The Development of a Dental Diagnostic Terminology

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Abstract: There is no commonly accepted standardized terminology for oral diagnoses. The purpose of this article is to report the development of a standardized dental diagnostic terminology by a work group of dental faculty members. The work group developed guiding principles for decision making and adhered to principles of terminology development. The members used an iterative process to develop a terminology incorporating concepts represented in the Toronto/University of California, San Francisco/ Creighton University and International Classification of Diseases (ICD)-9/10 codes and periodontal and endodontic diagnoses. Domain experts were consulted to develop a final list of diagnostic terms. A structure was developed, consisting of thirteen categories, seventy-eight subcategories, and 1,158 diagnostic terms, hierarchically organized and mappable to other terminologies and ontologies. Use of this standardized diagnostic terminology will reinforce the diagnosis-treatment link and will facilitate clinical research, quality assurance, and patient communication. Future work will focus on implementation and approaches to enhance the validity and reliability of diagnostic term utilization.

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To date, the dental profession has failed to develop a commonly accepted standardized terminology to describe oral diagnoses and has lagged far behind medicine in its codification of diagnoses. The benefits of a common terminology describing diagnoses include empowering dentists to document the types and frequency of conditions they encounter, enhancing communication with patients and other clinicians, enabling outcomes-tracking, and facilitating data sharing across sites.[1] Diagnostic terms would allow epidemiologists to evaluate disease patterns, treatment patterns, and disease outcomes, while health services researchers could use the codes to study risk-adjusted, cross-sectional, and temporal variations in access to health care, health care quality, costs of care, and treatment effectiveness.[2] Beyond these, a standardized diagnostic terminology has further advantages in the educational setting: it hones formal diagnostic skills, emphasizes the link between diagnosis and treatment, and enhances patient care. Thus, there is a pressing need to develop and implement a standardized dental diagnostic terminology, especially in dental schools training the next generation of dental providers.

This development of a dental diagnostic terminology is timely given the expanding presence of

electronic health records (EHR) in dentistry, which medicine is capitalizing upon. For example, through the analysis of International Classification of Diseases (ICD) codes entered into the EHR, researchers were able to identify an association between myocardial infarction and the COX-2 inhibitors rofecoxib and celecoxib.[3] The dental profession's ability to conduct similar studies is critically impeded by the lack of a standardized dental diagnostic terminology.

In medicine, a number of standard terminologies have been developed to facilitate data exchange among individuals and systems because no single terminology has satisfied all needs for all users. In addition to the ICD, other widely used terminologies include Diagnosis-Related Groups (DRGs), developed for the purpose of Medicare prospective payment; International Classification of Primary Care (ICPC), a classification of about 1,400 diagnostic concepts that are partially mapped to ICD-9; Current Procedural Terminology (CPT), used for billing and reimbursement; and the Diagnostic and Statistical Manual of Mental Disorders (DSM), providing definitions of psychiatric disorders and specific diagnostic criteria.

In contrast, while there have been previous efforts to standardize dental diagnostic terms, they have not achieved widespread acceptance, and they have fallen short in their comprehensiveness or availability. Early on, it was noted that terms for oral diseases within the ICD terminology were insufficiently precise and not consolidated within the ICD volume. Consequently, the ICD-DA (application of the ICD to Dentistry and Stomatology) was added at the time of the eighth revision of the ICD in 1965.[4] Nevertheless, recent articles have highlighted the inadequacy of the existing ICD terminology as it pertains to oral diagnosis documentation.[5] In the United States, organized dentistry has become increasingly involved in the movement to codify diagnostic terms. Since the early 1990s, the American Dental Association (ADA) has led the creation of SNODENT, the Systematized Nomenclature for Dentistry. Where ICD is a terminology, SNODENT is an ontology. The distinction between the two is that a terminology is a set of terms representing the concepts within a particular field, while an ontology represents the relationships between these concepts. SNODENT is comprised of diagnoses, signs, symptoms, and complaints[6] and currently includes over 6,000 terms. However, unlike its available medical counterparts (SNOMED and ICD-9), SNODENT has not yet been finalized and is not available for use by general practitioners or dental schools. To address the critical need, some groups have independently generated dental diagnostic terminologies.[7,8] However, there is no supporting literature on whether they have served their purpose well,[9] and among these, only the Toronto codes have been systematically evaluated.[1] In 1998, the University of California, San Francisco (UCSF) created Z codes based upon the Toronto codes[10] and the existing ICD version. In 2007 Creighton University made further modifications to these Z codes.

The EHR itself is a powerful vehicle to standardize the use of dental diagnostic codes. The vast majority of North American dental schools operate in a fully digital format or are on track to do so within the next two to three years. In February 2007, fourteen dental schools that use a common EHR system, axiUm (Exan Corporation, Vancouver, Canada), agreed to share oral health data and formed the Consortium for Oral Health-Related Informatics (COHRI), which now includes more than twenty dental schools. A more detailed discussion of the formation of COHRI, including which schools are in COHRI, can be found elsewhere.[11] COHRI's effort to create an interuniversity oral health research database based upon the common EHR software system was funded by the National Library of Medicine (1G08LM010075-01). An overarching goal of COHRI is to develop common core information within the EHR to facilitate data sharing among the dental schools. In February 2008 the members agreed that implementing and thus standardizing diagnostic terms would be paramount, and a diagnostic terminology work group was formed. This article discusses the consensus development process for the creation of the dental diagnostic terminology.

Methods

The goal was to create a dental diagnostic terminology. The words "terminology" and "vocabulary" are often used interchangeably. A terminology is a set of terms (designation of a defined concept) representing the systems of concepts of a particular subject field. A concept is defined as a unit of thought and a vocabulary as a dictionary containing the terminology of a subject field. Ontology is defined as a set of concepts within a domain and the relationships between those concepts.

Work Group Charge

COHRI charged the diagnostic codes work group with developing a dental diagnostic terminol-

ogy that 1) all COHRI members can utilize; 2) shall be easy to use, intuitive, and inclusive of existing terminologies because two schools have used the Z codes for many years and oral surgeons use the ICD system for surgical diagnoses; 3) shall be loaded into the EHR system; 4) shall be hierarchically organized to facilitate retrieval of terms and mappable to other terminologies and ontologies, such as SNODENT in the future; and 5) shall be developed for rapid implementation. There were two primary motivations driving the creation and development of the terminology. The first was to enhance the academic and clinical experience of dental students. The second was to facilitate the integration of data between dental schools and the data analyses for research and quality improvement purposes. It was furthermore decided that the diagnostic terminology created would be called "EZcodes."

Guiding Principles

As a first step, the work group developed a set of guiding principles. Guiding principles are an effective tool for self-managed teams to use in making strategic decisions.[12] Guiding principles rely on the power of shared, emotional narratives to help guide decision making. This is a dialogue-intensive process involving stages of inquiry, divergence, and convergence. Guiding principles function as the group's justifications for their developed rules and differ from norms in that they embed self-referential storylines to which team members feel emotionally attached. Guiding principles do not outline various kinds of detailed decision criteria. Instead, they call upon narrative logics and forms of understanding among individuals and are used to guide specific actions in specific contexts. Guiding principles are thus not as specific as "simple rules," but they may constitute a form of foundation upon which such rules could be developed. As described by Oliver and Roos they serve as "rules of thumb."[13] The process of drafting, discussing, and agreeing on the guiding principles led to a climate of collegiality and buy-in.

Guiding Principle 1. Incorporate and integrate oral health concepts in existing controlled terminologies. Oral health concepts already exist in some medical terminologies such as ICD-9, ICD-10, and SNOMED. Further, some dental schools are using Z codes (UCSF and Creighton University) to describe dental diagnoses. The distinction between findings and diagnoses was debated amongst members of the work group. In SNOMED, findings are defined as a "clinical observation, assessment or judgment, and [which] include both normal and abnormal clinical states" (www.ihtsdo.org/snomed-ct/snomed-ct0/snomed-ct-hierarchies/clinical-findingdisorder/). Instead of diagnosis, SNOMED uses the term "Disease" (or "Disorder"), which by definition are "always and necessarily abnormal clinical states." We have included findings that were part of the Z code structure, e.g., mandibular torus, following Principle 1. For the initial version of EZcodes (Table 1) it was decided that findings and diagnoses would be structured under the same hierarchy (used for facilitating retrieval of concepts). The work group plans to monitor and evaluate the use of findings and adjust their inclusion in the EZcodes and how they are classified in future revisions.

Guiding Principle 2. Conform to best practices of clinical terminology development. By adhering to best practices in terminology development,[14] we aimed to create a robust terminology that can be used in modern electronic health record systems, modified appropriately as new knowledge is discovered, and be mapped to other vocabularies such as SNOMED to facilitate information exchange. Therefore, as recommended by Cimino,[14] each diagnostic concept was assigned a preferred term and a nonsemantic concept identifier, i.e., an identifier without hierarchical or other connotations, in order to avoid two major problems: 1) running out of room in the coding system and 2) reclassification issues as the EZcodes are updated. It is expected that end users will select terms based on the concept name rather than a specific "code" or identifier. Furthermore, this approach allows concepts to be placed in multiple hierarchies and allows reclassification.[14] However, we were cognizant of time and resource constraints and therefore took a deliberately pragmatic approach to rapidly develop the terminology adhering to as many of the desirable terminology best practices as possible. For instance, formal definitions have not yet been defined for each concept, and a few instances of "Not Otherwise Specified" remain. Also, our terminology would not currently support inferencing,[15] as relationships have not yet been defined. However, such relationships will be specified in the future. For example, concepts in the EZcodes could be related to other terminologies such as the Functional Model of Anatomy ontology, which could help describe an anatomical location of a dental diagnosis.

Guiding Principle 3. Facilitate retrieval by hierarchically structuring concepts into categories and subcategories. Every term will be assigned to one

Table 1. Dental diagnostic categories and their subcategories in initial version of EZcodes

Category	Subcategories		Number of Terms
Abnormalities of Teeth	Cementum Defect Dentin Defect Enamel and Dentin Defect Enamel Defect Eruption Abnormalities	Number Alteration Pulp Abnormalities Shape Alteration Size Alteration	76
Temporomandibular Joint (TMJ) Disorders	Articular Incompatibility Condyle-Disc Derangement Mandibular Hypomobility Masticatory Muscle Disorder	TMJ Growth Disorder TMJ Inflammatory Disorders TMJ Pain TMJ Dysfunction	59
Endodontics	Pulpal Diagnosis Secondary Pulpal Conditions Periapical Diagnosis	Secondary Periapical Conditions Root Fractures	30
Periodontics	Acute Inflammatory Lesions: Periodontal Chronic Gingival Lesions Chronic Periodontal Lesions Combined Periodontic-Endodontic Lesions	Gingiva Deformity Ridge Association Gingiva Deformity Tooth Association Other: Periodontal Trauma from Occlusion	76
Oral Pathology/Radiology	Benign Nonodontogenic Pathosis Benign Odontogenic Pathosis Buccal Mucosal Swelling Cyst of the Oral Region Face Swelling Floor of Mouth Swelling Genetic Jaw Disease Gingival Swelling Inflammatory Jaw Lesion Allergic Reaction Lip Swelling Malignant Neoplasm Metabolic Jaw Disease Throat/Neck Swelling Palatal Swelling Other Hard Tissue Lesion	Other Soft Tissue Enlargement Other Surface Lesion Oral/Perioral Pigmentation Paranasal Sinus Pathology Red-Blue Lesion Salivary Gland Pathology Skin Lesion Soft Tissue Calcification Sexual Transmitted Diseases Systemic Disease Manifest Jaw Tongue Swelling/Pathology Ulcerative Condition Verrucal-Papillary Lesion Vesiculo-Bullous Condition White-Yellow Lesion	609
Trauma/Fractures	Facial Fracture Mandible Fracture	Maxilla Fracture Oral Structure Trauma	63
Caries/Loss of Tooth Structure	Caries Loss of Tooth Structure	Deposits on/Staining of Teeth Caries Risk	72
Occlusion Disorders	Malocclusion Teeth Position	Jaw Development	50
Removable Prosthetics	Complete Denture	Removable Partial Denture	31
Anatomic Abnormalities	Hard Tissue Abnormality	Soft Tissue Abnormality	25
Harmful Oral Habits	Harmful Oral Habits		21
Pain/Altered Sensation	Altered Sensation	Pain	36
Defective Restoration	Defective Restorations		11

or more subcategories. The means of organizing the codes was selected in order to facilitate identification of the appropriate EZcode term by an end user. The structure of categories and subcategories was based upon the Toronto/UCSF/Creighton Z code structure.

Guiding Principle 4. Evaluate and refine on a regular basis. It was decided that the Harvard School of Dental Medicine (HSDM) and the Academic Center for Dentistry at Amsterdam (ACTA) would formally pilot the EZcodes for eighteen months. However, during this time, the EZcodes were made available to all COHRI schools, and to date three dental schools (at Western University of Health Sciences, University of Oklahoma, and Virginia Commonwealth University) are using the EZcodes. After the piloting period, EZcodes will be made available to all axiUm schools and will be updated by the COHRI Diagnostic Codes Work Group through a biannual review process. This principle also implied that once the list was considered complete, schools could not add or create additional codes, except through the biannual revision of the EZcodes.

Guiding Principle 5. Link diagnostic and procedure codes. The diagnostic codes should be linked to the appropriate Dental Procedure Code, which is owned and biannually updated by the ADA. This code is designated by the federal government under the Health Insurance Portability and Accountability Act (HIPAA) as the national terminology for reporting dental services and is recognized by third-party payers nationwide.[16] In the academic environment, the purpose is to reinforce the connection between diagnosis and treatment. Furthermore, this mapping can be employed to validate diagnostic code entry. The mapping is in progress for the ADA Dental Procedure Code, and an analogous process can be followed for international procedure coding systems.

Development Process

The development process for EZcodes is outlined in Figure 1. It is generally accepted that terminologies must have a clearly defined goal in order to be useful. The primary educational goal of this effort is to clarify why a procedure is being done and, thus, in an educational sense, tie the student's chosen treatment to the patient's diagnosis.

In accordance with the charge that the developed terminology be easy to use, intuitive, and inclusive of existing terminologies, we developed the EZcodes to build upon existing terminologies and be structured in a way that would be readily understood by its users and would integrate with existing procedural coding systems, e.g., the CDT system that is used for billing in U.S. dentistry. As described in Guiding Principle 3, the Toronto/UCSF/Creighton Z code categories and subcategories structure was selected as the skeleton upon which the EZcodes would be built. This skeleton, rather than the ICD skeleton, was chosen because it better represents dental clinical practice. For instance, ICD does not contain any subcategories to describe the commonly encountered diagnoses of defective restoration or broken removable prosthesis. Because the EZcodes will be mappable to ICD-9 and ICD-10 as well as SNOMED, they satisfy the objectives and measures of the meaningful use criteria set forth by the Health Information Technology Policy Council in accordance with the HITECH section of the American Recovery and Reinvestment Act.[17] Recognizing the limitations of the strict hierarchical ICD-9/10 structure, we decided to adopt a polyhierarchical structure, such as SNOMED's in which terms could exist in multiple places yet correspond to the same concept.

The next step was to populate this skeleton with content, which is a key factor in terminology development.[14] The work group's objective was to ensure adequate concept orientation, i.e., "that terms must correspond to at least one meaning ('nonvagueness') and no more than one meaning ('nonambiguity'), and that the meaning corresponds to no more than one term ('nonredundancy')."[14] It was found that this quality was not present in the existing ICD terminology. For example, hypodontia and oligodontia are listed under anodontia. Anodontia denotes the complete absence of teeth, whereas hypodontia indicate that one or a few teeth are missing and oligodontia is used when a significant number of teeth are missing. Though related, each of these diagnoses is distinct enough to require separate coding. Initially, we considered only the concepts represented in the Toronto/UCSF/Creighton Z codes and ICD-9/10. Following consultation with domain experts, we decided to include concepts in the American Academy of Periodontology (AAP)'s periodontal diagnoses[18] and the American Board of Endodontics (ABE)'s endodontic diagnoses.[19] In so doing, the work group was directed by Guiding Principle 1, that EZcodes will be inclusive. The content was built by sequentially considering these four sources. We began by aligning the concepts represented in the Z codes, ICD-9/10, the AAP's periodontal diagnoses, and the ABE's endodontic diagnoses. Terms were sequentially selected to represent a concept in the EZcodes in the following

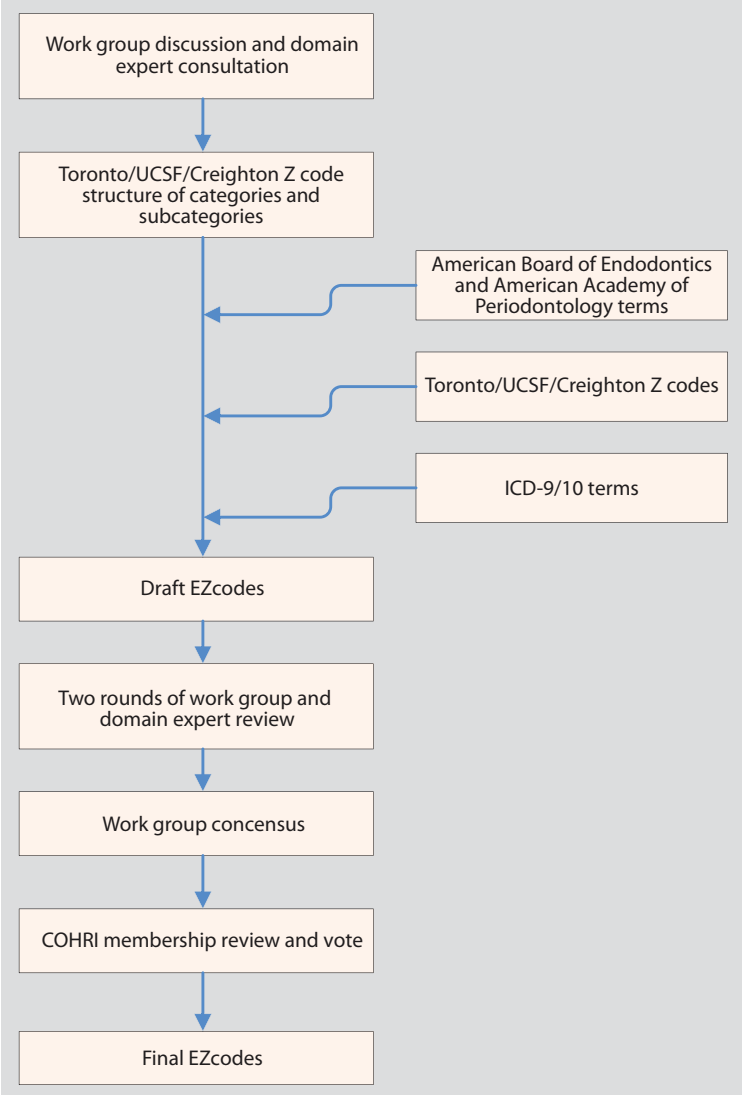

Figure 1. Development process for EZcodes

order: AAP and ABE diagnoses, Z codes, and ICD-9/10. In other words, when a concept was adequately represented by an AAP or an ABE term, that term was selected to be represented in the EZcodes. The remaining concepts were then represented by a Z code, when available. The concepts not represented in the Z codes were represented by an ICD-9/10 term.

At its next meeting the group agreed to review the draft list of diagnostic terms and once again share the specialty categories (e.g., endodontics, periodontics, oral surgery) with their schools' experts for input, especially for additions, as the objective was to have broad terminology content. Since a European dental school (ACTA) was included in the group, European endodontic, periodontal,[20] and other specialty terms were considered. It was decided that these terms would be added exclusively for European use, and they are not discussed further in this report. Suggestions for change were e-mailed to the group leader, who prepared an amended list for the next meeting for discussion. Changes were discussed at this meeting and accepted or rejected after extensive discussion

and 100 percent member agreement. This process was repeated once more until a finalized list was created for presentation to the COHRI membership. At the COHRI membership meeting in February 2009, the finalized list of diagnostic terms was accepted after extensive discussion and some minor amendments.

Results

Following the Toronto/UCSF/Creighton Z code structure, the EZcodes are divided into thirteen major categories and seventy-eight subcategories (Table 1). There are a total of 1,158 unique diagnostic terms: thirty ABE terms, seventy-five AAP terms, 611 Toronto/UCSF/Creighton Z code terms, 139 Toronto/UCSF/Creighton Z code terms that were also specifically represented in the ICD-9/10 terms, and 479 terms from ICD-9/10. The contribution of each of these sources to the EZcodes is shown in Figure 2. Some are present in more than one subcategory. For instance, Turner's tooth falls under the category of "Abnormalities of Teeth" and sits in the subcategories of "Enamel Defect" as well as "Shape Alteration." Mulberry molar falls under the category of "Abnormalities of Teeth" (subcategory of "Shape Alteration") as well as under the category of "Oral Pathology" (subcategory of "STD"). Some terms have synonyms in parenthesis, e.g., Recurrent aphthous ulcer (Periadenitis mucosa necrotica recurrens, Sutton's Disease, recurrent scarring aphthae), but otherwise synonyms are not entered into this list.

Discussion

We described the development of a comprehensive dental diagnostic terminology that adheres to many best practices in terminology development, is updatable, and can be mapped to procedure codes. To date, diagnostic terms, as opposed to treatment codes used for billing, have not been commonly used in dentistry. Furthermore, the few attempts to implement them have been localized, with no standardization across sites, nor any assessment of the reliability and validity of their use.

Despite the fairly broadly accepted need for and utility of a diagnostic terminology in dentistry,

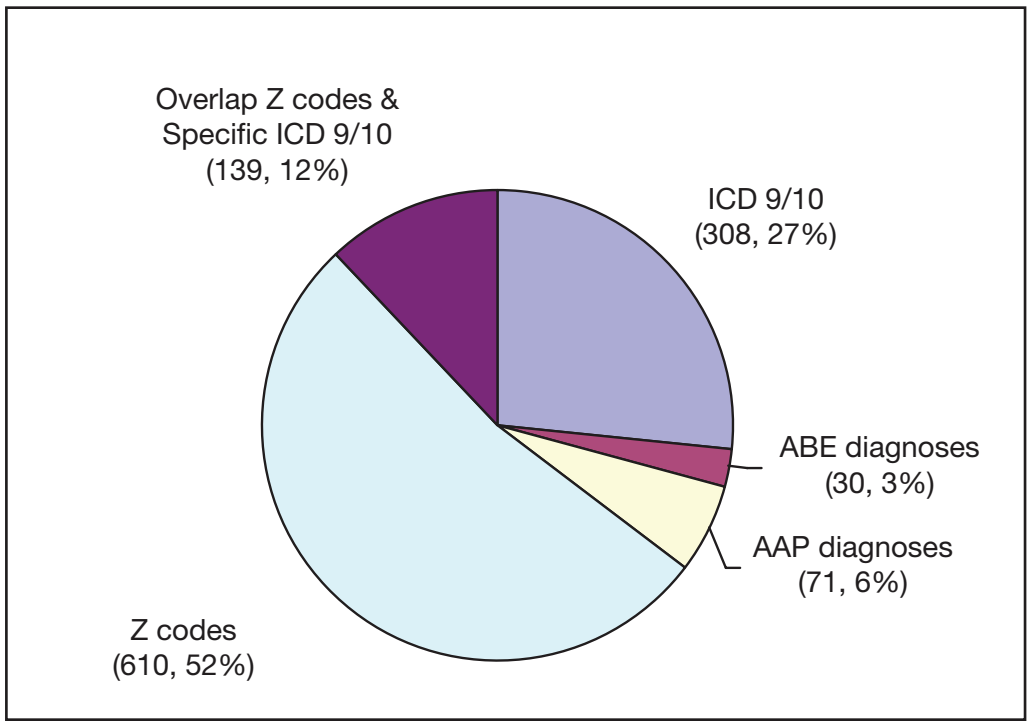

Figure 2. Distribution of sources for the final EZcodes terminology

the profession has not made more progress towards its development and adoption. Existing efforts are either locally developed and used (such as the Leake codes) or mired in a developmental process from which they are uncertain to emerge. SNODENT has been in development for at least fifteen years, but it has not yet yielded practical value for the academic or clinical dentist.

We believe that the implementation of the EZcodes will not suffer a similar fate. In the academic world, we are much better able to make the use of a diagnostic terminology mandatory, through the use of simple forcing functions within the EHR. This will result in a significant number of annual graduates who are trained in and accustomed to the use of a dental terminology as part of their patient care. Additionally, to date already five dental schools have implemented the EZcode terminology, and the two schools using the original Z codes have firm plans to migrate to the EZcode terminology in the near future as reported in the Informatics Short Talks at the 2010 American Dental Education Association Annual Session & Exhibition. An additional school is in the process of implementing axiUm, with the EZcodes loaded into it. This alone represents more adoption than either the Leake codes or SNODENT has enjoyed.

There are numerous benefits to the implementation of a standardized diagnostic terminology, like EZcodes, in the academic setting. EZcodes will play an important role in the consistent reinforcement of the link between diagnosis and treatment. They will also empower both students and faculty members to perform efficient outcomes assessment and continuity of care monitoring, skills that will serve students well in their careers as clinicians. Beyond the benefits to the individual, the profession will be served by the knowledge generated through the research enabled by standardized diagnostic terms.

To achieve the goal of reinforcing the link between diagnosis and treatment, we must ensure that the diagnostic terms are entered into the EHR correctly by the student and verified by the faculty member on approval. Analysis of ICD entry has identified errors that can be substantial.[2] Some of the errors in ICD coding arise due to the sheer scope of ICD, which has grown to include over 120,000 codes.[2] The EZcode terminology contains a more manageable 1,158 terms, but even so, we should make efforts to ensure that clinicians understand the framework and organization of the terminology. Ambiguities in the diagnostic framework have been found to be an additional source of errors. The formal piloting and periodic review processes instituted by COHRI have been designed to reduce this cause of errors. The EHR itself can enhance valid diagnostic term entry. The fact that EZcodes can be mapped to the Dental Procedure Code will enable the EHR to alert the clinician if he or she has selected a procedure code outside of the suggested mapping, while directly clarifying the relationship between diagnosis and treatment.

Limitations

We have described the creation of EZcodes, a dental diagnostic terminology with substantial benefits to and buy-in from dental academia. This is a first, meaningful step towards the overarching goal of representing oral health knowledge in all of its richness. However, our development approach was limited by time and resource constraints, and therefore decisions were made to create a terminology that was "good enough" and allowed immediate use by dental schools. Further, EZcodes do not contain "all clinically salient particulars—from the disorder on the side of the patient and the body parts in which it occurs to the treatments given"[21] that are such desirable features of an ontology. Our development approach was also necessarily top-down, where decisions were made at a committee level by experienced clinicians and domain experts. In future work, and through our formative and summative evaluation process, we expect to enhance the content, coverage, and organization of the terminology by examining actual usage data, observing clinicians using the terminology in their practice, and eliciting feedback for improvement. The work group has started its first round of terms review, by eliciting feedback from those schools that have used the EZcodes for the last twelve to eighteen months. Additionally, in future work we plan to evaluate the terminology by identifying cognitive and functional impediments to dental diagnosis entry relating to workflow and the EHR user interface.

Conclusion

The EZcode diagnostic terminology has been designed to allow for straightforward, consistent collection of dental diagnostic information. This information will empower dental academia to enhance teaching, conduct research and outcomes analyses,

and ensure quality improvement. The EZcodes have been integrated into the treatment planning module of the axiUm EHR. Several schools have already implemented the EZcodes terminology, and this terminology is available to be used by all schools who are members of COHRI.[11] However, a rapid terminology development approach was used to create the EZcodes, and therefore may not yet contain all clinical salient particulars. Future work will focus on refinement of the terms and strategies to enhance valid and efficient entry of these terms.

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