Gap Analysis of Static Automated Perimetry Concept Representation in OMOP CDM

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Background

Preserving the field of vision and minimizing its loss is the end point of glaucoma care, an outcome routinely monitored in daily practice via assessment of the field of vision using static automated perimetry (SAP). [1-3] Despite the widespread use of this modality and the significance of its results in ophthalmology, SAP data are often unavailable in "big data" collections (e.g., *All of Us*, institutional EHR data warehouses, and centralized registries), with the reason being that these data cannot be easily extracted and do not have any representations in standard data models like the Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM). [4] We aimed to identify and address gaps in the representation of SAP data elements in standardized terminologies and the OMOP CDM.

Methods

SAP source data elements were extracted from the two most frequently used perimeter devices, the Humphrey Visual Field Analyzer (HFA), and Octopus Perimeter (OP), entailing both data extracted from the devices as well as data elements from the DICOM OPhthalmic Visual field (OPV) supplement 146. Supplement 146 is the existing standard for representing SAP data set forth by DICOM Ophthalmology Working Group 9. In that standard, SAP data can be represented using 16 modules, which include 448 attributes. These were extracted and compared against existing terms in the Logical Observation Identifiers Names and Codes (LOINC) browser and the OMOP CDM using the OHDSI Athena browser. Gap areas were classified following standards put forth by Health Level 7 (HL7) Fast Healthcare Interoperability Resources (FHIR). The classifications were defined as follows: "Equivalent" meant the OMOP mapping directly represented the source data element; "Wider" indicated the mapping captured the source element but with some information loss; "Narrower" meant the mapping included additional, potentially inaccurate information; and "Unmatched" signified that no appropriate mapping could be found. Then, a Sankey diagram was employed to summarize the mapping results. Gaps were discussed within the OHDSI Eye Care and Vision Research Workgroup consisting of informaticists, ophthalmologists, and glaucoma specialists in iterative rounds aiming to address gaps. New codes were developed upon reaching consensus within the workgroup and proposed for inclusion in LOINC.

Results

A total of 107 data elements were extracted from HFA and OP source files and grouped into data elements that provide information around test specifications, eye level, cluster level, point level information, or trend analysis results. Of these data elements, 88 (82.2%) were unmatched in the OMOP CDM. Of the 19 (17.8%) remaining data elements, 3 (2.8%) had wider, and 2 (1.9%) had narrower representation. Only 14 (13.1%) had equivalent representation (Figure 1). Of the 116 OPV DICOM class-specific attributes, only 3 (2.6%) had representation in the OMOP CDM. Upon searching the Athena browser, we came across 18 relevant data elements that were deemed erroneous and not useful upon discussion within the workgroup. Concepts such as "visual field index" appeared to be erroneous because the term "index" was used in its literal meaning, and it subsumed other global parameters, including "glaucoma hemifield test", "loss variance", "mean deviation", and "pattern standard deviation"; whereas in the context of the HFA, visual field index (VFI) expresses the visual field status as a percent of a normal age-adjusted visual field (so a vendor-specific metric). "Pupil diameter" was defined as a parent code that subsumed "Pupil diameter | Left eye | Ophthalmology and Optometry" and "Pupil diameter | Right eye | Ophthalmology and Optometry". Further, existing LOINC codes appeared erroneous in this context (e.g., Perimeter format Humphrey, Perimeter format Octopus, etc.). New codes addressing areas of gap and closely aligning with DICOM supplement 146 were proposed for addition to LOINC.

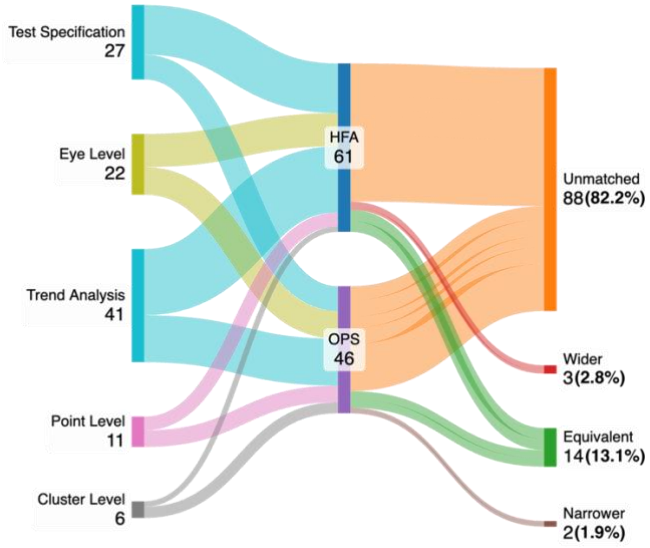

Figure 1. Mapping of the extracted data elements to OMOP concepts. HFA: Humphrey Field Analyzer, OPS: Octopus Perimeter

Conclusion

Our gap analysis highlights significant deficiencies in the current representation of SAP visual field testing data within the OMOP CDM and LOINC. The proposed new codes, aligned with OPV DICOM supplement 146, offer a promising solution to these gaps. By enabling more accurate and comprehensive data representation, this work will facilitate research, clinical practice, and data sharing across the ophthalmology community. Future efforts may focus on expanding these standards to include additional forms of perimetry and ensuring widespread adoption and compliance across various devices and vendors.

References

1. Nouri-Mahdavi, K. Selecting visual field tests and assessing visual field deterioration in glaucoma. Canadian Journal of Ophthalmology. 2014;49(6):497-505.
2. Jampel, H. D.; Singh, K.; Lin, S. C., et al. Assessment of visual function in glaucoma: a report by the American Academy of Ophthalmology. Ophthalmology. 2011;118(5):986-1002.
3. Delgado, M. F.; Nguyen, N. T.; Cox, T. A., et al. Automated perimetry: a report by the American Academy of Ophthalmology. Ophthalmology. 2002;109(12):2362-2374.
4. Goetz, K. E.; Reed, A. A.; Chiang, M. F., et al. Accelerating Care: A Roadmap to Interoperable Ophthalmic Imaging Standards in the United States. Ophthalmology. 2024;131(1):12-15.