EZCodes: A diagnostic terminology as the foundational step of quality for the dental profession
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Citation for published version (APA):
Kalenderian-Groenewegen, E. (2013). EZCodes: A diagnostic terminology as the foundational step of quality for the dental profession

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Summary
This thesis discussed the validated development of a practical diagnostic terminology in dentistry. As a result of several differences between dentistry and medicine, the dental community faces a number of unique challenges not otherwise shared by the general medical community in regards to developing a standardized diagnostic terminology. One primary way that dentistry differs from medicine is that dental care is not insured in the same way as medical care. Unlike health insurance, dental insurance is more akin to a “benefit”, that individuals can receive up to a maximum amount per year, but even that does not cover extensive restorative care. As such, patients are responsible for most, if not all, of their dental care and often cannot afford the optimal treatment plan. Another key difference between dentistry and medicine result from billing practices and the mandate, or lack thereof, of documentation of a diagnosis. Dental billing practices do not mandate documentation of a diagnosis, and as a result, dental care is treatment centered. Thus, the ability to conduct evidence-based research in oral health care is impacted because documentation of treatment alone is insufficient for structured epidemiologic, clinical, or public health research. However, when dental providers enter diagnostic terms in a valid and consistent way, information gained will enhance teaching, digital evaluation, research and outcomes analysis as well as ensure quality improvement.

Although the International Classification of Diseases (ICD) is undoubtedly the international standard for diagnostic classification in medicine, as well as in epidemiology, it does not have adequate coverage of oral health diagnostic terms. In contrast, the sheer size of terms covering diseases, signs, symptoms, and complaints contained in the Systematized Nomenclature for Dentistry (SNODENT), which is included as the oral health component of the Systematized Nomenclature Of Medicine (SNOMED), makes effective integration into an electronic health record (EHR) and actual utilization improbable for most dental EHRs. The current version, SNOMED CT, contains more than 311,000 terms, and more than one million relationships between the terms.

Terminologies, as well as classifications, are useful to capture detailed data in the EHR. Classifications and terminologies are complementary in that classifications, for example ICD, are used for “output”, such as billing or external reporting, and terminologies for example SNOMED CT, are used for “input” such as documentation of care rendered.

There are a number of benefits to documenting diagnoses in a standardized and consistent way in dentistry. For example, the capacity for internal quality control is one such benefit that results directly from the ability to document the types and frequency of diseases treated by the provider. It also improves consistent communication, both with patients and between care providers, and facilitates data
sharing across sites. Additionally, it allows epidemiologists to evaluate disease patterns, treatment patterns, and disease outcomes. Research will be enriched since it will be possible to study risk-adjusted, cross sectional, and temporal variations in access to health care, health care quality, costs of care, and treatment effectiveness. In the academic setting, a standardized dental diagnostic terminology will allow us to emphasize the link between diagnosis and treatment. By allowing for the true measuring of outcomes, which is defined as the condition of a patient at the end of therapy or a disease process, the standardization of documenting diagnoses forms the foundation of the development of clinical guidelines or recommendations to inform evidence-based dentistry (EBD).

Currently, the medical arena is aggressively pursuing ways to improve patients’ health, their care, while lowering costs and oral health providers can actively participate in this effort by forging medical-dental partnerships. Specifically, the management of chronically ill patients will provide a rich opportunity for improving health and lowering healthcare costs for the patient as well as the system. A shared and standardized diagnostic terminology is foundational to such efforts.

**Standardized diagnostic codes are a fundamental public health tool**

**Chapter 2** describes the development of diagnostic terminologies and the importance of standardized diagnostic terminologies for dental public health. The history of medical diagnostic terminologies spans 250 years with ICD underpinning the public health activities in medicine. However due to lack of oral health representation in ICD, dental public health and quality improvement in the oral health arena have not been able to benefit from the use of a diagnostic terminology.

Chiefly, there are four ways in which a terminology can be developed as a standard: (1) a group of interested people can create an *ad hoc* standard, (2) a market domineering organization can create a *de facto* standard (for example, Microsoft with Windows), (3) the government can mandate a *de jure* standard, or (4) a *consensus* standard can be created through an open process that involves many stakeholders and standard development organizations. Standards take time to develop, or “mature”, and there are a number of critical success factors, including early and rapid implementation and acceptance in the market place. Standard development organizations (SDO) involved with diagnostic terminology development include the American National Standards Institute (ANSI), the International Standards Organization (ISO), the Comité Européen de Normalisation (CEN) and the Netherlands Standardization Institute (NEN).
The current representation of oral health conditions in ICD remains insufficient. For example, it does not differentiate between primary and recurrent caries. The U.S. developed the ICD-CM version, which is more granular, but still does not include diagnoses that cover the need for tooth restoration, such as biologically unacceptable restoration. SNOMED, and its later version SNOMED CT, contains SNODENT. The more than 311,000 unique terms are organized into hierarchies and form more than 1 million relationships.

The EZCodes terminology was developed to meet the need for a comprehensive yet concise set of dental diagnostic terms to serve as a middle ground between the sparseness of ICD and ICD-CM and the enormousness of SNOMED CT. With 1158 terms in its original format, the EZCodes terminology functions as an interface terminology, with SNOMED CT as its reference terminology. EZCodes operates as a bridge by allowing the user to describe the diagnosis using natural language that is then mapped on the back end to the formal language of SNOMED CT and ICD to satisfy regulatory requirements.

There are great public health benefits to standardizing the documentation of diagnoses in dentistry. To date, we still do not capture why teeth become non-vital or why teeth are extracted in a structured fashion, which is to the detriment of dental public health. Overcoming these barriers to the implementation of a standardized diagnostic terminology would yield a powerful instrument in the dental public health toolbox.

**The development of the EZCodes dental diagnostic terminology**

**Chapter 3** discusses the development process of the EZCodes terminology. Since the 1990s, the American Dental Association has been involved with the development of SNODENT. Where as ICD is a terminology, SNODENT is an ontology. The difference being that a terminology represents concepts within a particular field, while an ontology represents the relationships between these concepts. In addition to diagnoses, SNODENT also contains signs, symptoms, and complaints. However, SNODENT had not been made available to the dental practitioner. Seizing the opportunity created by the expanding presence of EHRs in dental schools, a workgroup of dental academicians set out to develop a dental diagnostic terminology that was easy to use, could be loaded into the EHRs’ of all members (AxiUm, Exan, Vancouver, Canada), and was developed for rapid implementation. The group was motivated by the desire to improve dental research and quality by creating a standardized terminology that would facilitate data integration and data analyses.

The terminology was developed following a set of guiding principles:
(1) Include oral health concepts of existing terminologies (i.e. ICD).
(2) Adhere to best practices in terminology development. As such, each term was assigned a preferred term and a non-semantic identifier (number).
(3) Facilitate retrieval by hierarchically structuring concepts into categories and sub-categories.
(4) Evaluate and refine the terminology on a regular basis.
(5) Link diagnostic terms to procedure codes.

The development process was iterative and started with UCSF Dental School’s Toronto Z skeleton, because it better represented dental clinical practice. This skeleton was populated with concepts from the American Academy of Periodontology, the American Board of Endodontics, Z code terms, and ICD terms to ensure adequate concept orientation. Two rounds of discussion with domain experts and subsequent review by the workgroup produced the first version of the EZCodes diagnostic terminology, which consisted of 1158 terms in 13 categories and 78 sub-categories.

Limitations to the development included time and resource constraints, resulting in the creation of a terminology that was “good enough” to allow for immediate use by dental schools. Furthermore, the first version of the terminology does not contain all clinically salient particulars, synonyms, or descriptions. The development process was rather top-down, with committee level experience clinicians and domain experts making decisions.

**Evaluating a dental diagnostic terminology in an EHR**

**Chapter 4** explores the utilization and validation of the Z codes, which is the diagnostic terminology on which the EZCodes are built. The Z codes were developed by UCSF Dental School over a period of two years and have more granularity than the ICD oral health terms. The Z codes are available to all dental students and supervising faculty, but are not set as a mandatory field. Rather, their use is based on the requirements of good clinical practice as taught by the faculty. Analyzing all diagnostic codes entered by student providers for final diagnosis during a one-year period assessed Z codes’ utilization. Validation was measured by determining the percentage of accurate diagnostic-procedure codes’ combinations. The entry of a standardized treatment code (CDT) is closely supervised as it directly impacts billing, reimbursement, and is open to auditing oversight.

Diagnostic codes were paired with a treatment code 38.9% of the time. This low utilization rate reflects a lack of attention to detail by the students and supervising faculty and an overall lack of understanding with regards to the importance of
documenting a diagnosis in a structured way. Despite their low utilization rate, diagnostic-treatment code pairs were entered accurately 76.7% of the time.

Improvement of the diagnostic terminology and better integration of the terminology into the clinic workflow were considered immediate focus for future work.

**Assessing the use of the EZCodes in an EHR**

Building on Chapter 4, Chapter 5 assessed the utilization and validity of the EZCodes terminology in three dental schools. Again, the diagnostic terminology is at the discretion of the student and supervising faculty. All three schools use the same EHR (axiUm, Exan, Canada). All students were trained in aspects of EHR use, including treatment planning and entering of diagnostic terms. Two schools use the American Current Dental Terminology (CDT) as their billing terminology. For the third dental school (ACTA), the Uniforme Particuliere Tarieven (UPT) billing codes were first mapped to the CDT codes. Due to faculty oversight and the audit processes associated with the billing process, dental procedures codes are entered with high accuracy. Thus, examining whether the procedure associated with the diagnosis was correct formed the basis for validation of the diagnostic terminology.

Between July 2010 and June 2011, the EZCodes were utilized 12% of the time in these three dental schools. More than 1000 terms of the available 1321 terms were never chosen. Caries and periodontics were the most frequently used categories. 60.5% of the EZCodes entries were found to be valid. The low utilization rate reiterated the findings from Chapter 4, but also suggested the need to conduct more training, improve the EHR interface, and add descriptions and synonyms to the terms.

**Treatment planning in dentistry using an EHR**

Chapter 6 explores the implications of introducing the EZCodes into the EHR for undergraduate education. As part of the research to explore cognitive and functional impediments to diagnostic term use in the EHR, 25 dental students from two American schools completed diagnosis and treatment planning EHR based exercises. Two clinical scenarios mimicked diagnosis entry, diagnosis-treatment pairing, and sequencing of treatment according to criteria taught in their curriculum. Earlier studies had shown that treatment planning is most strongly influenced by patients’ needs and requests rather than students’ curricular requirement. This is the first study exploring the subject of treatment planning using an EHR. More
specifically, the study investigates the process of and link between selecting a diagnosis and treatment planning within the EHR framework.

In the first scenario, participants were asked to treatment plan emergency palliative care for a single diagnosis. The second scenario was more complicated with multiple diagnoses and treatments to be entered in the full treatment module of the EHR. Neither scenario had a time limit. Overall, participants earned 48.2% of all available points. With respect to picking the correct diagnosis, participants earned 41.9% of the available points. Participants earned 59.8% of the available points for overall treatment planning, but received only 41.7% of available points for phasing and sequencing. Participants performed better with Scenario 1 (mean score 51.4%) than Scenario 2 (mean score 34.1).

We inferred a number of explanations from the results. Scenario 1 was significantly simpler than Scenario 2 and as such posed less of a challenge to the participants. Using the less complex “Chart Add” module may also have contributed to the better result of Scenario 1. Students appeared to perform better at selecting certain diagnoses than others. This may be due to the way the terms are situated within the EHR, the retrievability of the terms in the EHR, or the familiarity of the students with the diagnosis. Students fared better selecting the appropriate treatment plan, thus raising the question if it is relevant to be able to select the correct diagnosis. Verdonschot et al. have shown that improving diagnostic abilities has a positive effect on treatment decision and outcomes, which this study corroborates. In situations where students selected the correct diagnosis, the correct treatment was also selected 93.4% of the time. However, when the participants 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). Lastly we found that the lack of a more holistic approach to treatment planning was pervasive. Preventive and maintenance procedures were often missing from the participants’ treatment plan.

Although the study had a number of limitations, including its small sample size and artificial testing environment, the results highlight the importance of including technology considerations within the diagnosis and treatment-planning curriculum. Future work will mainly focus on including a large number of schools and additional qualitative analysis of the data.

**The value of the EZCodes**

**Chapter 7** is an early foray in exploring the value of the EZCodes in outcome assessment for clinical care. EHR data from the dental schools involved with this research project (HSDM, UCSF, UT Houston) have been pooled into the first dental
data repository. Scripts were developed to measure the relationship between documenting diagnoses and outcome. The use case describing moderate periodontitis clearly indicates that it is possible to measure the percentage of patients diagnosed with generalized moderate chronic periodontitis who are being treated according to current guidelines. At the dental school level, this allows for modifications in student oversight, curriculum reform, or student and faculty training in the use of the EHR and clinical guidelines. On a larger scale, it allows researchers to make inferences regarding public health and epidemiological results.

The general discussion of Chapter 8 integrates the studies discussed previously regarding the development, validity, applicability and value of the EZCodes dental diagnostic terminology.

Public health has long since enjoyed the benefits of the ICD terminology. However, dental public health and oral health quality improvement efforts have not been able to do so because of the lack of oral health representation in ICD, the unavailability of SNODENT to the dental practitioner, and the fact that insurers do not mandate use of diagnostic codes on billing forms. As health care increasingly depends on the connectivity within and between institutions and providers, the ability to interchange data in a seamless manner becomes critical; dentistry needs to be part of this. In a world with multiple code sets, dental care providers prefer the use of a smaller interface terminology that uses natural language, which is more easily understood by the dental provider chair-side. The EZCodes terminology is mapped on the back end to formal terminologies, such as ICD and SNOMED CT, in order to meet various requirements for reimbursement. Additionally, the EZCodes are mapped to treatment codes, such as CDT and UPT/Vaste/Vrije tarieven, in order to perform quality control through outcome metrics. Of course, mandating the documentation of a diagnosis in a structured format as part of the billing process will greatly facilitate implementation of diagnostic code use. The ability to perform outcome measure studies, as well as epidemiological and public health studies, would also serve to put dentistry on par with medicine.

In the mean time, adoption will greatly improve when the terminology is integrated into the EHR in a way that is intuitive and usable. Hence, the quality of the interface and addition of relevant knowledge in the form of attributes is crucial. Furthermore, the process needs to fit in the ordinary workflow of the way care is provided and documented.

A team of academicians developed the EZCodes. They first developed a set of guiding principles that assisted the self-managed team in making decisions. Four years after the implementation of the EZCodes terminology, a review of these guiding principles indicates that the process has served the research team well. As noted in
Chapter 3, these principles were adhered to throughout the development and further refinement of the terminology. The EZCodes revision process for the creation of Version 2013 was inclusive, creative, and highly productive. Original limitations to the development were addressed through formative and summative evaluation processes. Examining actual usage data, observing clinicians’ use of the terminology in their practice, and eliciting feedback for improvement enhanced the content, coverage, and organization of the terminology.

As concluded in Chapter 4 and 5, utilization of the terminology was low, but valid use was rather high. The results did not reveal any clear pattern between frequency of term use in any diagnostic category and error rate in the entry of the terms. The error rate, which was close to 40%, was 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 retrieving and inputting terms within the EHR. The research team actively explored EHR workflow and user interface to the diagnostic terms in order to help identify and reduce cognitive and functional impediments to diagnostic term use. We were able to identify and characterize 24 high-level usability problems, including confusing ways of displaying diagnosis, lack of visibility, inconsistent use of user interface widgets (i.e. the buttons used for adding and removing items had different icons and locations), 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.

The EZCodes have great applicability in the dental profession. This study showed that participants who selected a correct diagnosis were more likely to also select the correct treatment. Beyond the dental school setting, a dental diagnostic terminology is of value for the dental profession and in the dental care setting. It will allow for the development of outcome metrics and quality control measurement. Linking diagnostic terms to treatment codes creates a powerful tool for use in clinical decision-making. For example, when orthodontic treatment cannot be linked to a diagnosis of active caries or periodontal disease, patients with active disease will be spared from preventable sequelae by making sure that their active disease is treated first. Dental diagnostic terminologies can also play a role in restructuring the healthcare payment system in order to restore the patient’s oral health as quickly as possible. In such an approach, payment is provided to the “system” of providers for the entire treatment provided over time, instead of reimbursing each provider per treatment rendered. This implies close collaboration and excellent communication between providers as well as sharing of electronic health data. A common diagnostic language in the form of a standardized diagnostic terminology is sine qua non.
The EZCodes are at the center of the care cycle defining the continuous quality improvement for our patients. First, findings and problems are materialized as the patient presents with a chief complaint as well as through the medical/dental history and physical exam. We will be able to document those findings and problems using the concepts in the EZCodes, combined with documentation in the odontogram and perio chart. For regulatory reasons, findings need to be documented through SNOMED CT and diagnoses through ICD. The EZCodes map to these terminologies on the backend, without interfering with the provider. As a next step, the patient receives a diagnosis, which can be documented using the EZCodes terminology. Subsequently, a treatment indication, including a preferred treatment plan is developed. Ideally, students will use the CDT or UPT/Vaste/Vrije tarieven treatment codes, which do not have a monetary value attached to it, thus, precluding preconceived notions of ability to pay. Lastly, after taking the medical, social, and financial context of the patient into consideration, a final treatment plan will be developed. This plan will link to Fee codes, which are CDP/UPT/Vaste/Vrije tarieven codes that have a monetary value attached to them. The EZCodes are linked to the treatment and fee codes (CDT/UPT/Vaste tarieven en Vrije tarieven codes) in order to measure quality improvement and clinical care.

The idea that a “one size fits all” diagnostic terminology will satisfy all requirements is unrealistic. An interface terminology, such as the EZCodes diagnostic terminology, can be positioned to help satisfy the provider’s need for natural language, while simultaneously fulfilling regulatory requirements by being linked to formal terminologies. In order to continue adoption throughout the dental profession, the research team is actively involved in an ongoing effort to refine the EZCodes terminology and improve the EHR interface and workflow for the foreseeable future.