An Ontologic Approach to Leverage Surgical Training Data

Development and application of a CranioMaxilloFacial ontology

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Oral and maxillofacial surgery (OMS) is a surgical specialty involving procedures on the neck and head. OMS training program accreditation and evaluation requires reporting the surgical experiences of trainees. Current systems for tracking these experiences are based on coarse payment coding systems. To provide more granular training data, we are developing an ontology-driven surgical resident training log (OMSLog). We use a blended architecture consisting of an interface for trainees, faculty, and/or administrators to record surgical experiences, a traditional relational database back-end for data storage, with both supported by a new domain ontology. The CranioMaxilloFacial (CMF) ontology is built on a SNOMED CT foundation and is extended to include granular domain concepts and educational experiences. Current results are a pilot graphical user interface (GUI) driven by a >7,000 concept domain ontology. Future steps include pilot testing in the residency program and ontological alignment with the Human Phenotype Ontology (HPO).

Keywords—Oral and maxillofacial surgery; craniofacial; ontology; training; human phenotype ontology

I. INTRODUCTION

Oral and Maxillofacial (OMS) residents are required to track their surgical experiences in non-standardized program training logs. Each year, OMS training programs expend resources to gather disparate data to meet reporting requirements for the Commission on Dental Accreditation (CODA) Annual Survey. In both cases, localized, ad hoc tools populated with data based on clinical billing terminologies such as the International Classification of Disease (ICD-9) and Current Procedure Terminology (CPT) are used.

Reliance on reimbursement codes for clinical data yields coarse reporting that does not correlate educational experience with surgical competency. Given the impediments of current OMS data format and flow, opportunities for transparent, real-time individual and program-level quality improvement activities are being missed. To address this problem, we developed the "OMSLog," a resident log system driven by a new CranioMaxilloFacial (CMF) domain ontology.

II. CRANIOMAXILLOFACIAL ONTOLOGY

A. Ontology Development Model

To develop the CMF ontology, we leveraged an existing clinical ontology (SNOMED-CT) and built in enhancements to improve domain knowledge representation. This was performed by a clinical domain expert who identified relevant clinical finding and procedure concepts for leverage in SNOMED and extended these into more granular domain concepts. The logic model of the CMF ontology is consistent with SNOMED as it arranges concept terminology into the existing SNOMED hierarchy and leverages SNOMED's property types and anatomical sites. Additionally, a custom class hierarchy of OMS educational concepts was created to characterize the educational experience of each respective clinical finding and procedure concept. Concept definitions, synonyms, and mappings to CPT, ICD-9, and ICD-10 will be included as annotations.

B. System Architecture

The application interface (Figures 1 and 2) is built on an open-source Java web application stack utilizing Linux, the Apache webserver, with Java server pages (JSP) being hosted by a by Tomcat server. All system code is sub-versioned using GitHub. Static data and reporting is supported by a MySQL relational database (RDB). The resource description framework (RDF) triple-store is indexed via Solr/Lucene to support rapid querying and traversal of the procedure and diagnosis trees for browsing and selection. Both the RDB and RDF are driven by the CMF ontology. The ontology will be rendered and versioned as a set of OWL files that merge to drive the SOLR/Lucene functionality. Next steps include mapping historical log data to the existing RDB, and performing pilot testing and evaluation of the system. We are also developing a plan to align the CMF ontology with the Human Phenotype Ontology (HPO) in order to contribute new craniofacial malformation classes to the existing HPO class hierarchy.

Funding provided by NIH Grant number 2T15LM007088-21 REVISED

III. SCREENSHOTS

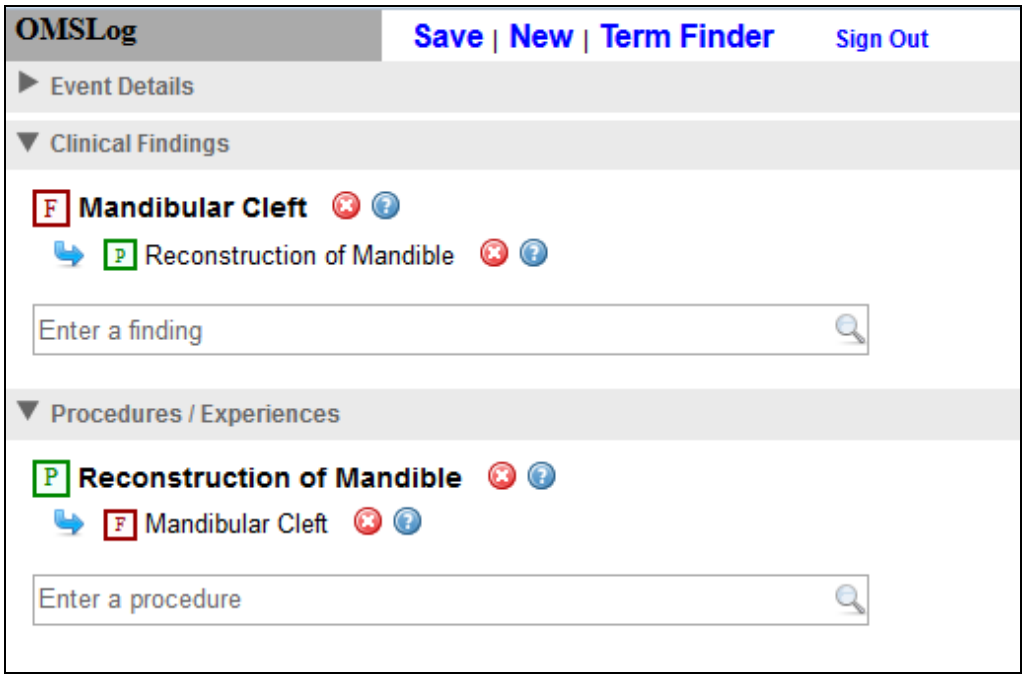

Figure 1 OMSLog Term Entry & Association

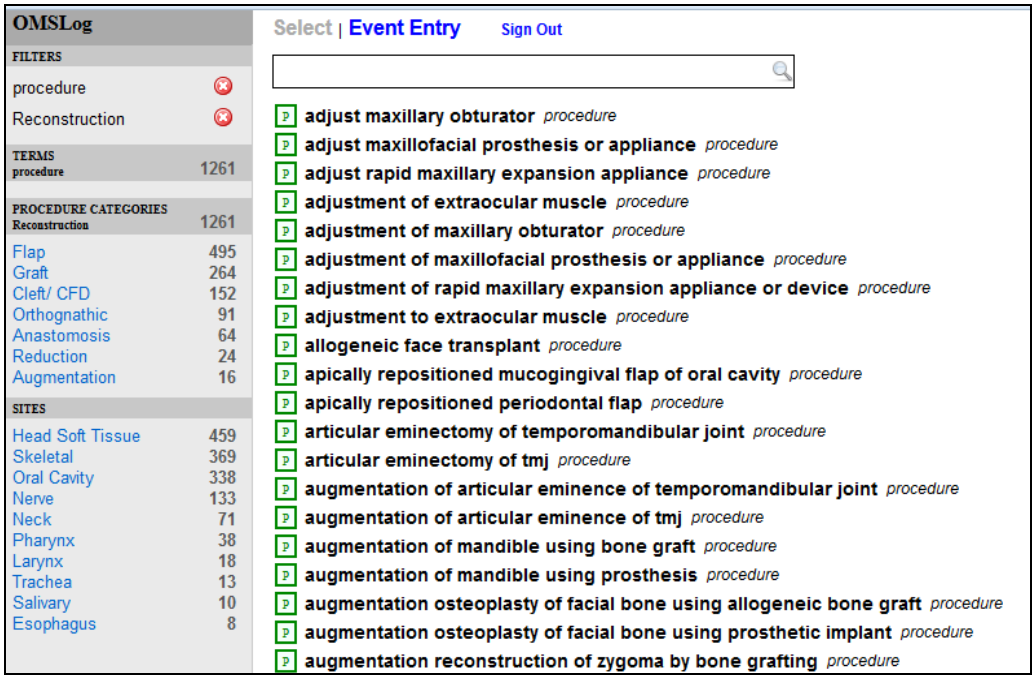

Figure 2 OMSLog Term Search Builder