EZCodes: A diagnostic terminology as the foundational step of quality for the dental profession

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CHAPTER 8

General Discussion

Preface

This thesis described the development and implementation of the EZCodes terminology, a diagnostic terminology successfully deployed in academic dentistry. In order to determine the utility of the EZCodes terminology, studies were conducted with specific questions focusing on the validity, applicability, and value of the EZCodes terminology when used by the dental provider. The following topics were explored:

- The public health impact of using a standardized dental diagnostic terminology (Chapter 2)
- The importance of positioning the EZCodes as an interface terminology (Chapter 2)
- The process of developing a dental diagnostic terminology (Chapter 3)
- The validity of the EZCodes terminology (Chapter 4 and 5)
- The applicability (utilization and use in treatment planning) of the EZCodes terminology (Chapter 5 and 6)
- The value of the EZCodes terminology (Chapter 7)

This chapter integrates the results of these efforts and discusses implications for the dental profession. Recommendations for future work are also made.

Standardized dental diagnostic terminology and the connected healthcare system

Introduction

The current patient-centered care model of healthcare delivery has highlighted the need for coordinated, integrated, and consolidated information. As health care increasingly depends on connectivity within and among institutions, the ability to interchange data in a seamless manner has become critical. With each communication in the nexus of patient centered care (Figure 8.1), there is an opportunity for miscommunication.

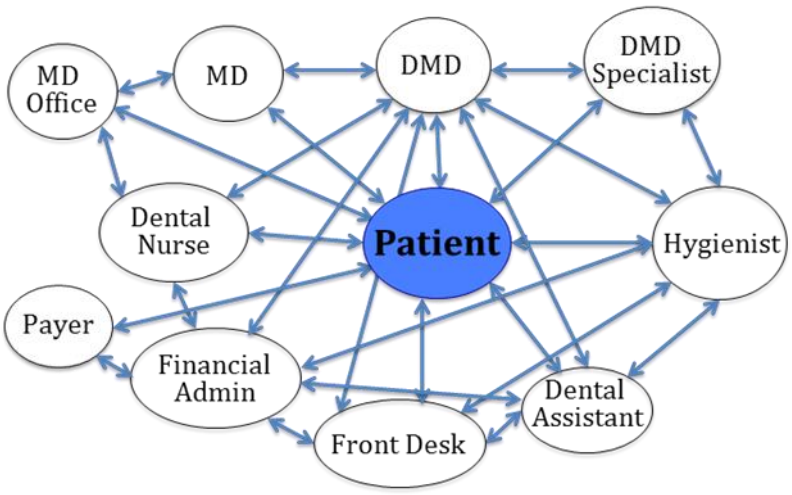

Figure 8.1: Figure modified from HealthPartners New Model of Patient Centered Care. M. Bisognano, C. Kenney. Pursuing the Triple Aim.[1]

Standardization and communication in dentistry

The American Dental Association (ADA) Standards Committee on Dental Informatics became an American National Standards Institute (ANSI) accredited committee in 1983.[2] Through this committee, considerable progress has been made. For instance, there has been significant advancement in specifying the exchange formats for digital images such that they can be readily shared and viewed. Less progress had been made on specifying standards for unambiguously sharing information about diagnosis. Though the International Classification of Disease (ICD) has served as this role in medicine for over two centuries, ICD coverage of oral health concepts is too limited to convey diagnosis with sufficient specificity. In this vacuum, the EZCodes were formed.

Creating a dental diagnostic lingua franca

Following the development and implementation of the EZCodes, the ADA released the Systematized Nomenclature for Dentistry (SNODENT) Version II, which has over 7700 terms that cover diagnoses, signs, symptoms, and complaints.[3] SNODENT is now a part of Systematized Nomenclature Of Medicine Clinical Terms (SNOMED CT).[4] The EZCodes are built as an interface terminology to the formal terminologies, e.g., ICD and SNOMED CT, and, as such, has been mapped to them. Without mapping between them, a world with multiple terminologies, e.g., SNODENT, ICD, can be as confusing as a world without any terminology. Positioning the EZCodes as an interface terminology is significant. It means that on the front end, the practitioner is faced with a reasonable number of terms that are granular enough to document a detailed diagnosis, but not so expansive that they become impossible to create a meaningful interface with. On the back end, the interface terminology is mapped to relevant terminologies required for billing (ICD), Meaningful Use (SNOMED CT), or quality improvement and outcome measurement (Dental Treatment Codes such as CDT/UPT). As such, the EZCodes terminology can provide the practitioner with relevant information through EHR-generated reports.

Adoption of any diagnostic terminology will only occur if it is easy for the provider to select a diagnostic term chair-side. Hence, a high quality interface to the terms in the EHR is essential to the utilization and valid use of diagnostic terms. Usability increases when the interface terminology is enhanced with attributes that improve efficiency when selecting terms.[5, 6] These attributes include (1) the presence of additional, relevant medical/dental information (assertional knowledge), (2) synonyms, (3) a balance between pre-developed terms (pre-coordination) and the ability of the provider to create new terms by adding two or more terms together while using the EHR (post-coordination), and (4) mapping to terminologies that have formal concept representations, such as ICD and SNOMED CT. The EZCodes terminology includes a full set of synonyms and descriptions for each term as part of the 2013 version, as well as assertional knowledge build into the EHR. See Figure 2. Finally, the entire process needs to fit into the ordinary workflow of the way in which care should be provided and documented.

On a systems-level, achieving critical mass in the dental community is essential. We envision a multi-pronged approach that will include reaching out to CEOs of large group practices and ongoing conversations with government agencies and community health centers. In the era of EHRs, the EHR vendors play a central role in building critical mass, as the EHR needs to incorporate the diagnostic terms as well as a usable interface. The current dissemination has been achieved through collaboration with one EHR vendor, Exan. The Current Dental Terminology (CDT)

and Uniforme Particuliere Tarieven (UPT) treatment codes have enjoyed widespread adoption because insurance payers require these codes to process claims. Similarly, mandating the documentation of a diagnosis in a structured format as part of the billing process will greatly facilitate adoption of diagnostic terms.

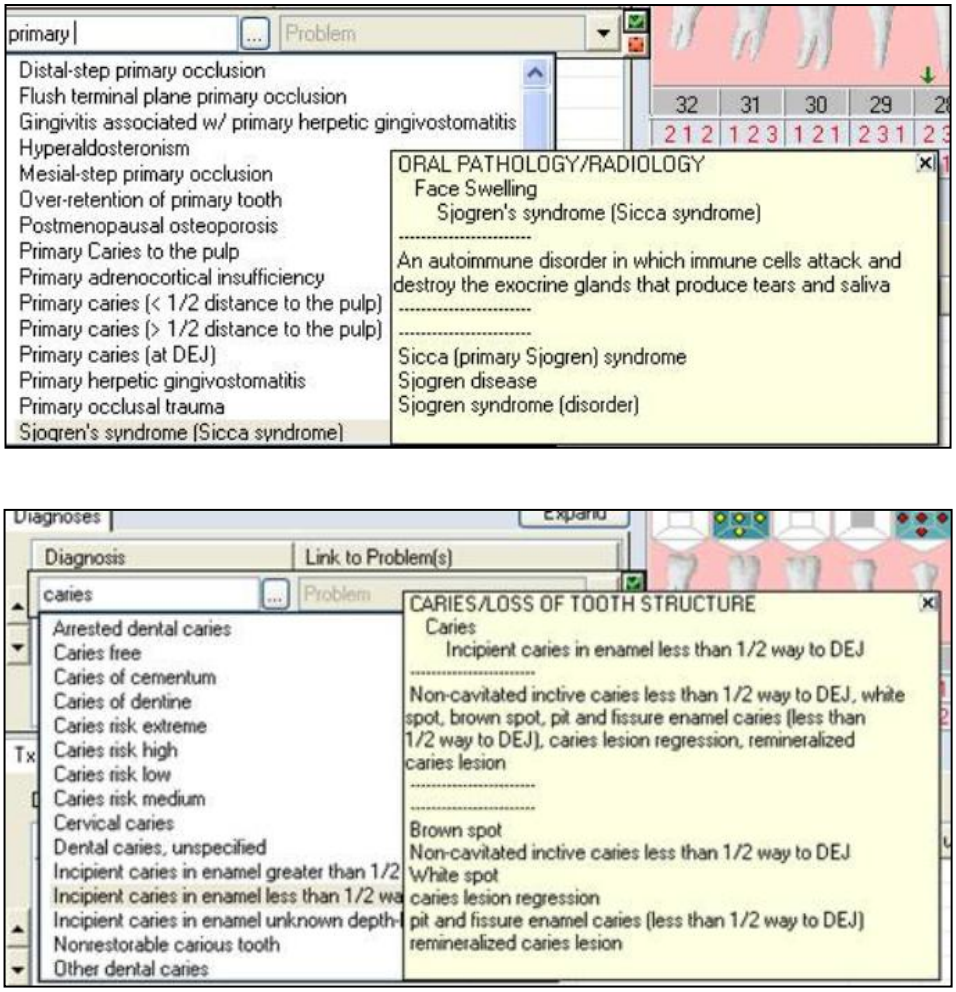

Figure 8.2: Assertional knowledge appears in pop-up box when term is highlighted. Notice the pre-coordination of terms.

Connected healthcare, in which dental care is integrated with the overall healthcare of the patient, demands clear communication among patients, caregivers, clinicians, and payers. With the creation and adoption of the EZCodes, we have given dental teams the tools to clearly communicate diagnoses and have taken a step closer to ensuring that this foundation of connected healthcare is solidly established.

Development of the EZCodes terminology

Introduction

The impetus for the work in this thesis was the surprising fact that as we

entered the 21st century, the dental profession still did not have a commonly accepted standardized vocabulary for oral diagnoses. After the first draft of the EZCodes terminology was created, a workgroup of academicians from dental schools that are members of the Consortium for Oral Health Research and Informatics (COHRI)[7] was formed. They developed an iterative process, negotiating with each other to further refine the vocabulary and incorporate concepts represented in the Toronto/UCSF/Creighton Z codes, ICD9/10 codes, and periodontal and endodontic diagnoses into the EZCodes. Domain experts were used to develop a final list of diagnostic terms. These efforts resulted in the final first version of the EZCodes terminology, which was released in 2009 and consisted of a structure with 13 categories, 78 subcategories, and 1158 diagnostic terms, hierarchically organized with the possibility to be mapped to other terminologies and ontologies. Clinical implications of the use of diagnostic terminologies include improved diagnosis documentation, treatment planning, research, quality assurance, and patient communication.[8, 9]

Guiding principles underlying the EZCodes development process

The EZCodes terminology was developed using a set of guiding principles that served as an effective tool for making decisions.[10] These principles have been a welcome tool since the start of the EZCodes' development and have guided the research team in the ongoing evolution of the terminology. Here, I review the progress made in the context of the foundational guiding principles, which were introduced in Chapter 3.

Guiding Principle 1: Incorporate and integrate oral health concepts in existing controlled terminologies.

Despite limitations in specificity and coverage of oral health terms, the initial principle of the EZCodes specified including all diagnostic concepts that exist in other terminologies (Figure 8.3). We now extend this principle to mean that new concepts in the EZCodes should feed back into diagnostic terminologies and, specifically, its reference terminology, SNOMED CT. During 2012, the EZCodes terminology was submitted to the National Library of Medicine (NLM) for review and integration into SNOMED CT. Our submission preceded the submission of SNODENT Version II to SNOMED CT for review and acceptance. All but 14 of the EZCodes terms were accepted for integration early in 2013. 8 terms were rejected because they contain quantitative values (e.g. Myogenous TMD pain > 6 months) and 6 terms were rejected because they consist of more than one concept (pre-coordination). Additionally, the EZCodes terminology has been mapped to ICD 10 and ICD-10-CM, the more

comprehensive American version. Approximately 700 EZCodes terms map exactly to ICD 10-CM, however, another 350 terms are more granular and cannot be mapped precisely. Those terms have been submitted for inclusion into ICD-10-CM. Further integration will allow more precise mapping between the EZCodes and ICD within the EHR on the back end, improving the billing process for the provider as well as for the payer.

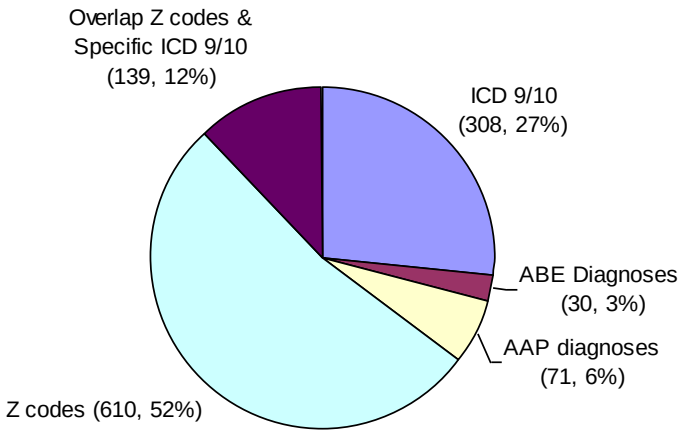

Figure 8.3: Distribution of Sources for the Original EZCodes Terminology

Guiding Principle 2: Conform to best practices of clinical terminology development.

By adhering to best practices in terminology development,[11] we developed a robust terminology that can be used in modern EHR systems, modified appropriately as new knowledge is discovered, and mapped to other vocabularies. Each diagnostic concept was assigned a preferred term and a non-semantic concept identifier. The EZCodes have now gone through 3 revisions, we have been able to prevent running out of room in the coding system or running into reclassification issues. As we expected at the time we were developing the EZCodes, providers select terms based on the concept name rather than the numeric identifier. As a result, the latest EHR update will remove the numeric identifier from the EZCodes list. Additionally, our approach allows concepts to be placed in multiple hierarchies because providers find it helpful to have the same term in multiple (sub) categories (e.g. mulberry molar falls under the "Abnormalities of Teeth" category as well as under the "Oral Pathology" category). As some terms had to be reclassified once it was discovered that the original classification was erroneous (following Principle 4 below), our approach also allows reclassification.

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

Although the search function has been improved in the EHR, providers also look for a term themselves within the relevant subcategory and many terms are represented in multiple subcategories. As the terminology expands, this feature continues to be important. When deemed appropriate, we will add terms into additional subcategories based on feedback from end-users. Based on the pattern of term utilization and errors, the research team was able to infer challenges faced by EZCodes users with regards to the organization and categorization of the terminology. In the "Occlusion disorders" diagnostic category, for instance, *malocclusion, unspecified*, which appeared first in the list, was observed to be the most commonly selected diagnosis. It was also found to be the most commonly incorrectly used diagnosis from that category. As a result, in the latest iteration of the EZCodes dental diagnostic terminology, the terms were reorganized such that the more specific terms are now placed earlier in the list, and the generic, non-specific terms are always located at the bottom of the list. Incorrect categorizations were detected by examining diagnosis-treatment pairs. For instance, the procedure *prophylaxis* was often incorrectly paired because the correct diagnostic term to which it might be paired (*Supragingival calculus*) was mis-categorized under "Caries/Loss of tooth structure", instead of under "Periodontics".

The need to enhance the organization of the EZCodes dental diagnostic terminology was made even more evident by reviewing ongoing user feedback and monitoring dental professional societies to identify newly professionally endorsed diagnostic terms. In comparison with the original EZCodes terminology, which consisted of 1158 diagnostic concepts organized into 78 subcategories and 13 major categories, the 2012 version added seven new sub-categories and one new category. All the terms contained within the new category (esthetic concerns) were already represented in other subcategories in the 2011 version of the terminology. In the 2013 version, two subcategories that contained the exact same terms were merged.

Guiding Principle 4: Evaluate and refine on a regular basis.

If controlled terminologies, including interface terminologies, are to continue to meet the requirements of their intended users beyond the initial development process, they need to evolve as a result of consistent evaluation. Even if there was a perfect terminology that "got it right the first time", the vocabulary would have to be modified in response to the evolution of knowledge and would need to be receptive to the inclusion of new concepts. ICD is revised every 10 years, which has recently been

criticized as too long of a cycle to accommodate evolving clinical needs.[12] In contrast, The International Health Terminology Standards Development Organisation (IHTSDO) releases revisions to SNOMED CT twice a year. IHTSDO's advisory bodies, with guidance from its Content Committee, drives updates through requests and priorities. Most updates include refinements to descriptions and concept definitions as well as the addition of new concepts.[13]

The revision process for the EZCodes was modeled on IHTSDO's process. During the months following the release of the EZCodes terminology, comments received on the terms, their organization, and their set up for use within the EHR were collated in a logbook. Additionally, one year after the original release, formal requests soliciting suggestions for improvement were sent out to all institutions using the terminology. The terminology was revised through an iterative, consensus-building process among clinicians from the research team. The options for revision included keeping, changing, deleting, or adding the suggestion. In situations where a consensus was not reached, domain experts from the participating dental schools were consulted for advice. Synonyms for each term were also introduced in order to facilitate easier navigation to the terms. Operculitis, for example, has been included as a synonym for Pericoronitis.

The research group understood that reorganizing terms in a more meaningful manner[14] would greatly enhance usability of selecting diagnostic terms. So, in addition to focusing on content, the group also explored how to better order and display diagnostic terms in the user interface of the EHR. As a result, the diagnostic terms within each category and subcategory have been reordered to facilitate quicker and easier retrieval. To this end, we developed a revised rationale for ordering terms along the following axes:

- Location: from localized to generalized, from enamel to pulp (e.g., those diagnoses affecting the enamel would be listed before those affecting the pulp)
- Severity: from acute to chronic
- Clinical progression: from acute to chronic, from primary caries to secondary caries
- Size: from small to large
- Frequency: from most commonly used to least commonly used
- When no specific rationale appeared to exist, the list was alphabetized
- Use of Unspecified/Not Otherwise Specified (NOS) concepts has been minimized and, when required, have been placed at the bottom of every list

The revision process for the EZCodes terminology is illustrated in Figure 8.4.

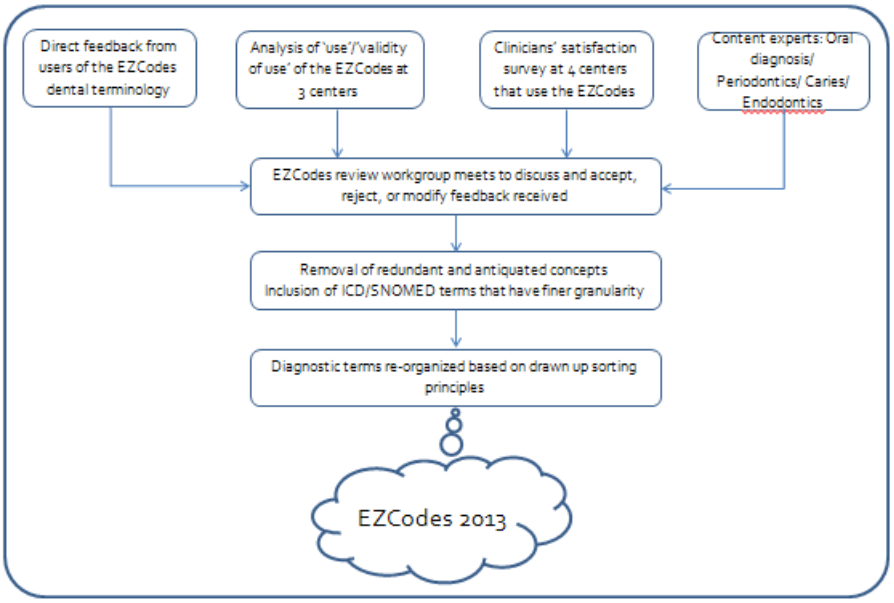

Figure 8.4: Revision Process of the EZCodes Terminology

Another guiding principle emerging from Principle 4, which is to evaluate and refine on a regular basis, is that users are not allowed to make local changes in order to maintain trans-institutional value of the standard. This becomes more challenging with the success of the dissemination and adoption of the terminology over time. The best way to try to avoid this problem is through participatory and agile development, as mentioned before, as well as clear licensing terms.

At the time of the original roll out of the EZCodes terminology in 2009, in addition to three sites of the research project (Harvard School of Dental Medicine, University of California San Francisco School of Dentistry and the Academic Center for Dentistry at Amsterdam), two American dental schools had implemented the terminology. To date, 15 dental schools, one large group practice that consists of 54 dental practices, and one academic hospital practice have implemented the EZCodes terminology. In total, 3,707 dental providers use the EZCodes during 1,909,557 patient visits on an annual basis. All participating institutions are aware of the fact that they can only add or change terms through the annual revision process of the EZCodes. Many are actively participating.

Guiding Principle 5: Link diagnostic and procedure codes.

In the academic clinical environment, the purpose of linking diagnosis to treatment is not only to reinforce this important connection, but also to allow outcome measurement, decision support, and quality control assessment. Furthermore, the research team realized early on that mapping the EZCodes to the CDT could be used

to validate diagnostic code entry. The CDT Code is designated as the national terminology for reporting dental services by the U.S. Federal Government under the Health Insurance Portability and Accountability Act (HIPAA) and is recognized by third-party payers nationwide.[15] Mapping the EZCodes to the CDT terminology has been completed. An example for decision support is depicted in Figure 8.5. Restricting certain procedures (e.g. orthodontic treatment) based on diagnoses (e.g. active caries disease) allows for innovative management of patient populations. It also enables the pre-loading of the most frequently used procedures with certain commonly encountered diagnoses, thus improving system usability for the provider.

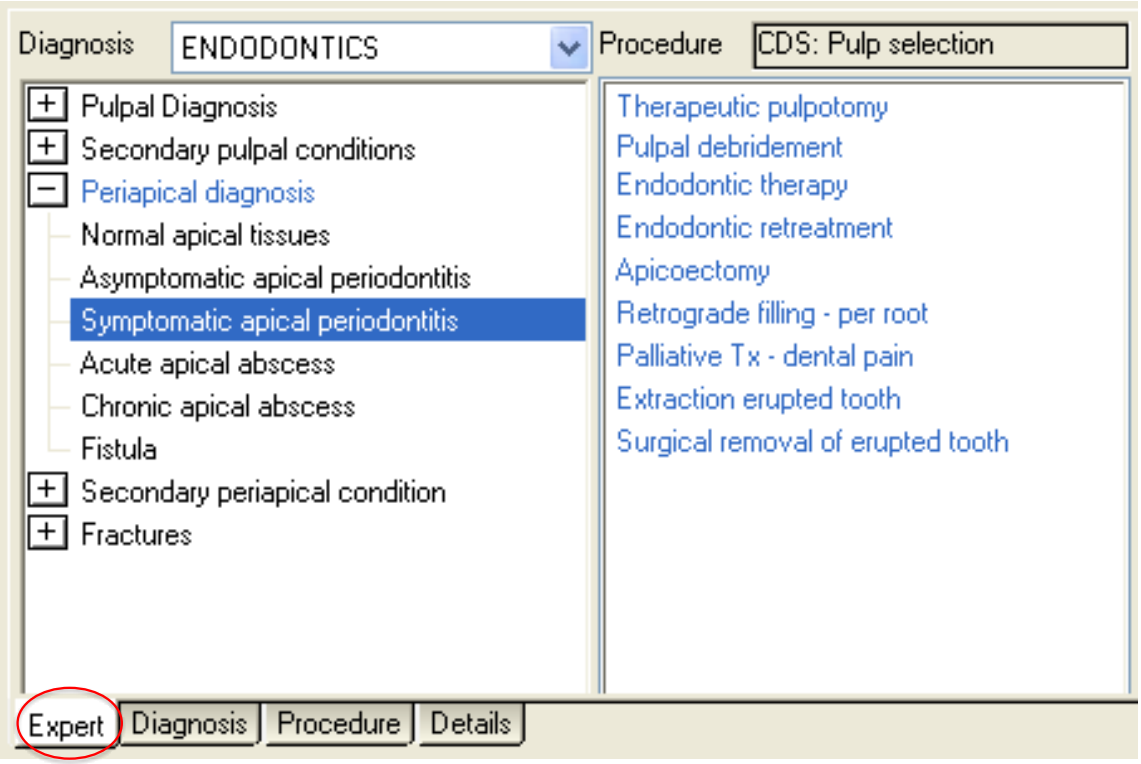

Figure 8.5: Clinical Decision Support – Mapping to CDT

Initial limitations

The original development of the EZCodes terminology was practical and focused on implementation into the EHR. As such, it was limited by time and resource constraints. Therefore, decisions were made to create a terminology that was "good enough" and could be immediately used by dental schools. Furthermore, our development approach was also necessarily top-down; decisions were made at the research team level by experienced clinicians with input from domain experts. In our continued work, we enhanced the content, coverage, and organization of the terminology through formative and summative evaluation processes. This was done by examining actual usage data, observing clinicians' use of the terminology in their

practice, and eliciting feedback for improvement.

Additional Limitations

In general, the valid use of an interface terminology is tested against the reference standard. Because the EZCodes have been positioned as an interface terminology, one might argue it should accurately reflect the concepts contained within its reference terminology (SNOMED CT). The circumstance is more complicated, though, as the reference terminology is incomplete with respect to oral health concepts, i.e., for some of the diagnoses, there might not be a reference standard to which the EZCodes refer. Indeed, in these early stages, our interface terminology is in fact informing its reference terminology as well as other formal terminologies like ICD, e.g. calcified stylohyoid ligament (Eagle syndrome) was submitted to IHTSDO for adoption into SNOMED CT. In the future, we imagine building out the EZCodes to capture the multiplicity of ways that a concept contained within the reference terminology can be expressed, thereby extending its usefulness as an interface terminology and perhaps informing efforts at natural language processing of dental notes.

The CDT validation approach is limited to diagnoses for which an intervention was available. In Chapter 6 we assessed the correct selection of diagnosis based upon the information made available in the clinical scenario we created, taking the first steps to extend the validation approach. We chose the treatment-based validation as our initial approach because it can leverage secondary data collected via the EHR and is therefore efficient. Being a thesis, this work is a significant first step toward what will be years and decades of work. We anticipate that in the future, our work will include the time- and resource-intensive real-time future observational studies that would be required to assess the validity of diagnoses that cannot be verified via secondary data.

By undertaking a rigorous consensus process to create the diagnosis-intervention mappings and assuring that these mappings were quite liberal (i.e., inclusive of a broad range of potentially acceptable treatment-diagnosis pairs), we made sure to reduce the effect that the agreement reported might simply reflect evaluation of agreement on decisions for well-established interventions.

Utilization and Valid Use of the EZCodes terminology

Introduction

The Z Codes were developed by the University of California at San Francisco (UCSF) and have more granularity than the oral health concepts in ICD. They have been available to all dental students and faculty since 2005, yet it has never been

mandatory to include them in the EHR as part of clinical practice. UCSF upgraded to the EZCodes when they became available in 2009. The Harvard School of Dental Medicine (HSDM) was the first adopter of the EZCodes. In April 2009, HSDM implemented the EZCodes for its teaching (student) practices and in September 2009 for its private faculty practice. Similar to UCSF, the diagnostic field in the EHR was not mandatory and could be bypassed.

Benchmarking diagnostic term valid use and utilization

The original EZCodes terminology was based in part on the Z codes that were in use at the UCSF Dental School, as shown in Figure 8.3. In order to establish a baseline against which to assess the effect of the EZCodes transition, both in the near- and long-term, we assessed the valid use and utilization of the Z codes prior to the implementation of the EZCodes. Of the 147 available diagnostic terms (Z codes), 93 were used (63%), indicating that 37% of the codes were never used. 38.9% of the time that practitioners entered a procedure that corresponded to a Z code, they also entered a Z code. 76.7% of these procedure-Z code diagnostic term pairs were valid.

As a next step, we explored the utilization and valid entry of the EZCodes at three dental schools (UCSF, HSDM and ACTA). Of the 1321 available EZCodes terms, 1094 (82.8%) were never used. 12% of the time that practitioners entered a procedure that corresponded to an EZCodes term, they also entered an EZCodes term. 60.5% of these procedure-EZCodes diagnostic term pairs were valid. Assessment of validity was performed by three independent, calibrated faculty dentsits. Agreement between reviewers ranged in the Z code study from slight to almost perfect; while in the EZcodes study agreement was uniformly substantial. Given the very large sample sizes in the Z code study (Chapter 4) and the EZCodes study (Chapter 5), the calculation of a confidence interval was considered to be superfluous.

The Z code study had 2539 variables (Diagnostic codes – CDT pairings) per individual and the EZCodes study had 4399 variables (Diagnostic codes – CDT pairings) per individual. Both studies had two response options per variable per individual: valid or not valid. This dichotomous scale is justified as the diagnosis-treatment pairing was judged to be either valid or not. The consensus process used to create the valid diagnosis-treatment pairings was liberal, i.e., when there was doubt, the judges determined that the pairing was valid.

Implications

There are a number of reasons that may explain the drop in utilization and valid use in the inaugural year of the EZCodes as compared to the Z Codes' valid use and utilization.

The EZCodes diagnostic terminology is more comprehensive than the Z codes. At the time of this study, the Z codes contained 147 diagnostic terms, while the EZCodes terminology consisted of 1321 terms, almost ten times the number of Z codes. Indeed, most (>1000) of the diagnoses available for selection were not used at the three dental schools within this one-year period. It is inevitable that a larger terminology is more difficult to navigate. UCSF's overall utilization of diagnostic terms dropped from 39% to 23%, although the second study, which assessed utilization of the EZCodes, did not measure the same users as the first study, which measured the Z code utilization.

A number of dental schools are proponents of implementing a "pick list", which is a subset of the EZCodes terminology that contains a list of the more commonly used diagnostic terms in each category. This would help manage the tension between offering a robust range of diagnoses from which users can select and constraining the volume of the vocabulary so that users are not challenged by the large variety of options from which to choose.[11] In those circumstances when a provider does not find a specific diagnosis in this pick list, they can then search the full list of diagnoses. This might be an excellent option for the private practitioner; however, it may not be a valid option in dental schools. During the formative years of dental education, it is important to expose the students to all diagnostic options and not limit their thinking to a number of pre-selected choices. Exposure to the rare and unknown, even if it is just diagnoses listed in an EHR, is part of what enriches an academic education.

The initial study reported an overall error rate in diagnostic term entry of 23.3%, which is considerably lower than the follow up study rate of 39.5%. In part, this can be explained by the fact that the study population was different and that one group of CDT procedure codes (D0100-D0999) was not included in the second study, since a diagnostic term had not been included in the original EZCodes that could link to this evaluative treatment code. However, an error proportion of nearly 40% is concerning and moved the research team to explore two areas that are attributable to diagnosis selection: (1) issues originating from the clinicians or the diagnostic terms and (2) issues originating from term retrieval and entry into the EHR. The research team actively explored EHR workflow and user interface to the diagnostic terms in order to address these issues.

Usability issues are cited as one of the major obstacles to the adoption of EHR systems.[16-18] Poor EHR usability has been shown to reduce efficiency, decrease clinician satisfaction, and even compromise patient safety.[19-28] In our follow up research, we have focused on usability problems that hinder the appropriate use of EZCodes term entries. We were able to identify and characterize 24 high-level usability problems,[29] including confusing ways of displaying diagnosis, lack of

visibility, inconsistent use of user interface widgets (i.e. location of the "save" button) and missing or mis-categorized concepts in the terminology itself. As part of our overall research project, we are able to work closely with the EHR vendor to prioritize each usability problem and to set a timeline to resolve the concerns.

Clinical applications of the EZCodes terminology

As Levin *et al.* noted, a dental practice grounded in evidenced-based care should center on the integration of clinically relevant scientific information with the patient's needs and the provider's clinical skills. As such, they reason, and I agree, that the development of a standardized diagnostic terminology should be at the center of patient care in order to facilitate communication between the patient and the oral health care team.[30] Additionally, as O'Malley indicates,[9] diagnostic code accuracy, defined as the extent to which the diagnostic code reflects the underlying patient's disease, directly impacts the decisions that are based on them, and accurately choosing the applicable diagnostic term is important.

Use of the EZCodes in treatment planning

Treatment planning has become embedded in EHR technology, which is now a mainstay in our dental schools. Although the principles of treatment planning remain constant, the clinical environment has changed. Dental education must be cognizant of these changes and keep pace with them. Our fieldwork involved assessing the usability of a dental EHR for developing a treatment plan. As part of this work, 25 pre-doctoral dental students from two U.S. schools (HSDM and UCSF) completed diagnosis and treatment planning exercises for two clinical scenarios in the EHR. This fieldwork created an excellent opportunity for my colleagues and I to critically explore the subject of treatment planning using an EHR. Specifically, we were able to investigate the process of, and link between, selecting a diagnosis and treatment planning within the EHR framework. Most importantly, we were able to explore whether selecting a correct diagnosis influences the selection of a correct treatment.

Two clinical scenarios were developed by the research team to present the participants with two typical patient cases seen in everyday dental practice: emergency palliative care and dental rehabilitation using fixed partial dentures. In situations where respondents selected the correct diagnosis, the correct treatment was also selected 93.4% of the time. However, when the respondent did not select the correct diagnosis, the correct treatment was selected only 81.4% of the time. This difference was statistically significant ($p=0.045$) and corroborates a previous study that found a relationship between selecting the correct diagnosis and deciding upon the correct treatment plan.[31]

As mentioned in Chapter 6, there are several plausible reasons that may explain the performance of the participants, such as students' familiarity with certain diagnoses over others. The simpler interface and treatment plan featured in one of the scenarios may also be a contributing factor.

The assessment of the participants entries into the EHR was performed by three independent and calibrated faculty dentists. Agreement between reviewers for Scenario 1 ranged from moderate, Kappa=0.55, 95% CI: (0.36, 0.73) to perfect agreement, Kappa =1.00, 95% CI: (1.00, 1.00). Agreement for Scenario 2 ranged from fair, Kappa = 0.40, 95% CI: (0.34, 0.46) to almost perfect, Kappa=0.85, 95% CI: (0.81, 0.89).

This study had 6 variables per individual for scenario 1 and 46 variables per individual for scenario 2. Both scenarios had 2 options per variable: correct or incorrect. This dichotomous scale is appropriate because the diagnosis, diagnostic-treatment pairing and sequencing was adjudicated as either correct or incorrect. For example, the pairing of periodontitis with scaling and root planning would have been determined to be correct. However, if the same diagnosis were paired with an amalgam filling, it would have been deemed incorrect. The scenarios were intentionally unambiguous and straightforward because the intent was to test the ability of the participants to find the terms within the terminology as presented in the EHR and to explore participants' ease in treatment planning using an EHR. The intent was not to test participants' ability to treatment plan complex clinical scenarios. One might also argue that in certain instances it is possible to sequence the care in various ways. But again, in these straightforward scenarios the aim was to reduce this ambiguity, e.g. sequencing orthodontic care before treatment of active disease is considered incorrect. Additionally, although participants could earn more points for some categories than others, indicating the relative importance of certain parts of the exercise, the scale for the answers was dichotomous, i.e. correct or incorrect. As such there was no range of agreement between the adjudicators thus obviating the need for a weighted kappa.

As the study of the use of standardized dental diagnostic terms in the context of treatment planning in the EHR matures, we will continue to develop and test more complex scenarios.

Value of the EZCodes terminology

For the EZCodes to continue to gain traction, it is essential to demonstrate its value. Below, the value of the EZCodes terminology is exhibited in several ways. The use case (Outcome metrics section) explains how the EZCodes allow for outcome

metrics, which is one important benefit of the EZCodes terminology. The next section describes the ways in which the provider can use the EZCodes everyday for clinical decision-support. The Quality section describes current and future work value. A more philosophical discussion explores applying the value concepts described by Michael Porter and Tom Lee to dentistry and the indispensable need of a dental diagnostic terminology to do so. Lastly, I describe how the EZCodes terminology brings value to the clinical continuum of chief complaint – diagnosis – treatment – and follow up.

Outcome metrics

The availability of a structured diagnosis, i.e., the EZCodes terminology, in an EHR allows for meaningful secondary data analysis and enables linking diagnosis to treatment. As has been demonstrated through the use of ICD in medicine, this will catalyze an expansion of epidemiologic and dental public health research, as well as quality control and clinical outcomes measurement. Four academic institutions, including HSDM, are currently contributing data to a pooled clinical data repository. The data repository houses information for over 1 million unique patients. Through data queries, we are now able to explore many measures, e.g.:

- Comparing the documentation of diagnoses by region and discipline
- Comparing the validity of diagnoses and treatment pairs by region and discipline
- Calculating the prevalence of diagnoses, stratified by patient characteristics
- Exploring adherence to evidence-based guidelines for the treatment of a given diagnosis

The periodontal use case as described in Chapter 7 illustrates the power of this EZCodes-fueled population perspective. In combination with the dental data repository, the EZCodes allowed us to assess the following health services measures:

a) Only 9% of patients with generalized chronic moderate periodontitis in three dental schools received complete treatment according to current guidelines, i.e., scaling and root planing combined with periodontal maintenance and prophylaxis treatment.
b) Only 15% of patients being treated for generalized chronic moderate periodontitis with scaling and root planing received follow up care according to current guidelines, i.e., periodontal maintenance and prophylaxis treatment.
c) 18% of patients diagnosed with generalized chronic moderate periodontitis did not receive scaling and root planing treatment, periodontal maintenance or prophylaxis treatment.

The ability to conduct these queries will form the basis of a new toolkit for our educators as they continue to develop dental curricula and student assessment tools in innovative ways.

Clinical decision support

Positioned as an interface terminology,[32, 33] the EZCodes allow diagnoses to be mapped to ICD, a clinical terminology mainly used for billing purposes, as well as SNOMED CT, the EZCodes' reference terminology. This makes the terminology compliant with both Meaningful Use requirements as well as with the new U.S. 5010 electronic billing form, used for payment of care provided to Medicaid (medical public assistance program) patients.[34] Mapping to the required standard terminologies (ICD or SNOMED CT) happens "on the backend" in the EHR and is not intrusive to the user. Additionally, the EZCodes terms are paired with procedure terminologies (CDT in the US and its counterpart UPT/Vaste tarieven en Vrije tarieven in the Netherlands). This pairing can be configured in the EHR in such a way that the diagnosis, or set of diagnoses, selected can guide treatment decisions. For example, built-in logic could be configured in a way that would not allow the provider to choose a restorative treatment code (e.g. filling or crown) for a periodontitis diagnosis. An exciting example of this application can be seen in the work being undertaken by a large American group practice, which has configured built-in logic to support treatment sequencing. For example, one cannot initiate fixed orthodontic treatment for a patient until a diagnosis of active caries or periodontal disease is resolved.

Quality

Speaking a common diagnostic language will allow us to compare outcomes of varying treatments of the same diagnosis (evidence-based care), to compare the trajectory of a patient with a given diagnosis relative to the population with the same diagnosis, to enhance communication with the patient, to better tailor care to diagnosis, to more efficiently audit the appropriateness of a treatment for a given diagnosis, to determine the cost-effectiveness of treatments for a given diagnosis, and to report and compile data consistently.

After sufficient dissemination and implementation of the EZCodes terminology, future work will be able to assess the impact on quality, e.g. measuring adherence to and attitudes towards documentation of fundamental quality practices (e.g. documenting diagnosis, perio charting, and updating medical history), measuring diagnostic errors, or developing the optimum workflow for the process that leads from findings/conditions/problems to diagnosis to treatment.

Empowering high value dental care

As Tom Lee and Michael Porter explain,[35] achieving high value for patients must become the overarching goal of health care delivery. The best way to drive system progress is through rigorous, disciplined measurement and improvement of value. Since it depends on results and not inputs, value in health care is measured by the outcomes achieved, not the volume of services delivered. Changing the current focus from volume to value is a paradigm-shift. Despite their importance, process and improvement metrics do not measure value.

Value is defined as outcomes relative to costs and thus includes efficiency. As such, reducing costs without considering health outcomes may lead to inaccurate savings and limit effective care. Outcomes are fundamentally condition-specific and often multidimensional. Therefore, no single outcome can capture the results of care for any medical or dental condition.[35, 36]

Cost refers to the total expense of the full cycle of care for the patient's medical/dental condition and not to the cost of individual services. Costs, like outcomes, should be measured around the patient. Measuring the total costs accumulated over a patient's entire care cycle and weighing them against the outcomes will truly enable structural cost reduction. This would be achieved through a number of steps, including reallocating spending, eliminating non–value-adding services, maximizing capacity, shortening cycle time, and providing services in the appropriate settings, among others.[35, 36]

The proper unit for measuring value should therefore include all services or activities that jointly determine success in meeting the patient's needs. For our dental patients, these needs are determined by the patient's oral health condition, defined as an interrelated set of oral health circumstances that are best addressed in an integrated way.

Care for the patient's oral health condition often involves one or more specialties and numerous interventions. Value is created for the patient by providers' combined efforts over the full cycle of care. Thus, the benefits of any one intervention will depend on the effectiveness of other interventions throughout the care cycle. Thus, the providers involved should share accountability for value. Because value is determined by examining the full cycle of care, it makes sense that value needs to be measured over time.[35]

An example of an outcomes hierarchy model for severe localized periodontitis, based on the one developed by Tom Lee,[36] is presented in Figure 8.6. In this model, value is created for the patient by providers' combined efforts over the full cycle of care. The periodontist, implant dentist, prosthodontist, and general dentist will all need to work together to restore the patient's health. Payment would be provided to the

system as a whole and would be divided between all providers and would depend on how well the providers were able to restore the patient's oral health back to its original status. Providers will have to work together to decide upon the integrated approach of care, since improving one outcome dimension will impact others. For example, placement of immediate loading implants decreases cycle time but may decrease the likelihood of complete recovery. Mapping these tradeoffs and seeking ways to reduce them is an essential part of the care-innovation process and creates value for our patients.

The ability to communicate the diagnosis of the patient between providers in a consistent way lays at the foundation of this value creating process. The EZCodes terminology is the underpinning to this essential communication.

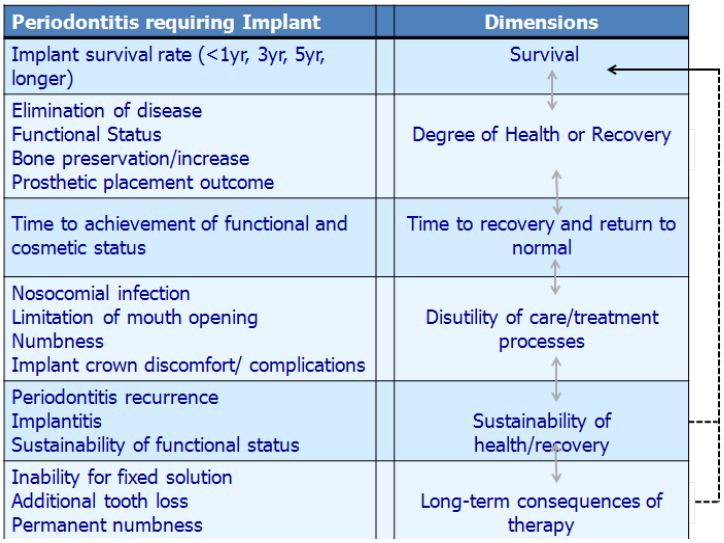

Figure 8.6: Outcomes Hierarchy for severe localized periodontitis

EZCodes and the clinical continuum

If the goal of the dental profession is to both improve the oral health of the public as well as maintain oral health for every person lifelong, it will be important to reach an agreement about the meaning of "oral health". Oral health includes not only treatment and freedom from disease, but also healthy soft tissues, proper esthetics, and adequate function, which encompasses functional speech and joints. Hence, the profession needs to shift from a mindset of "cure" to one of "care" and "maintaining (oral) health". This means the specific inclusion of preventive care, maintenance care, and collaborative care with the medical profession to manage the overall health and well being of the patients entrusted to us. As such, the process of findings – diagnosis - treatment - re-evaluation can be seen as a continuous circle, analogous to the Plan, Do, Study, Act (PDSA) circle that Deming developed for continuous improvement in management.[37]

In such a system, a patient presenting with a chief complaint will first undergo a thorough medical and dental history and exam. First, problems and findings are documented using the EZCodes terminology, which maps to the formal terminology for findings, SNOMED CT or ICD. Next, the diagnoses are documented using the EZCodes terminology that maps to ICD for billing purposes. Then, an indication for treatment is developed that includes a preferred treatment plan using the CDT/UPT/Vaste/Vrije tarieven terminologies that have been mapped to the EZCodes, which facilitates outcome metrics. Lastly, after taking the social, medical, and financial context into consideration, a final treatment plan, which will include the EZCodes-mapped treatment codes, is formulated. Clearly, without a standardized, documented diagnosis, the circle breaks and continuous improvement becomes difficult to obtain. Figure 8.7 indicates which terminology is utilized for the various parts of the continuous care cycle. Because SNOMED CT is required to document Findings (or Problems) in order to receive Meaningful Use incentives, and ICD is required to document diagnoses in order receive payment for Medicaid patients, it becomes clear that using EZCodes as an interface terminology could significantly simplify matters for the care provider. Additionally, because the EZCodes are mapped to treatment codes (CDT, UPT/ Vaste Tarieven en Vrije Tarieven), the billing form (e.g. U.S. form 5010) can be automatically populated with relevant diagnostic information. This also allows for quality and outcome measurement and epidemiologic and dental public health research.

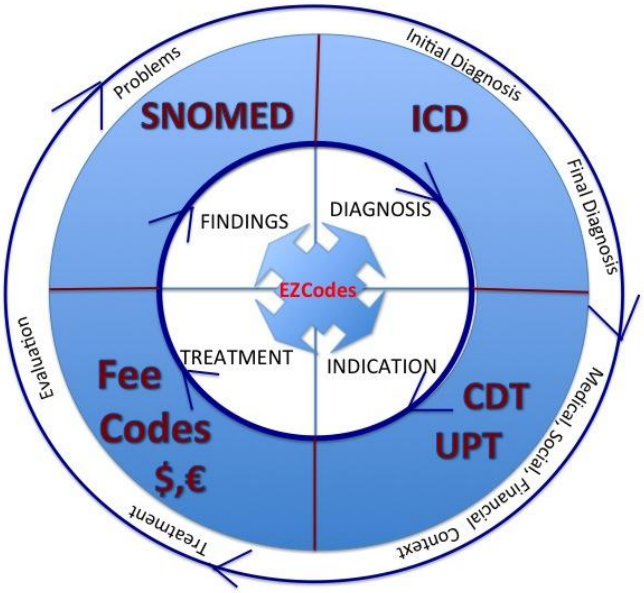

Figure 8.7: The care cycle as a continuous quality improvement cycle

Figure 8.7 also includes “Fee Codes”. This concept does not currently exist but should be envisioned as the actual treatment codes (CDT or UPT/Vaste tarieven en Vrije tarieven) with the reimbursement amount attached. Alternatively, it can be pictured as a more intricate fee schedule negotiated as part of contractual arrangements with insurers, payers, or Accountable Care Organizations (ACO) that are interested in collaborating with oral health providers to improve and maintain the health of their patients. The idea is that by allowing the student to disengage from the financial part of the treatment decision at the time of initial treatment planning, he or she can fully develop an indication for treatment and a preferred treatment plan without being influenced by the patient’s ability to pay or the student’s need to meet a financial quota. Some may believe that it is best for dental students to become familiar with the pricing structure and ability of patients to pay early on because it is the first step towards practice management. Others may believe that a true system of care should have a different payment structure that is based on value, as suggested by Porter and Lee. In such a system, payment is not provided to the individual dentist for each individual treatment, but rather, payment is provided as one lump sum to the providers as a group for all treatments necessary to bring the patient back to a healthy status. As the U.S. is moving towards Accountable Care and a fee structure that is more value based, it is not unthinkable that dental care reimbursement will undergo restructuring in the near future.

Increasing EZCodes’ adoption

The practice of medicine is diagnostic-centric at the foundation of many of its quality efforts, including the Triple Aim effort of “better health and better care at lower cost”.[1] Additionally, the mandate in the United States to record a diagnosis in the form of an ICD code as part of the medical billing process has reinforced the standardized documentation of diagnoses and allowed quality measurements and epidemiological surveillance. Because dentistry is predominantly treatment-centric, the development in 2009 of the EZCodes Dental Diagnostic Terminology[38] heralded a shift in attitude. Without the mandate to include documentation of a diagnosis during the billing process, acceptance to start recording diagnoses in a standardized way remains a slow process. Academic institutions and large practices have been the first to grasp its importance, especially with respect to quality measurement, and have been the “early adopters” so far.

When we introduced the concept of the diagnostic-centric relationship to quality at the 2012 Medicaid-Children's Health Insurance Program (CHIP) conference,[39] the EZCodes terminology had been implemented in 15 dental schools and a large group practice (consisting of 54 clinics in three states), along with the

dental clinic of Children's Hospital (Boston, MA). After the inaugural dental diagnostic terminology conference in November 2012, two additional large group practices, three Federal Qualified Health Centers (FQHCs), four dental schools, and six dental EHR vendors requested and received the EZCodes terminology. On an annual basis, over 3700 providers are delivering diagnostic centric care during more than 2 million patient visits. Furthermore, the EZCodes have been submitted to the Dutch Standards Committee (NEN) for consideration as a standard in the Netherlands. The application has been accepted and we are currently in the public comment process. Lastly, the Belgian government has mandated SNOMED CT as the terminology for diagnostic codes. Because of the sheer size of SNOMED CT each specialty is now developing its own reference set. The Association of Flemish Dentists (VVT) in Belgium has been charged with developing the reference set for the Belgian dentists and is considering EZCodes as terminology that will interface with SNOMED CT.

Change is possible. For the EZCodes to improve its "stickiness", we will need to find its Tipping Point.[40] This may depend on how information is presented, how results are disseminated, or reaching the right individuals who can "shape the epidemic". One way to improve the EZCodes' stickiness would be to have the largest dental EHR vendor create an effective interface and upload the EZCodes as a standard package for its dentists. A second example could be the requirement that dental providers who participate in Medicaid's Children's Health Insurance Program (CHIP) use the EZCodes. Adding questions about the importance of using a diagnostic terminology to Part II of the National Board exams would also serve to improve adoption of the EZCodes. Documenting the rigorous development process, utilization, valid use, public health relevance and clinical application of the EZCodes terminology are the important first steps before the dental profession can be "tipped".

References

1. Bisognano MA, Kenney C. Pursuing the triple aim: seven innovators show the way to better care, better health, and lower costs. 1st ed. San Francisco: Jossey-Bass; 2012.
2. Hammond WE, Cimino JJ. Standards in Biomediocal Informatics. In: Shortliffe EH, Cimino JJ, editors: Biomedical Informatics: Computer Applications in Health Care and Biomedicine. 3rd ed. New York, NY: Springer; 2006.
3. Knibbs GH. The International Classification of Disease and Causes of Death and its revision. Medical Journal of Australia 1929;1:2-12.
4. International Health Terminology Standards Development Organization SNOMED CT. Copenhagen, Denmark. http://www.ihtsdo.org/snomed-ct/. Accessed 4/20/2013.
5. Campbell JR. Semantic features of an enterprise interface terminology for SNOMED RT. Stud Health Technol Inform 2001;84(Pt 1):82-5.
6. Kahn CE, Jr., Wang K, Bell DS. Structured entry of radiology reports using World Wide Web technology. Radiographics 1996;16(3):683-91.
7. Stark PC, Kalenderian E, White JM, et al. Consortium for oral health-related informatics: improving dental research, education, and treatment. Journal of dental education 2010;74(10):1051-65.
8. Leake JL. Diagnostic codes in dentistry--definition, utility and developments to date. J Can Dent Assoc 2002;68(7):403-6.
9. O'Malley KJ, Cook KF, Price MD, et al. Measuring diagnoses: ICD code accuracy. Health services research 2005;40(5 Pt 2):1620-39.
10. Eisenhardt KM. Making fast decisions in high velocity environments. Academy of Management Journal 1989;32:543-77.
11. Cimino JJ. Desiderata for controlled medical vocabularies in the twenty-first century. Methods Inf Med 1998;37(4-5):394-403.
12. Services USDoHaH HHS Proposes Adoption of ICD-10 Code Sets and Updated Electronic Transaction Standards. Washington, D.C.: CMS 2008. http://www.dhhs.gov/news/press/2008pres/08/20080815a.html. Accessed: 5/4/2013 2013.
13. International Health Terminology Standards Development Organisation Release of SNOMED CT. Copenhagen, Denmark. http://www.ihtsdo.org/snomed-ct/release-of-snomed-ct/. Accessed: 5/4/2013.

14. Walji MF, Kalenderian E, Tran D, et al. Detection and characterization of usability problems in structured data entry interfaces in dentistry. International journal of medical informatics 2012.
15. American Dental Association. Current Dental Terminology 2009-2010. Chicago, IL: American Dental Associaton; 2008.
16. Patel VL, Zhang J, Yoskowitz NA, Green R, Sayan OR. Translational cognition for decision support in critical care environments: a review. J Biomed Inform 2008;41(3):413-31.
17. Zhang J. Human-centered computing in health information systems. Part 1: analysis and design. J Biomed Inform 2005;38(1):1-3.
18. Zhang J. Human-centered computing in health information systems part 2: evaluation. J Biomed Inform 2005;38(3):173-5.
19. Bates DW, Cohen M, Leape LL, et al. Reducing the frequency of errors in medicine using information technology. J Am Med Inform Assoc 2001;8(4):299-308.
20. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. J Am Med Inform Assoc 2004;11(2):104-12.
21. Thyvalikakath TP, Monaco V, Thambuganipalle HB, Schleyer T. A usability evaluation of four commercial dental computer-based patient record systems. J Am Dent Assoc 2008;139(12):1632-42.
22. Peute LW, Jaspers MW. The significance of a usability evaluation of an emerging laboratory order entry system. Int J Med Inform 2007;76(2-3):157-68.
23. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc 2006;13(5):547-56.
24. Kushniruk AW, Triola MM, Borycki EM, Stein B, Kannry JL. Technology induced error and usability: the relationship between usability problems and prescription errors when using a handheld application. Int J Med Inform 2005;74(7-8):519-26.
25. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. JAMA 2005;293(10):1197-203.
26. Horsky J, Zhang J, Patel VL. To err is not entirely human: complex technology and user cognition. J Biomed Inform 2005;38(4):264-6.
27. Horsky J, Kuperman GJ, Patel VL. Comprehensive analysis of a medication dosing error related to CPOE. J Am Med Inform Assoc 2005;12(4):377-82.

28. Han YY, Carcillo JA, Venkataraman ST, et al. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. Pediatrics 2005;116(6):1506-12.
29. Walji MF, Kalenderian E, Tran D, et al. Detection and characterization of usability problems in structured data entry interfaces in dentistry. Int J Med Inform 2012.
30. Levin LG, Law AS, Holland GR, Abbott PV, Roda RS. Identify and define all diagnostic terms for pulpal health and disease states. J Endod 2009;35(12):1645-57.
31. Verdonschot E, Angmar-Månsson B, Bosch J, et al. Developments in caries diagnosis and their relationship to treatment decisions and quality of care. Caries Res. 1999;33(1):32-40.
32. Griffon N, Savoye-Collet C, Massari P, Daniel C, Darmoni SJ. An interface terminology for medical imaging ordering purposes. AMIA Annu Symp Proc 2012;2012:1237-43.
33. Bronnert J, Masarie C, Naeymi-Rad F, Rose E, Aldin G. Problem-centered care delivery: how interface terminology makes standardized health information possible. J AHIMA 2012;83(7):30-5; quiz 36.
34. Fate of health care reform will NOT undo 'meaningful use' incentives. Mich Med 2012;111(3):9.
35. Porter ME. A strategy for health care reform--toward a value-based system. N Engl J Med 2009;361(2):109-12.
36. Lee TH. Putting the value framework to work. N Engl J Med 2010;363(26):2481-3.
37. Deming WE. The New Economics. Boston, MA: MIT Press; 1993.
38. Kalenderian E, Ramoni RL, White JM, et al. The development of a dental diagnostic terminology. J Dent Educ 2011;75(1):68-76.
39. Medicaid-Chip State Dental Association 2012 MSDA National Medicaid and CHIP Oral Health Symposium: Designing Quality in High Definition. 2012. http://www.medicaiddental.org/docs/2012_symposium_agenda.pdf. Accessed 4/14/2013.
40. Gladwell M. The tipping point : how little things can make a big difference. 1st ed. Boston: Little, Brown; 2000.