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Dental clinical research: an illustration of the value of standardized diagnostic terms

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Authors' contribution: RR, EK, MW, and JW conceived and developed the DDS diagnostic terminology. EK, MW, OT, NK, RV, and JW further refined the DDS dental diagnostic terminology. DP provided the data scripts and data from i2b2. MK and AY completed the data analysis. EK, OT, and RR drafted the manuscript. All authors have read and approved this final version of the manuscript.

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Abstract

Objective: Secondary data are a significant resource for in-depth epidemiologic and public health research. It also allows for effective quality control and clinical outcomes measurement. To illustrate the value of structured diagnostic entry, a use case was developed to quantify adherence to current practice guidelines for managing chronic moderate periodontitis (CMP).

Methods: Six dental schools using the same electronic health record (EHR) contribute data to a dental data repository (BigMouth) based on the i2b2 data-warehousing platform. Participating institutions are able to query across the full repository without being able to back trace specific data to its originating institution. At each of the three sites whose data are included in this analysis, the Dental Diagnostic System (DDS) terminology was used to document diagnoses in the clinics. We ran multiple queries against this multi-institutional database, and the output was validated by manually reviewing a subset of patient charts.

Results: Over the period under study, 1,866 patients were diagnosed with CMP. Of these, 15 percent received only periodontal prophylaxis treatment, 20 percent received only periodontal maintenance treatment, and only 41 percent received periodontal maintenance treatment in combination with other AAP guideline treatments.

Conclusions: Our results showed that most patients with CMP were not treated according to the AAP guidelines. On the basis of this use case, we conclude that the availability and habitual use of a structured diagnosis in an EHR allow for the aggregation and secondary analyses of clinical data to support downstream analyses for quality improvement and epidemiological assessments.

Introduction

Numerous stakeholders are calling for quality measurement in dentistry. The America's Health Insurance Plans wrote about dentistry that, "It is important that we begin to develop measures for quality care and measure provider performance against them." (1) The American Dental Association asserted, "the need to measure is rooted in the basic responsibility to assure that the public receives optimal benefits from available knowledge and effective care." Michael Leavitt, Secretary of Health and Human Services during the Bush administration, said when addressing the American Dental Association in 2007, "If you desire to do business with the Federal Government you need to adopt quality standards."

The good news for dental quality assessment is that, as a profession, we are halfway there: We have begun to take the lead in our own self-evaluation, and the documentation of dental treatment is reasonably well established in many countries throughout the world. The bad news, of course, is that we are *only* halfway there. In order to enhance oral health research and quality improvement, documentation of treatment alone is insufficient. At a minimum, in order to operationalize calculation of quality metrics, dental treatment has to be documented in combination with the dental diagnosis that formed the basis for the indication of treatment. Until recently, a commonly accepted standardized diagnostic terminology did not exist for oral diagnoses. As such, the vast majority of dental providers do not document diagnoses, whether in electronic or paper format, in a structured way. In contrast, medicine has used standardized diagnostic terminologies for over a century (2), and structured diagnostic documentation in the form of the International Classification of Diseases – Clinical Modification, ICD-CM, is required for reimbursement of medical claims in America. More recently, the U.S. Office of the National Coordinator has required the use of SNOMED CT (3) terms for populating the problem list in the EHR for those providers who want to participate in its "meaningful use incentive program" (4).

In addition to the calculation of quality metrics, there are a range of other benefits associated with documenting diagnoses in a standardized way. These diagnoses data can drive epidemiologic research, clinical outcomes measurement, communication, data sharing across providers and facilities, and the development of diagnostic skills for students and faculty in the academic setting (5-8). A Practice-Based Research Network (PBRN) study on periodontal disease concluded that a "Consensus of standardized terminology to increase diagnosis accuracy may have potential health benefits and cost savings" (9). In 2012, Meyers underscored the point, writing, "dentists do not have a set of diagnostic terms or clinical pathways to attain dental health for their patients based on the best available evidence and accurate risk assessment" (1). The National Quality Forum also states

"while process measures are abundant and seem to be the most well-defined; outcome measures are scarce. One factor is the lack of diagnostic coding available in dental claims, which limits the ability to collect and report this type of data" (10).

In 2009, however, a group of dental faculty led by Harvard School of Dental Medicine combined and expanded upon earlier dental diagnostic systems (DDS) to develop the DDS terminology (formerly called the EZCodes terminology) in an effort to address the gap created by the absence of an acceptable and readily available standardized dental terminology (8). Annual revisions and structured review funded through an NIDCR award R01DE021051 has led to a mature terminology. The DDS terminology has been developed as an interface terminology (11) within the electronic health record, which is easy to use and has sufficient granularity to document everyday dental diagnoses. The DDS is continuously updated and refined and has been mapped to the ICD and SNOMED reference terminologies.

Purpose of the study

The American Academy of Periodontology (AAP) defines chronic periodontitis as "the inflammation of the gingiva extending into the adjacent attachment apparatus. Chronic periodontitis with slight to moderate destruction is characterized by a loss of up to one-third of the supporting periodontal tissues." Treatment is centered on altering or eliminating the microbial etiology and contributing risk factors for the disease. Initial therapy consists of a number of steps (12):

1. Management of contributing systemic risk factors
2. Instruction, reinforcement, and evaluation of the patient's plaque control
3. Supra and subgingival scaling and root planing (SR/P)
4. Antimicrobial agents or devices may be used
5. Local factors contributing to chronic periodontitis should be eliminated or controlled
6. Evaluation of the initial therapy's outcomes
7. Periodontal maintenance should be scheduled at appropriate intervals

In this study, we planned to, for the first time, investigate to what extent patients who were diagnosed with chronic moderate periodontitis (CMP) received treatment according to established AAP guidelines. We specifically focused on guidelines #3, 6, and 7 (i.e., whether a patient received only periodontal prophylactic treatment, only periodontal maintenance treatment, only SR/P, or any combination of the three) for their diagnosis.

Methods

Permission to carry out this study was obtained from the Harvard Medical School's Institutional Review Board

Table 1 Diagnostic and Treatment Concepts Used for the Use Case

Terminology	Concept	ID#
DDS	Generalized chronic moderate periodontitis	785649
CDT	Periodontal prophylaxis adult treatment	D1110
CDT	Periodontal maintenance treatment	D4910
CDT	Periodontal SR/P, four or more teeth per quadrant	D4341
CDT	Periodontal SR/P, one to three teeth per quadrant	D4342

(IRB15 – 0007). The DDS was used by clinicians at each included site to capture diagnoses during the course of normal clinical care. All the three included institutions use the Universal Tooth Numbering System (13) for tooth designation. The time frame for *diagnostic* data was 7/1/2011 through 6/30/2012, and timeframe for *treatment* data was 7/1/2011 through 6/30/2013. We added an extra year for the treatment data study period in order to ensure that every patient with a documented diagnosis of CMP would have had enough time to receive treatment. De-identified research data, connecting diagnosis with treatment, were extracted from the BigMouth database (14). The developed query was run against the combined institutional datasets of three of the five institutions that make up BigMouth.

Validation of data

To ensure that patients that received a diagnosis of CMP actually have the disease, we explored how many of the documented CMP cases were supported by the clinical information in actual patient records. Using the AAP guideline: Moderate periodontitis is defined as ≥ 2 interproximal sites with ≥ 4 mm clinical attachment loss (CAL; not on the same tooth) or two or more interproximal sites with probing depth (PD) ≥ 5 mm, also not on the same tooth. The report of the query from one of the sites reflected that 434 charts were available for review. Of these 434 charts, a sample size of 205 records was calculated to be sufficient to estimate the proportion of CMP within 5 percent of its true value (initial anticipated proportion; $P = 0.5$ and absolute precision;

$d = 0.05$). Manual validation was done by comparing that the documented diagnosis of CMP was consistent with the documented periodontal indices (CAL and PD) as described by the AAP.

Assessment of treatment provided

The specific DDS term and treatment procedures (CDT codes) used for the database search are shown in Table 1. The search query/criteria are shown in Table 2. The included CDT codes are reflective of the procedures itemized by the AAP for the management of CMP.

Results

Validation of data

Manual review of 208 randomly selected charts showed that the diagnosis of CMP was consistent with the AAP definition, in 89 percent of the identified cases, according to the CAL and PD documented in the periodontal chart of the EHR.

Assessment of treatment provided

Over the period under study, 1,866 patients obtained a diagnosis of generalized CMP. Of these, 15 percent received only periodontal prophylaxis treatment (option “a” in Table 2); 20 percent received only periodontal maintenance treatment (option “b” in Table 2); 41 percent of the 1,866 patients received periodontal maintenance treatment in combination with other guideline treatments, and 26 percent received prophylaxis treatment in combination with other guideline treatments. SR/P is part of the recommended therapy for this disease, but 50 percent (Table 3) of the patients in our use case received this treatment. However, of these patients, only 31 percent also received periodontal maintenance treatment, and only 5 percent received periodontal maintenance as well as prophylaxis treatment.

Discussion

The standardized documentation of diagnosis is foundational to both building the knowledge store for and deploying

Table 2 Search Criteria for the Use Case

a	DDS ID 785649	AND	CDT D1110	OR	–
b	DDS ID 785649	AND	CDT D4910	OR	–
c (a + b)	DDS ID 785649	AND	CDT D4910; CDT D1110	OR	–
d	DDS ID 785649	AND	CDT D4341	OR	CDT D4342
e	DDS ID 785649	AND	CDT D4341; CDT D4342	OR	–
f (a + e)	DDS ID 785649	AND	CDT D4341 CDT D1110	OR	CDT D4342
g (b + e)	DDS ID 785649	AND	CDT D4341 CDT D4910	OR	–
h	DDS ID 785649	AND	–	OR	–

Table 3 Proportion of Patients with CMP That Received the Various Treatments

Treatments received	# Patients	%
Prophylaxis adult (D1110) <i>only</i>	282	15
Periodontal maintenance (D4910) <i>only</i>	367	20
Prophylaxis adult (D1110) and periodontal maintenance (D4910) <i>only</i>	64	3
Scaling and root planing 1-3 or >4 teeth/quadrant (D4341 or D4342) <i>only</i>	514	28
Scaling and root planing 1-3 or >4 teeth/quadrant (D4341 or D4342) and prophylaxis adult (D1110) <i>only</i>	85	5
Scaling and root planing 1-3 or >4 teeth/quadrant (D4341 or D4342) and periodontal maintenance (D4910) <i>only</i>	286	15
Scaling and root planing 1-3 or >4 teeth/quadrant (D4341 or D4342) and prophylaxis adult (D1110) and periodontal maintenance (D4910)	42	2
No scaling and root planing, prophylaxis adult or periodontal maintenance	226	12
Total patients with diagnosis generalized chronic moderate periodontitis	1,866	

clinical context-based evidence-based dentistry. Simply put, one can only evaluate the effectiveness of a given treatment for a particular diagnosis if both the treatment and the diagnosis are defined. Furthermore, the downstream usefulness of clinical data is contingent upon the quality of the data entered. Broadly speaking, without a well-defined diagnosis that is documented in a standardized way, it will be difficult to “identify and evaluate all of the evidence with which to answer a specific, narrowly focused clinical question” (15).

Take as a specific example the report “Evidence-Based Clinical Recommendations for the Use of Pit-and-Fissure Sealants” (16), which states that “in clinical care settings, diagnosis of caries implies not only determining whether caries is present (that is, detection) but also determining if the disease is arrested or active and, if active, progressing rapidly or slowly.” Additionally, the report states, “Pit-and-fissure sealants are underused, particularly among those at high risk of experiencing caries.” To put all these together, on the one hand, in the clinical setting, it is only when a patient’s level of caries risk, as well as specific diagnosis, is documented in a consistent, standardized way, can we make conclusions about which prevention or treatment approach is best; on the other hand, we can only assess adherence to best practices in real-world practice if all these pieces of information are documented in a standardized way. These all speak to the fundamental value of documenting clinical data (especially diagnoses) in a standardized manner.

Our study demonstrates the feasibility of leveraging standardized documentation of dental diagnoses using the DDS to enable quality improvement in the dental clinic. Because of

the use of the DDS terminology, we were rapidly able to determine that a sizeable proportion of patients in the BigMouth data repository (14) who had a documented diagnosis of CMP did not receive treatment according to current guidelines for this condition. The detailed results showed quality gaps at each point in the treatment and evaluation arc, from failure to perform sufficiently comprehensive treatment (SR/P) to failure to follow-up (periodontal maintenance). It is likely that a number of factors contributed to these shortfalls. For example, studies have shown that compliance with recall visits is not optimum among patients requiring periodontal maintenance treatment (17–19). While the causes can be debated, it is clear that these data are an important piece of dental schools’ armamentarium for curriculum development, student feedback, patient education, continuous quality improvement, and clinical care. Without the ability to assess these gaps, a practice cannot address these gaps.

The data we analyzed are from academic clinics, and the results reflect care provided mainly by students under the supervision of faculty. Our ability to get a window into private practice trends would be enhanced through the expansion of this work to the National Dental PBRN.

Based on earlier studies that report that dental schools document diagnosis for less than 50 percent of relevant patients visits (20), one may argue that our results here are based on diagnostic data entry in less than 50 percent of patients and as such cannot be viewed as representative. While there may truly be some limitation in terms of generalizability, it does not seem likely that those patients for whom diagnoses were *not* documented were systematically provided with care that better aligned with AAP recommendations than those patients for whom their diagnoses were documented. Perhaps the real point here is that the performance among the remaining fifty percent is and will remain unknown because of the lack of use of standardized diagnostic terms. Seen in this light, it becomes very clear that the documentation of structured diagnoses is important and relevant to every patient and practitioner in every practice.

Lastly, although manual review of 208 charts was performed to confirm the diagnosis of CMP and we observed a high validity of this diagnosis, clinic notes were not reviewed to assess CDT (treatment) coding accuracy to ensure there was no “down coding” to save the patient money, or other coding errors. As such, we do not know that the documented treatments are 100 percent accurate in reflecting the actual treatment rendered. The possibility of this is however low because of the strict oversight of dental procedure documentation that occurs at these participating dental institutions.

In conclusion, the availability, deployment, and habitual clinical use of a standardized dental diagnostic terminology provides a catalytic platform for epidemiologic and dental

public health research as well as quality control and clinical outcomes measurement. We assert that all dental practices need to move toward the standardized documentation of diagnostic information.

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