# 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 supported by a new domain ontology. both 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, realtime 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.

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III. SCREENSHOTS

OMSLog	Save   New   Term Finder	Sign Out
Event Details		
▼ Clinical Findings		
F Mandibular Cleft 🔞 🤅 🍉 🕑 Reconstruction of Mar		
Enter a finding		Q
Procedures / Experiences		
P Reconstruction of Man 🕒 F Mandibular Cleft 🙆		
Enter a procedure		9

Figure 1 OMSLog Term Entry & Association

OMSLog		Select   Event Entry Sign Out
FILTERS		
procedure	<b>(3)</b>	<u> </u>
Reconstruction	<b>(3)</b>	adjust maxillary obturator procedure
TERMS		adjust maxillofacial prosthesis or appliance procedure
procedure	1261	adjust rapid maxillary expansion appliance procedure
PROCEDURE CATEGORIES		adjustment of extraocular muscle procedure
Reconstruction	1261	adjustment of maxillary obturator procedure
Flap Graft	495 264	adjustment of maxillofacial prosthesis or appliance procedure
Graπ Cleft/ CFD	264 152	adjustment of rapid maxillary expansion appliance or device procedure
Orthognathic	91	adjustment to extraocular muscle procedure
Anastomosis Reduction	64 24	P allogeneic face transplant procedure
Augmentation	16	apically repositioned mucogingival flap of oral cavity procedure
SITES		apically repositioned periodontal flap procedure
Head Soft Tissue	459	articular eminectomy of temporomandibular joint procedure
Skeletal	369	articular eminectomy of tmj procedure
Oral Cavity Nerve	338 133	augmentation of articular eminence of temporomandibular joint procedure
Neck	71	augmentation of articular eminence of tmj procedure
Pharynx	38	augmentation of mandible using bone graft procedure
Larynx Trachea	18 13	augmentation of mandible using prosthesis procedure
Salivary	10	augmentation osteoplasty of facial bone using allogeneic bone graft procedul
Esophagus	8	augmentation osteoplasty of facial bone using prosthetic implant procedure
		augmentation reconstruction of zygoma by bone grafting procedure

Figure 2 OMSLog Term Search Builder