Visual Acuity: A Case Study for a Complex Clinical Concept

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Background

Visual acuity is one of the most important clinical measurements and outcomes in eye care and vision research, but it has several complexities that make it challenging to use in a standardized, observational health database. Visual acuity can be measured in multiple different ways, such as with corrective lenses and without, at distance or near, with the left eye, right eye, or both eyes, to name a few. With all these modifiers, creating fully pre-coordinated concepts would require thousands of concepts, which is not sustainable to maintain over time. Further, visual acuity can be measured using different methodologies and charts, resulting in different values and data types, such as "20/20", "28 letters", "hand motion", "fix and follow".[1] Finally, visual acuity is entered into free text fields in electronic health records (EHRs), which results in a huge variety of data entries, many of them considered to be non-standard.[2,3]

Methods

The OHDSI Eye Care and Vision Research workgroup has been addressing these challenges for the past two years using the following methods:

1. Mapping. We identified the fields in the EHR that were related to visual acuity and then mapped them to existing standardized concepts, noting whether the mapping was an exact match, narrower, wider, or missing.
2. New Concepts. We proposed a LOINC panel for representing visual acuity concepts.
3. Software Library. We developed a software library that extracts the visual acuity values and transforms them into standard values.
4. ETL Process. We are developing and documenting a standardized ETL process for visual acuity.

Results

1. Mapping. In the Epic EHR, there were 40 visual acuity fields; 31 of those mapped to wider concepts while 9 had exact matches. In Cerner, there were 33 visual acuity fields; 15 had exact matches while 14 mapped to wider concepts and 4 had no match.
2. New Concepts. We developed a proposed LOINC panel that fully represents the variety of visual acuity fields in the EHR (**Figure 1**). This panel includes the method for measuring visual acuity, along with some pre-conditions that include more details about the measurement, and then visual acuity for left, right, both, and unspecified laterality. The values for visual acuity can be in

x ft/*y* ft, *x* m/*y* m, log Minimal Angle of Resolution (logMAR), *x* cycles per degree, count fingers, hand motion, light perception, no light perception, *x* letters.

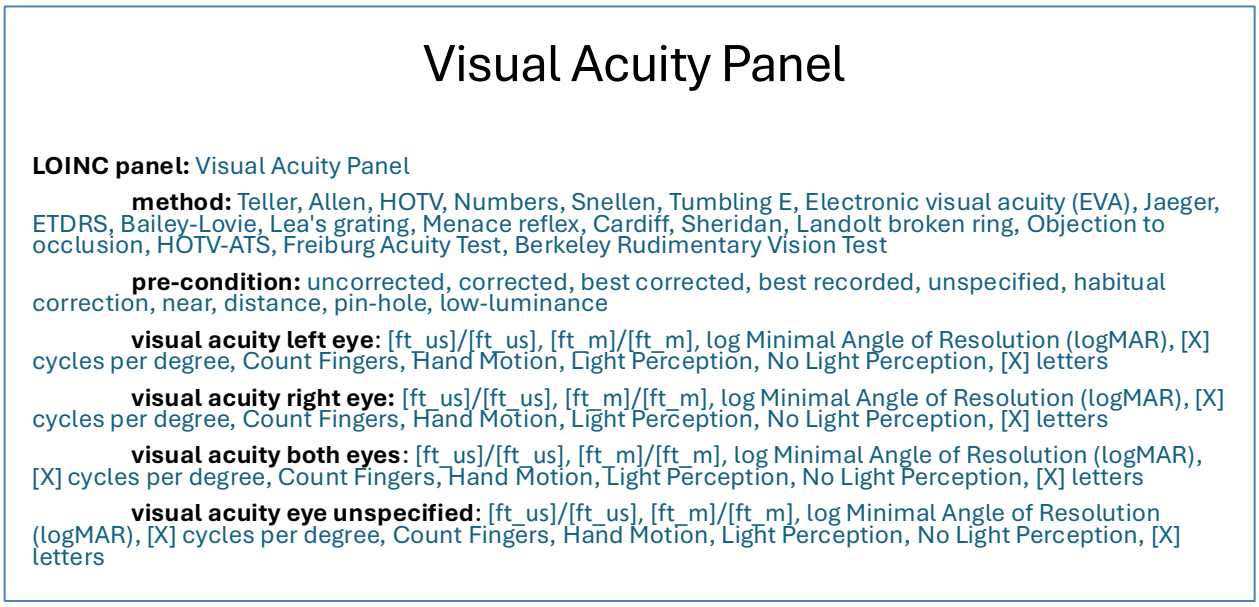

Figure 1: LOINC panel for visual acuity representation.

3. Software Library. We developed the `visualacuity` toolkit to consistently extract and transform values from EHR free text fields.[4] This library will take free text values and extract the visual acuity values, ignoring any extra text. It will also calculate Snellen and logMAR equivalents when possible. See **Table 1** for example inputs and outputs from the library.

Example EHR Entry	Visual Acuity Type	Visual Acuity Chart	Extracted Value	Plus Letters	Snellen Equivalent	LogMAR Equivalent
20/20 squinting	Distance	Snellen Chart	20/20		20/20	0.00
20/20 + 1	Distance	Snellen Chart	20/20	+1	20/20	-0.02
20/60 -2	Distance	Snellen Chart	20/60	-2	20/60	0.51
Hand Motion	Near Total Loss		HM			
J1+	Near	Jaegar Chart	J1+		20/20	0.00
83 Letters	Distance	ETDRS	83 Letters		20/20	0.00
38.0 cycles/degree	Distance	Teller Card	38.0 cycles/degree		20/23	0.06
CSM	Binocular		CSM			
NI	Pinhole	Snellen Chart				

Table 1: Example input and output from the `visualacuity` toolkit.

4. ETL Process. We are currently developing an ETL process that uses the LOINC panel and the `visualacuity` toolkit to map, extract, and store visual acuity values in an OMOP database. After multiple discussions, we agreed that visual acuity measurements will be stored as numbers (converted to logMAR using the formula: $logMAR = -1 \times log_{10}(Snellen\_fraction)$) in the measurement table, using measurement_source_concept_id to store modifiers related to that visual acuity measurement, and storing the extracted VA value (before conversion) as a string in the value_source_value field. See **Table 2** for an example ETL result for a left eye distance corrected visual acuity value of 20/20. Additionally, ETL scripts will calculate and store the best recorded visual acuity for each eye at each office visit, since this is the most common way that researchers will use visual acuity values from EHRs in research. **Table 3** shows an example ETL

result for a best recorded visual acuity for the left eye with a value of 20/20. Note: there is not yet a standardized concept for best recorded visual acuity.

Measurement Table	
Field	**Value**
measurement_concept_id	4131378 (LogMAR visual acuity left eye)
value_as_number	0
value_source_value	20/20
measurement_source_concept_id	4311837 (Snellen visual acuity) 4288368 (Corrected visual acuity) 4090514 (Distance visual acuity)

Table 2: Example ETL result for Left Eye Distance Corrected VA of 20/20

Measurement Table	
Field	**Value**
measurement_concept_id	4131378 (LogMAR visual acuity left eye)
value_as_number	0
value_source_value	20/20
measurement_source_concept_id	xxxxxxx (Best recorded visual acuity)

Table 3: Example ETL result for Left Eye Best Recorded VA of 20/20 (Note: need to add concept for best recorded VA)

Conclusion

Visual acuity is an important concept for eye care and vision research and has several challenges for mapping and extracting the visual acuity values from the EHR. A multi-pronged approach was needed to ensure that the values are extracted and transformed consistently, and are mapped properly into OMOP concepts. Future work includes submitting the visual acuity panel to LOINC, harmonizing visual acuity values that do not have logMAR equivalents, deploying the ETL process for visual acuity, adding visual acuity to the OMOP common data model, and adding concepts for units. The process we have followed for this complex concept can be copied for other concepts in other medical domains and settings.

References

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