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ASSESSING THE USE OF A STANDARDIZED DENTAL DIAGNOSTIC TERMINOLOGY

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Abstract

Although standardized terminologies, such as the International Classification of Diseases (ICD), have been in use in medicine for over a century, in the dental profession, efforts to standardize dental diagnostic terms have not achieved widespread acceptance. To address this gap, a standardized dental diagnostic terminology - the 'EZcodes' terminology was developed in 2009. Fifteen dental practices and schools in the United States and Europe have implemented the 'EZcodes'. In this paper we report on the utilization and valid entry of the EZcodes at three of the dental schools that have adopted this standardized dental diagnostic terminology.

Electronic data on the use of procedure codes with diagnostic terms from the three schools over a one-year period between July 2010 and June 2011 were aggregated. The diagnostic term and procedure code pairs were adjudicated by three calibrated dentists. Analyses were conducted to gain insight into the utilization and valid entry of the EZcodes diagnostic terminology in the one-year period extending from 7/1/2010 through 6/30/2011. Error proportions in the entry of diagnostic term (and by diagnostic category) were also computed.

Within the twelve-month period included in the analysis, a total of 29,965 diagnostic terms and 249,411 procedure codes were entered at the three institutions resulting in a utilization proportion of 12%. Caries and periodontics were the more frequently used categories. More than 1000 of the available 1321 diagnostic terms were never used at the three institutions. Overall, 60.5% of the EZcodes entries were found to be valid.

In summary, our results demonstrate low utilization of EZ codes in an electronic dental record and raise the need for specific training of dental providers on the importance of using dental diagnostic terminology and specifically how to use the terms within the EHR. This will serve to increase the use/correct use of the EZcodes diagnostic terminology and ultimately create a reliable platform for undertaking clinical, outcomes and quality improvement-related research.

Keywords

Diagnostic terms; Dentistry; Accuracy; Utilization

INTRODUCTION

Although standardized terminologies, such as the International Classification of Diseases (ICD), have been in use in medicine for over a century[1], in the dental profession, standardized dental diagnostic terms have not achieved widespread traction[2]. This is partly due to the lack of a comprehensive and readily available classification system. Previous efforts at creation of an acceptable dental vocabulary culminated in the creation of SNODENT (Systematized Nomenclature Of Dentistry) which is embedded in SNOMED and designed to be a diagnostic companion to the Current Dental Terminology (CDT). SNODENT is composed of diagnoses, signs, symptoms and complaints[3] and currently includes over 6000 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[4]. It is also reported that for SNODENT to become widely used in dentistry, it will require considerable enhancements in content and quality of coding[5]. To address the gap created by the absence of an acceptable and readily available standardized dental terminology and motivated by a desire to improve dental research,

education, and patient care, a workgroup comprised of trans-institutional members of the Consortium for Oral Health-Related Informatics (COHRI)[6] developed the 'EZcodes' terminology in 2009 which originally consisted of 13 diagnostic categories, 80 subcategories and 1,158 unique dental diagnostic terms[4]. These EZcodes were then incorporated into an electronic health record, which allowed for their use in a consistent way. While this development of the dental diagnosis terminology was a critical first step, the terminology must also be adopted by dental care providers and be used effectively in order to fully realize its benefits.

Since their development, fifteen dental institutions in the United States and Europe (five in the Midwest, three each in the West and Northeast, three in the South and one in the Netherlands) have implemented or are in the process of implementing the 'EZcodes', fourteen of these use the electronic dental software – axiUm ® (Exan Corporation, Vancouver), and the last one uses Dentrix ® (Henry Schein, Inc.). Given that the use of a standardized diagnostic terminology is in its initial stages in dentistry, it is important to evaluate the use of these terms and to assess if they are being used correctly.

In this paper we report on the utilization and valid entry of the EZcodes at three of the dental schools that have adopted this standardized dental diagnostic terminology. We also discuss possible challenges with the use of the EZcodes and offer insight into the promising next steps of dental diagnostic terminology development and use within electronic health records (EHRs).

METHODS

Utilization

The EZcodes diagnostic terms are available for use to providers at all the subscribed institutions. As part of their curriculum, students are trained in all aspects of EHR use including planning treatments and entering diagnoses. The use of the EZcodes terms (unlike the procedure codes) is however at the discretion of the student provider and their supervising faculty.

We sent out a request to all fifteen institutions that have implemented the terminology to make available to us their information on usage of the EZcodes diagnostic terminology. Three of the schools that had data spanning the requested time period (July 2010 to June 2011) by using any of the versions of the EZcodes in any area of their dental practice - University of California, San Francisco School of Dentistry (UCSF), Harvard School of Dental Medicine (HSDM) and the Academic Center for Dentistry in Amsterdam (ACTA) - provided the diagnostic terms used over the one-year period along with the standardized dental procedure codes used in association with each of the diagnostic terms.

UCSF had been using a locally developed dental diagnostic terminology (Z codes) in their EHR since 2000. The school adopted the original EZcode diagnostic terminology system in 2010. An upgrade to this original (2009) version was created in the fall of 2010 and UCSF upgraded to that version (EZcodes-2011) and have been using this upgrade since January 2011. At UCSF, students receive 2 hours of didactic instructions and 2 hours of hands-on experience on simulated patients in their second year in treatment planning and diagnostic term entry. As part of their clinical competencies, they perform a comprehensive oral examination competency examination, wherein treatment planning and diagnostic term entry are criteria which must be demonstrated successfully. In the clinical setting, virtually all of their patients require at a minimum a diagnostic term to be entered for each procedure they perform.

HSDM runs 2 different clinics. The Teaching Practices started using the original version of the EZcodes in their EHR in July of 2009, and the Faculty Group Practice began using the terminology in September of the same year. Both clinics migrated to using the EZcodes-2011 in April 2011. The treatment planning module training includes the diagnostic term entry training and takes 4 hours of didactic training and a minimum of 4 hours of “self-learning” by using the computer lab and completing a standardized case of a “fake” patient in the ‘training EHR' environment at HSDM.

ACTA began using the original EZcodes limited to Periodontics-related terms in May 2010, and started using the full original version of the EZcodes terminology in September 2010. At ACTA, the treatment planning module training includes the diagnostic term entry training and takes 1 hour of didactic training and a 4 hours self-learning training, in which the student has to make a treatment plan for a test-patient in the ‘training EHR' environment.

To report on utilization of the diagnostic terms, all patient visits and associated diagnosis and treatment data for the specified study period at these three institutions were analyzed. Descriptive statistics of the overall utilization and within each category of diagnosis were computed.

Determining Valid Treatment-Diagnosis Pairs

In modern times, dental care providers have been required to enter specific treatment procedure(s) - Current Dental Terminology, CDT in the US or its equivalent in the Netherlands, UPT (see later) - to be carried out during a patient visit into the patient record. Given the novelty of diagnostic term use in dentistry, however, its use is not mandatory and as a result, many clinicians do not routinely input patient diagnostic terms into the patient record. In the three schools diagnostic term entry was made an integral part of the educational process: teaching on entry of diagnostic terms is incorporated into the EHR training that all students and faculty receive. All three schools use the same EHR, axiUm (Exan, Vancouver, Canada).

Due to faculty oversight and/or the audit processes associated with the billing process, dental procedure codes are entered with high accuracy. Thus, validation of diagnostic terminology entry was performed by examining if the procedure code used in association with each diagnostic term was appropriate. The diagnosis “complete anodontia”, for example, can be validly associated with the procedure “complete denture – maxillary” but not with “sealant – per tooth”. Assessment of diagnostic term/CDT pairs as valid or otherwise was performed by three trained and calibrated dentists. Each of three evaluators independently rated every relationship as valid or non-valid and then met to adjudicate their assessments. Inter-rater agreement was calculated. The individual observer ratings were compared with the adjudicated data to determine the degree of agreement.

Data Synthesis/Analysis

The Current Dental Terminology, CDT (referred to earlier) is a set of codes that encompass the commonly accepted dental procedures. It was created by the American Dental Association in 1990 to achieve uniformity, consistency and specificity in accurately reporting dental treatment. One use of the CDT codes is to provide for the efficient processing of dental claims and consequently, great attention is paid to it within the dental community in the United States. The procedure codes used in the Netherlands are referred to as "Uniforme Particuliere Tarieven" (UPT codes), which directly translate as “Uniform Private Rates” and are the practical equivalent of the American CDT codes. To facilitate uniform reporting of our results, the UPT codes were mapped to their corresponding CDT codes. Two investigators, who are dentists, independently did the mapping – each of them

was provided with the English version of the UPT codes, and the CDT codes. They subsequently met to resolve the instances in which they differed and this was done until total agreement was obtained. In situations where the UPT code did not match any CDT code, the diagnostic term-procedure code pair was excluded from the analyses. D1320 (tobacco counseling for the prevention of oral disease), for instance, had no potential match in the UPT; C76 (issuing an oral health statement), conversely, did not have any match in the CDT.

Data on the use of procedure codes and diagnostic terms over a one-year period from the three schools were collated. With the collated data, an analysis was conducted to gain insight into the utilization and valid entry of use of the EZcodes diagnostic terminology in the one-year period extending from 7/1/2010 through 6/30/2011.

The proportions of diagnostic terms entered that were valid (by major diagnostic category) were also computed. Among the instances in which a diagnostic term was entered, we calculated the number and proportion of occasions in which this was correct. Our findings are reported as frequencies and proportions, and expressed in tables and charts.

RESULTS

American/Dutch procedure codes

There were 589 discrete CDT codes and 377 UPT codes, divided into 12 major categories in the CDT and 16 in the UPT. Many CDT codes were mapped to multiple UPT codes and vice versa. Eleven of the CDT code categories matched exactly to 13 of the UPT code categories (‘Adjunctive general services’ in the CDT was the equivalent of both ‘Anaesthetics’ and ‘Inhalation sedation’ in the UPT while ‘Restorative’ was split into ‘Restorations with plastic materials’ and ‘Restorations with non-plastic materials’ in the UPT, thus accounting for the 11 to 13 matching). The last CDT category – Maxillofacial prosthesis did not quite correspond to any of the UPT categories and the ‘Gnathology’, ‘Hourly fee for treatment of the mentally and/or physically disabled’ and ‘Subscription fees’ in the UPT did not correspond to any of the CDT codes categories (Table 1). Of the 589 CDT codes available, the investigators had exact agreement for 278 of them. Almost all of the discordant pairings were due to minor partial disagreements. 46 of the CDT codes had no matching UPT codes.

Utilization of Diagnostic Terms

Within the twelve-month period included in the analysis, a total of 29,965 diagnostic terms and 249,411 procedure codes were entered at the three centers. Precisely, 11,490, 10,725, and 7,750 diagnostic terms were entered at UCSF, HSDM and ACTA respectively. There were 49,733, 57,162, and 142,516 procedure codes used, respectively. Therefore, the overall utilization proportion of diagnostic terms was 12% and specifically 23% for UCSF, 19% for HSDM, and 5% for ACTA. The numbers of unique diagnostic terms used at the different schools were 173, 227, and 128 for UCSF, HSDM, and ACTA respectively out of a possible 1,158 or 1,321 terms in the original and 2011 versions respectively. In all schools, caries/periodontics diagnostic terms were the most frequently (19,279) used while TMJ/oral pathology terms were used least (41). A more detailed report on utilization of the EZcodes terminology is shown in Tables 2 and 3.

Validity of diagnostic term usage

Of the 7,750 diagnostic term-UPT pairings obtained from ACTA, 3779 pairs were excluded from these analyses because their UPT codes could not be mapped to a corresponding CDT code.

The 3 investigators who evaluated the diagnosis-procedure pairs (i.e. EZcode/CDTcode pairs) from the three centers agreed 75.1% of the time with individual kappa scores of 0.82, 0.80, and 0.71. Overall, the proportion of valid diagnosis-procedure pairs was 60.5% meaning that clinicians using the diagnostic terms got the pairing wrong (error proportion) for 39.5% of the entered diagnosis. Diagnoses from the Caries and Periodontics categories, which were the most frequently used categories, were validly paired for 57.1% and 64.4% of the entered diagnoses respectively (See Table 4 and Figure 1). Asides from the "No term can be assigned" category (made up of diagnostic terms for procedures where no diagnosis is generally made, like, routine dental visits, periodic exams, comprehensive examinations or xrays), the diagnostic category with the highest validity of use (71.0%) was the 'Pain/ Altered sensation' category which made up 0.3% of the total diagnoses entered. Conversely, the lowest proportion of valid pairs was recorded in the 'Occlusion disorders' diagnostic category (35.5%) and these made up just about 1.6% of the overall diagnosis.

Finally, our results did not reveal any clear pattern between frequency of use of terms from any diagnostic category and error proportions in the entry of the terms (Figures 2 and 3)

DISCUSSION

In this paper, we report on the utilization and valid entry proportions of a standardized dental diagnostic terminology within an EHR at three different dental institutions over a one-year period. Diagnostic terms were used 12% of the time, of which 60.5% were correct with respect to the dental treatment paired with them. 'Caries' and 'periodontics' diagnostic terms were the most frequently used whereas terms from the 'pain/altered sensation' diagnostic category were the most frequently **correctly** used. Also, most (>1000) of the diagnoses available for selection were not used at all at these three centers within this one-year period.

While providers are required to enter the specific procedures to be carried out during a patient visit into the EHR, entering the corresponding diagnostic term(s) is entirely voluntary and as a result, many clinicians do not routinely input patient diagnoses into the EHR. In our previous work on 'Evaluating a Dental Diagnostic Terminology in an Electronic Health Record',[2] the authors reported that diagnostic terms (Z codes) were utilized 38.9% of the time. They suggested that this low utilization was probably a reflection of the lack of attention to detail that students and faculty had in assuring complete utilization of the EHR given the fact that the field was not mandatory to complete; and that it also indicates a general lack of understanding of why the use of a standardized vocabulary is important. Our analysis reports an even lower utilization (12%) compared to the Z codes and this may be because the EZcodes diagnostic terminology is more comprehensive and, therefore, less easy to navigate – Z codes comprise of 147 diagnostic terms but the EZcode terminology consists of almost ten times that number, 1321. This observation is noteworthy given that in creating a controlled vocabulary, developers often straddle the threshold between providing users with a robust range of diagnoses from which they can select, and constraining the volume of the vocabulary so that users don't have to confront the challenge sometimes associated with having to choose from a large variety of options[7]. A potentially useful approach is to encourage the use of a separate 'pick list' – a subset of the EZcodes terminology that contains a list of the more commonly used diagnoses in each of the diagnostic categories. In those circumstances when a provider does not find a specific diagnosis in this pick list, they can then search in the full list of diagnoses.

We discovered an overall error proportion of 39.5% in the entry of the EZcodes terms into an EHR at the three dental institutions. The highest proportion of errors was recorded in the 'Occlusion disorders' diagnostic category (64.5%) and the least amount of errors in the 'No

term can be assigned' category (3.2%). Our previous study[2] reported an overall error proportion in diagnostic term entry of 23.3%, which is considerably lower than this, but the study population was different and we excluded an entire procedure (CDT) category from that analyses (D0100 – D0999, Diagnostic). Pairs were judged as valid only when we perceived a clear association between them therefore it is possible that some of the pairs we judged as non-valid may be correct in certain clinical circumstances or may reflect differing professional judgment. However, an error proportion of 0.4 is concerning and deserves further exploration. In addition, despite our assumption that patients always receive the appropriate treatment, we still pay close attention to the issue of diagnostic term entry because, if computer-stored clinical information is to be useful for purposes beyond individual patient care – quality improvement and assurance, disease surveillance, or answering clinical research questions - validity of the data is of utmost importance. Valid entry of diagnostic terms will consistently reinforce the 'best practices' notion that diagnoses should dictate treatment. It will also empower health care practitioners and administrators to perform efficient outcomes assessment and continuity of care monitoring. Ultimately, the dental discipline will be served by the new knowledge generated through the research enabled by use of standardized diagnostic terms.

The high proportion of errors in diagnosis-procedure pairing reported here is perhaps attributable to two issues that revolve around diagnosis selection – issues which could originate from the clinician themselves or the diagnostic terms and issues concerning how the terms can be retrieved and inputted within the EHR.

Regarding the first, having to select diagnostic terms in an EHR may be a new and potentially time-consuming exercise for many clinicians and as such, they may be inclined to pick terms that are generic without giving careful consideration to their accuracy as long as their patients receive the correct treatment. For instance, in the 'Occlusion disorders' category (which recorded the highest error proportion), '**malocclusion, unspecified**' was the most commonly selected diagnosis. This term was typically paired with "**surgical placement of an endosteal implant**" which we judged as incorrect. If this 'unspecified malocclusion' was caused by a congenitally missing tooth (in which case 'partial anodontia – congenital' is a more accurate diagnosis and "surgical placement of an endosteal implant", a correct treatment), then, the diagnostic term-procedure pair would have been judged to be correct.

The second issue refers to the diagnostic terms and how they are set up for use within the EHR; if a clinician is looking for a term and cannot find it in the category/subcategory that s/he expects it to be in, they may end up selecting a term with any form of connection to the one they were looking for. This might not have been the case if they could navigate easily to the term they were searching for. 'Supragingival calculus', for instance, which seems like a periodontal diagnosis sits under the 'Caries/loss of tooth structure' diagnostic category, and so, if a clinician searches for this term under the 'Periodontics' category and does not find it, s/he may select another diagnosis, say, 'unspecified periodontal disease and condition', which will be paired with 'prophylaxis' and judged as wrong. 'Supragingival calculus' would have been judged as correct if it was paired with 'prophylaxis'.

As shown by Figures 2 and 3 there was no clear association between the frequency of use of a term from any diagnostic category and the validity of its use.

Going forward, the challenge of increasing use/accuracy of these diagnostic terms is clear. First and foremost, it will be important to make the technology fit the user and not attempt to force the user to work around imperfect technology. Hence we will continue to refine the EZcode terminology regularly and continue obtaining feedback from providers on their

experience with using these terms and suggestions on how the terms can be improved. One example of an improvement will be the introduction of clearer descriptions and synonyms for all terms so that clinicians can search out a specific diagnosis by typing in descriptions that they are more familiar with. In addition, we also advocate for specific training of dental providers on the importance of using dental diagnostic terminology and specifically how to use the terms within their EHR.

One limitation of this study is that adjudication of diagnostic term-procedure pairs was done without the benefit of a clinical context and this may have biased our results. An alternative methodology would be to select patient charts at random, de-identify them and allocate them to experts, asking them to select the most appropriate diagnoses (given the clinical scenario), after which the diagnoses selected by the experts will be compared with those that were actually selected by the providers but the advantage in this is still restricted by the amount of clinical information present in the patient's chart. The strength of our method, however, is that we were able to include **all** patient entries in the one-year period under study.

We also suspect that the 12% utilization we observed may be an underestimation because there are a number of procedure (CDT) codes that have no appropriate diagnostic term match in both the original and current versions of the EZcodes. Examples include D5983 (Radiation carrier) and D7990 (Emergency tracheotomy).

Given the need for information and knowledge management in dentistry for the purposes of providing solid data for performing sophisticated quality improvement and clinical research, we can assume that diagnostic terms in dentistry (like in Medicine) have come to stay and so to maximize the benefits that can be achieved by their emergence and use within the EHR, we propose that further research should explore the EHR workflow and the EHR user interface to diagnostic terms so as to help identify and reduce the cognitive and functional impediments to diagnostic term use. This will serve to increase utilization of these diagnostic terms; it will also increase the satisfaction of the users while reducing error rates in the entry of the terms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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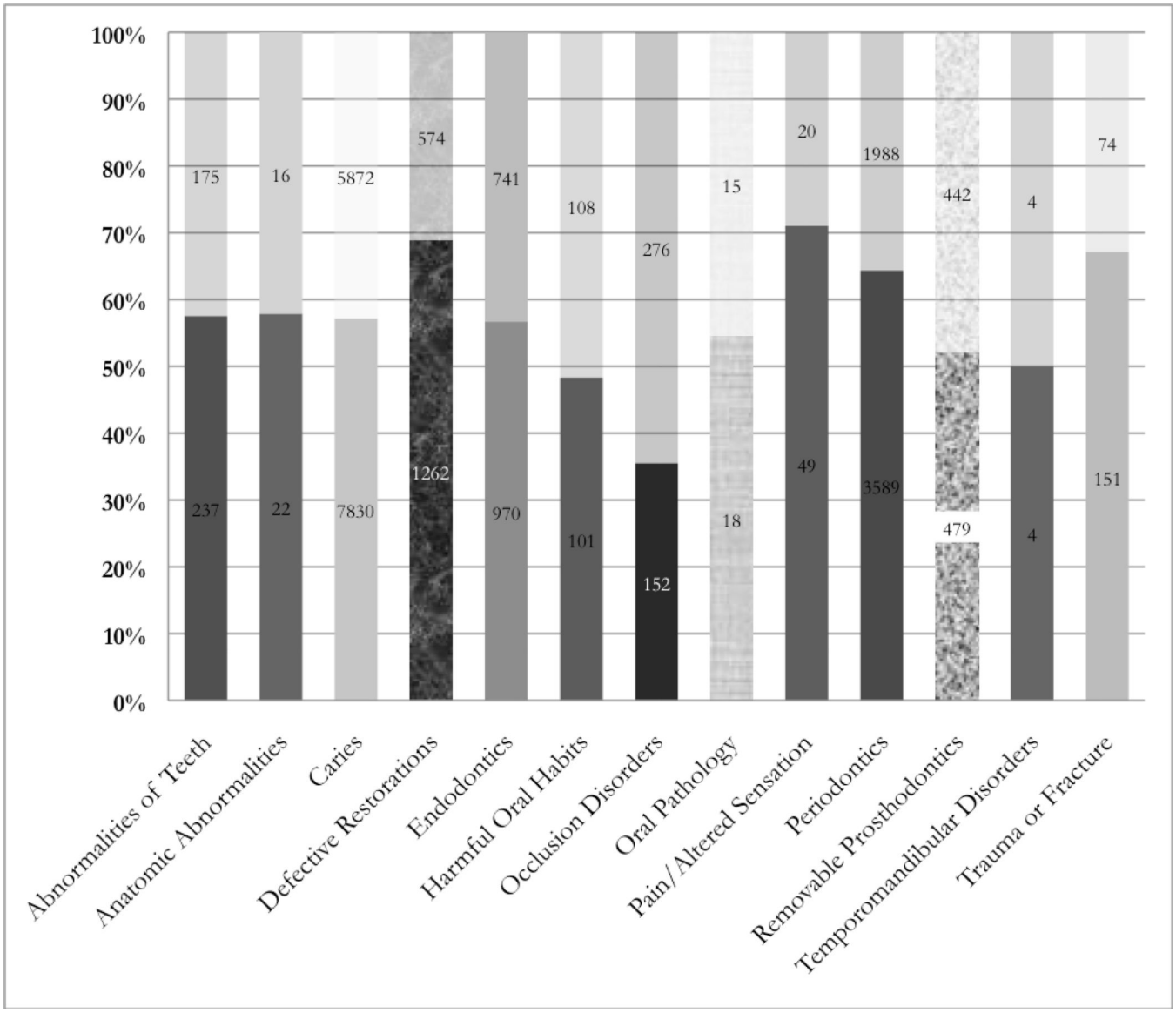

Figure 1.
Validity of entry of diagnostic terms (Bold colors represent valid proportions)

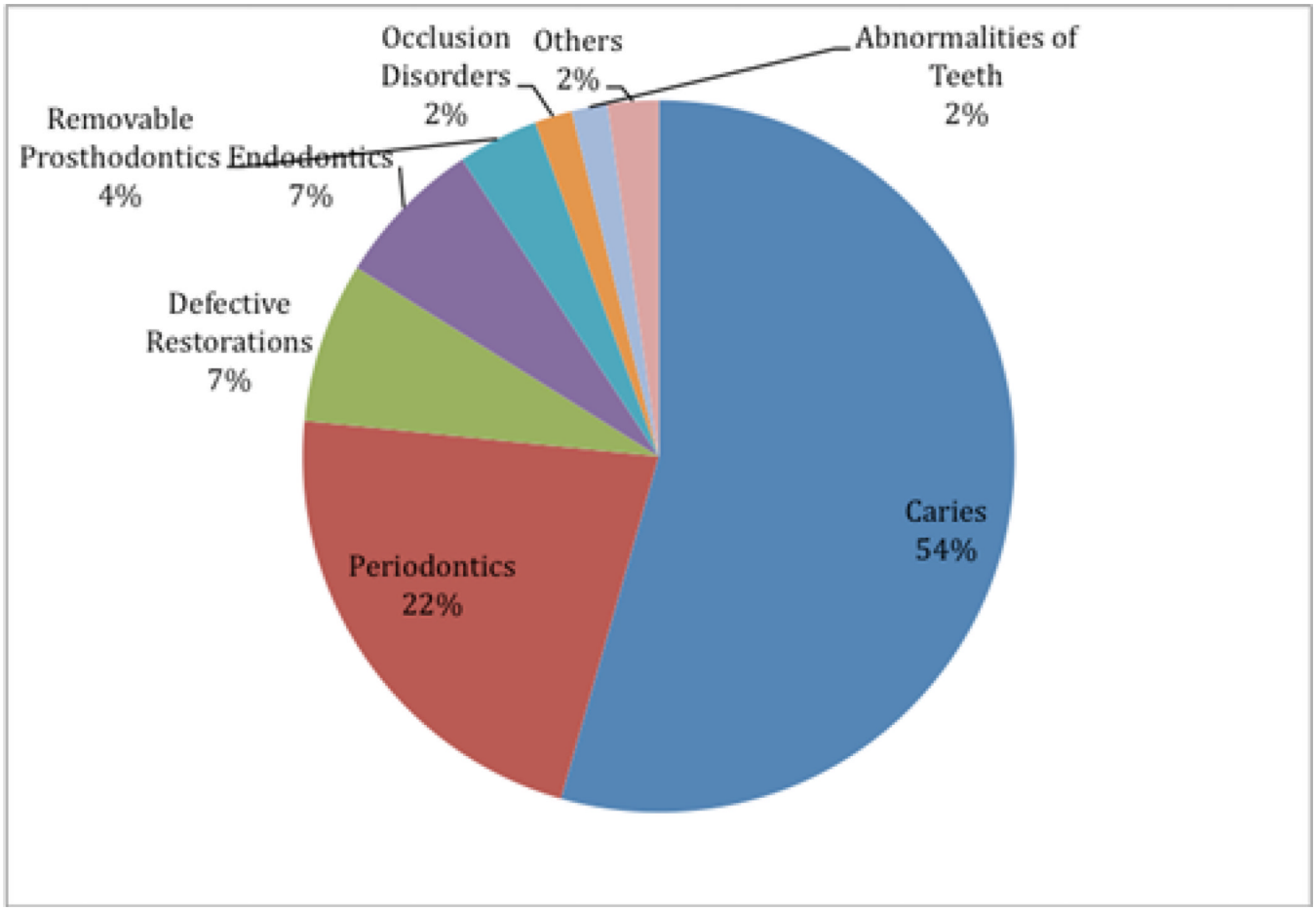

Figure 2.
'Utilization' data

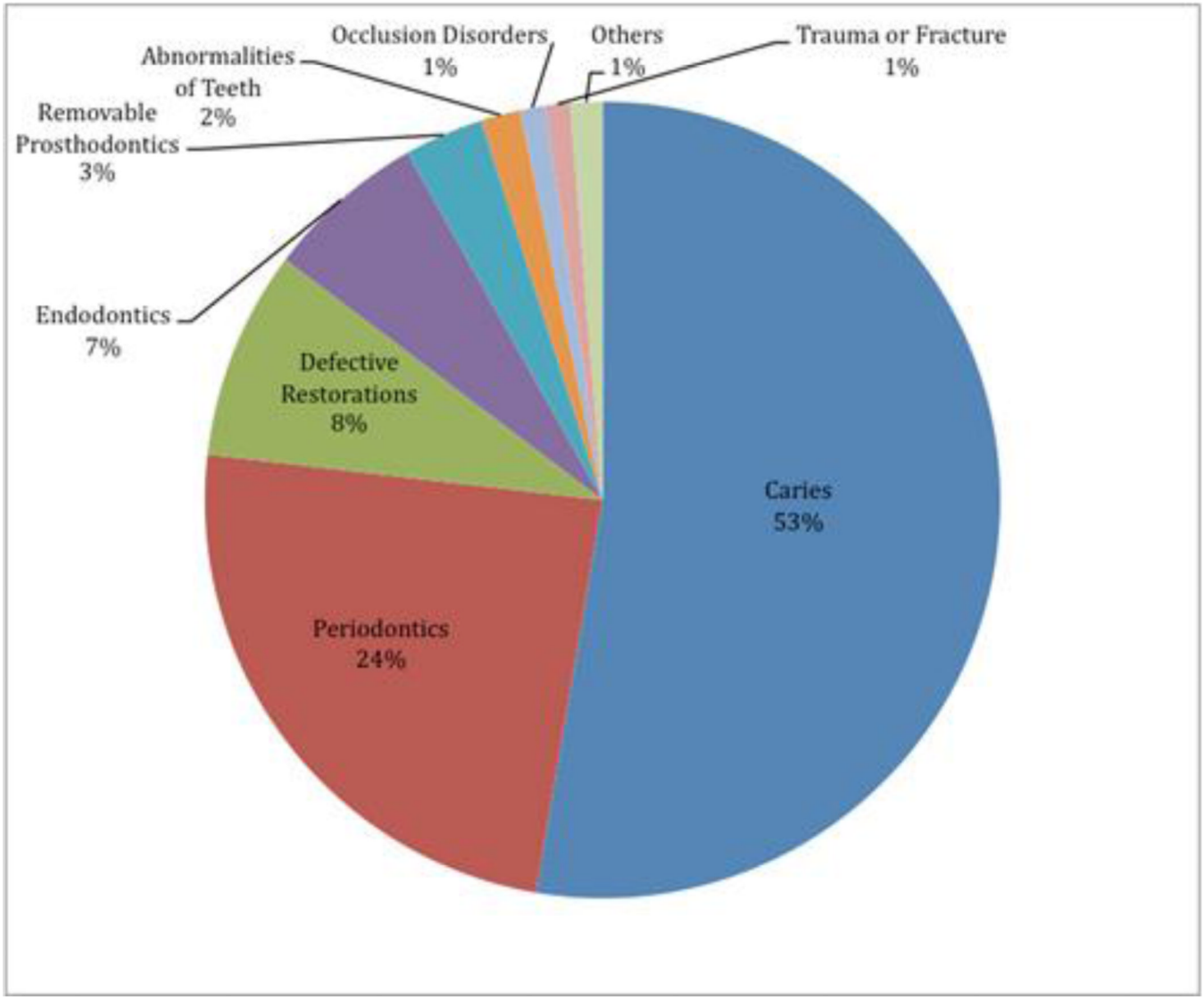

Figure 3.
'Valid utilization' data

Table 1

Link between the CDT and UPT categories

CDT	UPT
Diagnostics	Consultations and Diagnostics Xray Diagnostics
Preventive	Prevention and Oral Hygiene
Restorative	Restorations with plastic materials Restorations with non-plastic materials
Endodontics	Endodontics
Periodontics	Periodontics
Prosthodontics (removable)	Removable Prosthetics
Maxillofacial Prosthetics	
Implant Services	Oral Implants
Prosthodontics, fixed	Restorations with non-plastic materials
Oral and Maxillofacial Surgery	Surgery
Orthodontics	Orthodontics
Adjunctive General Services	Anaesthetics Inhalation sedation
	Gnathology
	Hourly fee for treatment of the mentally and/or physically disabled
	Subscription fees

Table 2

Top 10 most frequently entered diagnoses

UCSF

DIAGNOSIS	FREQ	%
Caries risk high	2,636	22.9
Recurrent caries (Secondary caries)-DEJ	1,199	10.4
Dental caries, unspecified	796	6.9
Primary caries (at DEJ)	587	5.1
Generalized Moderate Chronic Periodontitis	533	4.6
Generalized Gingivitis	457	4.0
Generalized Severe Chronic Periodontitis	428	3.7
Primary caries (< 1/2 distance to the pulp)	364	3.2
Generalized Slight Chronic Periodontitis	293	2.6
Root caries	264	2.3

HSDM

DIAGNOSIS	FREQ	%
Periodic visit (Hygiene visit with periodic/annual exam)	793	7.4
Recurrent caries (Secondary caries)-DEJ	642	6.0
Primary caries (< 1/2 distance to the pulp)	610	5.7
Caries of dentine	571	5.3
Dental caries, unspecified	558	5.2
Generalized Moderate Chronic Periodontitis	397	3.7
Primary caries (> 1/2 distance to the pulp)	374	3.5
Defective restoration: fracture	368	3.4
Non restorable carious tooth	354	3.3
Generalized Severe Chronic Periodontitis	351	3.3

ACTA

DIAGNOSIS	FREQ	%
Dental caries, unspecified	1118	14.4
Recurrent caries (Secondary caries)-DEJ	513	6.6
Generalized Severe Chronic Periodontitis	509	6.6
Localized Severe Chronic Periodontitis	358	4.6
Diastema	310	4.0
Large restoration: Needs full coverage	206	2.7
Partially edentulous maxilla	194	2.5
Defective restoration: poor esthetics	173	2.2
Caries of dentine	172	2.2
Pulp Necrosis	163	2.1

Table 3

Summary of EZcodes utilization, by institution

Institution	Total number of EZcodes used	Total number of CDT codes used	% Utilization
UCSF	11,490	49,733	23
HSDM	10,725	57,162	19
ACTA	7,750	142,516	5

Table 4

Validity of entry of diagnostic terms

Diagnostic category	Total EZ/CDT pairs	Accurate EZ/CDT pairs	Unique EZ/CDT pairs	Unique accurate EZ/CDT pairs	% Valid
Pain/Altered Sensation	69	49	25	17	71.0
Defective Restorations	1836	1262	455	255	68.7
Trauma or Fracture	225	151	79	40	67.1
Periodontics	5577	3589	791	308	64.4
Anatomic Abnormalities	38	22	21	11	57.9
Abnormalities of Teeth	412	237	150	71	57.5
Caries	13702	7830	1859	752	57.1
Endodontics	1711	970	396	170	56.7
Oral Pathology	33	18	23	15	54.6
Removable Prosthodontics	921	479	325	152	52.0
Temporomandibular Disorders	8	4	7	4	50.0
Harmful Oral Habits	209	101	80	18	48.3
Occlusion Disorders	428	152	150	59	35.5

Footnotes

Total EZ/CDT pairs: Total number of diagnosis-procedure pairs within each diagnostic category

Accurate EZ/CDT pairs: Number of correctly paired diagnosis and procedure within each diagnostic category

Unique EZ/CDT pairs: Total number of distinct diagnosis-procedure pairs within each diagnostic category

Unique accurate EZ/CDT pairs: Number of distinct correctly paired diagnosis and procedure within each diagnostic category