)
Creatinine umol/L - M	44 - 106 (P)	44-106	53 - 115 (*WB)	44 - 106	60 - 110 (S)	35 - 105 (S)
Creatinine umol/L - F	35-97 (P)	35-97	53 - 115 (*WB)	35-97	50-100 (S)	35-97 (S)
Urea/Creatinine Ratio mmol urea/mmol creatinine	<70 (P)	<70			40 – 110 (S)	
eGFR ml/min/1.73 m sq	>=60 (P)	>=60		>=60	> 60 (S)	> 60 (S)

P = plasma, S = serum, WB=whole blood — ** some rural labs use whole blood*

Challenges: Governance and Communication

- There will need to be continual "buy in" from the labs and Manitoba eHealth to maintain these standards
- There will be tests that we cannot normalize due to lack of standardized guidelines and studies
- Continual monitoring of changes from the labs which needs to be brought forward to the working group
- Communication needs to be standardized from the labs
- Implementation and at each lab may occur at different times

Lab Interoperability

- More than LOINC mapping
- Involves standardization of lab results where applicable
- Working together as a team of labs with one common goal **:** to ensure that lab results reported from the various LIS' are managed and interpreted in a reliable way

Questions?