In Brief

Inadequate coordination of care between dentists and medical doctors presents a barrier to comprehensive management of patients with diabetes. New technologies for managing and exchanging health data hold a promise of improved transfer of clinical information between specialties. The authors present a model of how information technology can be used to support standardized workflows in medicine and dentistry to optimize care coordination for patients with diabetes.

Health Information Exchange and Care Coordination of Diabetic Patients Between Medicine and Dentistry

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Despite periodic efforts to bridge the gap between dentistry and primary care medicine, including family practice, internal medicine, pediatrics, and obstetrics and gynecology,[1] these two knowledge domains within health care remain prime examples of informational silos to the extent that coordination of care between disciplines represents an exception rather than the norm. Nowhere is this dynamic more dysfunctional from a patient's perspective than in the management of diabetes, in which growing evidence for a synergistic interaction between oral pathology and systemic disease progression has not resulted in a widespread organized approach to information sharing in support of optimal disease management.[2] The recent acceleration in implementation of electronic health records (EHRs) in primary care practices stimulated by federal financial incentives has led to new ways of thinking about the management of information to support patient-centric workflows.[3] This article presents a conceptual framework for a delivery of care process that crosses the boundary between medicine and dentistry with a corresponding model for the exchange of information to support the workflow.

Although caries, salivary flow disorders, and mucosal disease, including lichen planus or candidiasis, are all thought be more prevalent and difficult to manage in patients with diabetes, it is periodontal disease for which the strongest evidence exists to support a positive and detrimental feedback loop in diabetes.[4] The odds

ratio for periodontal disease among adults with diabetes ranges from 1.56 in those with good glycemic control to 2.9 in those with poor glycemic control.[5] A mechanistic model explaining this association has been described involving advanced glycation end-products (AGEs), which mediate an inflammatory reaction in endothelial and mast cells and play a role in stimulating both periodontal inflammation and bacterial overgrowth.[6]

At the same time, the presence of periodontal disease appears to interfere with glycemic control through the release of pro-inflammatory cytokines that antagonize insulin and may also play a role in accelerated end-organ damage to kidneys and other vascular tissues. Observational studies have shown that diabetic patients with periodontal disease have worse glycemic control than those without, a situation that can be improved with the use of systemic antibiotics and aggressive local measures to treat gingival and periodontal inflammation.[7] Even more provocative are studies showing that among patients with diabetes, the presence of poorly controlled periodontal disease is associated with a threefold increase in cardiac and renal mortality.[8]

That such an important relationship could remain so challenging to recognize and treat in clinical practice largely results from the fact that diabetes and periodontal disease lie on opposite sides of the artificial construct of professional licensure that divides this otherwise continuous pathophysiology, with only the most limited exchange of information between medical and dental providers. Many physicians have difficulty recognizing periodontal disease, and even if they identify it and understand its significance in diabetes, the intervention often consists of telling patients to see their dentist to be treated rather than initiating a shared treatment plan with structured communication between physician and dentist to co-manage the condition. Likewise, most dentists are uncomfortable playing a role in the treatment of medical conditions, including diabetes. A dentist will know if a patient has been diagnosed with diabetes and review the patient's medication and allergy lists. However, outside of settings such as federally qualified health centers, in which medical and dental services are often housed in the same facility, it would be unusual for a dentist to have information available from a medical record on the state of a patient's glycemic control, cardiac risk factor management, and end-organ damage.

The resulting situation is one in which patients with diabetes are dependent on two experts, one on each side of a divide, each of whom is responsible for making clinical decisions that require information the other possesses and that affect the decisions the other must make. Even if primary care can restructure itself along the lines of a patient-centered medical home that includes dentists as part of the care team, the challenge remains to design a workflow, along with the information system to support it, that can ensure that both physicians and dentists treating the same patients with diabetes have all the information they need organized correctly at the point of care to make the right clinical decisions.

A Conceptual Framework for Co-management Using Health Information Exchange

Health information exchange (HIE) is defined as "the electronic movement of healthcare-related information among organizations according to national standards."[9] HIE facilitates communication between health care providers that use different EHR systems. Currently, the Office of the National Coordinator for Health Information Technology is supporting HIE efforts in 56 states and territories through a cooperative agreement program funded by the 2009 HITECH Act.[10] Although the architecture for information exchange varies widely among states, all federally subsidized systems are required to be compatible with a Nation-Wide Health Information Network.[11] In addition, in many areas of the country, health care providers are using EHR vendor systems to facilitate the exchange of health information between separate health care facilities based on natural referral patterns.[12] The development of a clearly defined business model remains a significant challenge in efforts to establish sustainable systems for HIE.[13,14]

Figure 1 shows a model for information flow to support the shared management of patients with conditions requiring co-management between medicine and dentistry. This process can be thought of as a cycle of hand-offs in which a provider (either the physician or the dentist) in one clinical domain goes through a process of clinical evaluation, including gathering and organizing information, followed by ordering tests, treatments, and referrals, before sending the patient to a provider in the other clinical domain.

In an EHR environment, information that is best suited to be organized by the computer includes vital signs, problem lists, medication and allergy lists, and laboratory values, which are entered as structured data. Information that is best entered as text includes history, questions, or nuanced interpretations to another person. HIE provides a mechanism for making both types of information available to providers at the point of care when a patient is seen in the other domain.

The provider to whom the patient is referred will gather any additional information needed to clarify a diagnosis and provide treatment. This will initiate a similar decision-support prompt to ensure that key information is transmitted via the HIE back to the referring provider. The patient is guided back across the professional barrier to be further managed by the first provider. For co-managed chronic conditions such as diabetes with periodontal disease, there is no limit to the number of times a patient may go back and forth across the professional barrier.

Information exchange is an essential part of the process of care coordination, which is designed to facilitate referrals, provide care management for high-risk patients, integrate care across multiple specialties, track patients to ensure that they are receiving necessary services, and communicate results of consultations to patients and their families.[15] One major benefit of HIE is that it allows providers on both sides of the referral process to monitor patients' progression; if patients become lost or fail to follow through on recommended actions, referring providers can be alerted. Several major steps must be taken if such an effort is to be successful. First, there must be an organizational agreement between the physician and the dentist that includes a defined set of information to be shared through HIE, so expectations for the referral process are aligned. In single-provider office settings, the

organizational agreement can be negotiated directly between the providers. For larger offices or institutional settings, the medical and the dental organizations each appoint a representative to negotiate agreements that will include clinical parameters for referrals; relevant clinical data, including tests results; and a timeframe for communication between both sides of the referral process.

One of the barriers to this process in large practices may be provider resistance to following a standardized format for communication. The most effective means for overcoming this barrier is clear communication from leadership articulating the reasons for structured care coordination and the importance of adhering to the organizational agreement.[16]

The second step is to format the information so that it can be used easily to support a range of workflows in both the medical and dental offices in which patients may receive care. Invariably, providers want just the information they need, and extraneous information may actually make their job more difficult. Therefore, the parties sharing information must define a "high-value dataset." This set of structured data is made available so that requesting authorized providers can make an electronic request and receive the information through the HIE hub. This is a "pull" system, in that it delivers the high-value dataset to the point of care on request.

The HIE must also be able to "push" information from one provider to another. The kind of information most likely to be pushed is textual information conveying human thought content. Examples of this are questions that a referring provider asks of a consultant and responses from a consultant back to a referring provider. These thought-content messages are delivered to the recipient when sent and should also be retrievable from the EHR when electronically requested.

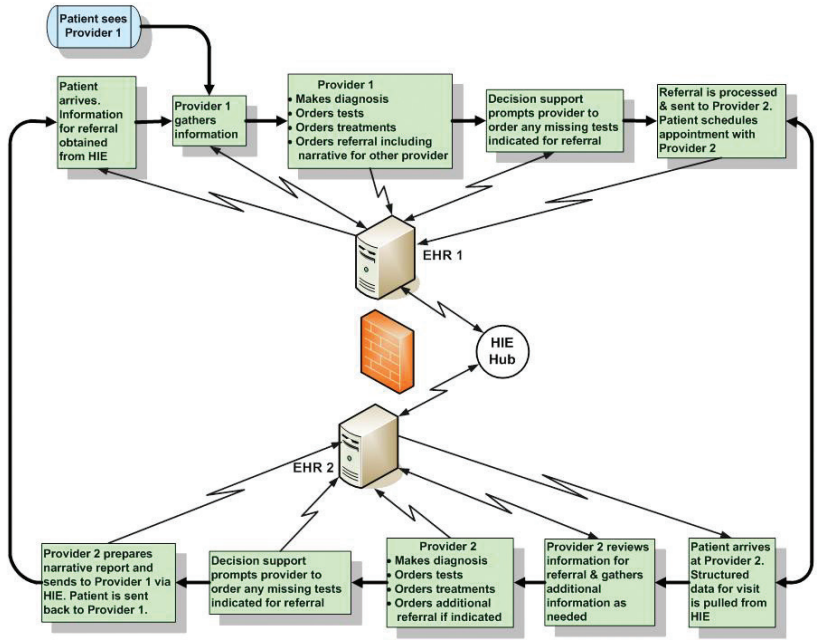

Figure 1. A model for information flow to support the shared management of patients with conditions requiring co-management between medicine and dentistry.

HIE and Co-management of Patients With Diabetes

Part of the function of an organizational agreement relevant to diabetes and oral health is to help medical and dental care providers understand how their colleagues diagnose and manage diabetes in their respective areas of expertise. For dental providers, important information from medical providers about their patients with diabetes includes vital signs, status of glycemic control, interpretation of laboratory test results, and assessment of cardiovascular disease and end-organ status.[17] Table 1 shows an example of a high-value dataset from a medical EHR containing information of importance to a dentist. This dataset would be sent via HIE to the dental office to be available to the dentist at the time the patient was evaluated. This information facilitates treatment planning, safe delivery of treatment, and assessment of treatment outcomes.

For medical providers, information about how dental care providers treat periodontal disease and other oral conditions is essential. For example, typical treatment includes one or more of the following: oral hygiene and nutrition education; scaling and root planing (debridement of plaque and scraping of calculus to remove surface deposits harboring bacterial sources of inflammation); minor surgery (access to periodontal pockets and bony defects through laying of a surgical flap); bone graft placement; and use of antibiotics (administered systemically or locally).[18] Potential complications of oral procedures include prolonged bleeding, postoperative infection, pain, and adverse sequelae of local anesthesia administration. Inclusion of planned or completed periodontal treatment descriptions in organizational agreements will inform medical providers of concurrent pharmacological and surgical therapies and facilitate accurate interpretation of treatment effects by both medical and dental providers.

Data of interest to medical providers may not typically exist as structured data in dental EHRs. In that case, organized information sent from the dentist to the medical doctor would need to be entered by hand and pushed to the physician. An electronic form can be designed to prompt the dentist to include important information accompanied by a narrative text. Figure 2 provides a sample form. The providers on both sides of the interface need to validate the terminology by which they describe clinical conditions (e.g., disease severity). Efforts to standardize communication (e.g., information about periodontal treatments and outcomes) should be tested within the organizations in which they are to be used to ensure that they meet the needs of the corresponding providers.

Case Studies

To illustrate in detail how this would work, two case studies are presented below. In the first, the referring provider is the physician, and in the second, the referring provider is the dentist. In each case, the goal of the workflow is to guide the patient across

the professional barrier as determined by the clinical situation, accompanied by the appropriate information.

Case Study 1: Primary Care Physician Sees a Patient With Diabetes

1. The physician sees a patient with diabetes and gathers information to assess glycemic control, cardiovascular risk factors, and end-organ status.
2. The physician documents the findings and orders tests and treatments as structured data in the EHR.
3. The physician is prompted by clinical decision support to order a dental consultation to evaluate the patient for periodontal disease and other oral conditions associated with diabetes.
4. The patient's key dataset is automatically identified within the EHR for HIE with the dentist. The patient is referred to the dentist with a narrative request to evaluate for periodontal disease and treat as necessary. The referral is sent to the dentist through the HIE. The patient is scheduled for follow-up with the referring physician after being seen by the dentist.
5. When the patient arrives at the dentist's office, a copy of the key dataset (Table 1) is obtained through the HIE. The dentist reviews the data and gathers additional information per dental protocol.
6. The dentist completes the diagnostic evaluation and develops a care plan. The EHR has decision-support tools to ensure that evidence-based treatments that have not been ordered are suggested to the dentist as prompts.
7. The dentist provides treatment and evaluates the response.
8. The patient is scheduled for a follow-up dental appointment for ongoing care.
9. Dental findings and treatment, including new medications and response to care (e.g., Figure 2) and a narrative report are sent via the HIE to the referring physician. The report from the dentist is delivered to the physician's electronic in-basket and attached in the patient's chart to the original referral order.

Case Study 2: Dentist Sees a Patient With Diabetes and Periodontal Disease

1. The dentist evaluates and treats a diabetic patient with acute periodontal disease. The patient's periodontal disease does not respond adequately to treatment. The dentist is concerned that poor glycemic control may be contributing to the severity of the patient's periodontal disease.
2. The dentist documents the findings in the dental EHR. The dentist fills out a referral request and an oral health key dataset report (e.g., Figure 2) outlining the concern and requesting that the physician review the patient's glycemic control to determine whether the treatment for diabetes should be adjusted. This step includes decision support to prompt the dentist to include specific findings that may be of value to the physician
3. The patient is scheduled for an office visit with the physician and a follow-up visit with the dentist.
4. The referral/key dataset is sent to the physician. The referral arrives in the physician's electronic in-basket, where it is reviewed and entered into the patient's chart. When the patient arrives at the office, the physician reviews the referral request. The physician obtains additional information from the patient and from laboratory tests, the results of which are returned to the EHR, where they become part of the key dataset for HIE.
5. The physician and the patient develop a treatment plan that may include home glucose monitoring and changes in diet, exercise, and medication regimens designed to improve the patient's glycemic control. This information is documented in the EHR, where it becomes part of the key dataset for HIE that will be available to the dentist.
6. The EHR has decision-support tools to ensure that evidence-based treatments that have not been ordered are suggested to the physician as prompts.
7. The physician enters narrative information into a field that is sent to the referring dentist addressing any specific issues raised by the dentist in the consultation. The medical office verifies that the patient has a follow-up appointment with the dentist and is given a follow-up appointment for medical care.

In these two case studies, the core process is a standardized workflow, in which the EHR serves both as a place to store structured information and a mechanism to prompt the provider to consider referring the patient to a provider in another knowledge domain.

An information technology (IT) specialist plays a crucial role in adapting the technology in the EHR to the clinical needs of the care team. Ideally, a clinician with an understanding of how the technology functions will work directly with the IT specialist (e.g., database analyst) to translate

Table 1. Key Medical HIE Dataset to Accompany Patients Sent From Medicine to Dentistry

Data Element	Comments
Problem list	Standard data in an EHR, including known cardiovascular disease, hypertension, and renal disease
Medication list	Must be checked to identify medication changes
Allergy list	Medication allergies and other adverse reactions
Vital signs	Blood pressure, pulse, height, and weight
Smoking status	May have different ways of quantifying in different EHRs
Laboratory test results	Date and value of most recent results; a filter should be considered to limit the test results to A1C and serum creatinine; in addition, a simple interpretation schema for dentists would be useful (e.g., A1C: < 7.0% = good control, 7–9% = moderate control, > 9.0% = poor control)

Key Data Set to Accompany Patients Sent from Dentistry to Medicine

Oral Health Key Data Set Report	**Date:** *day/month/year*
Condition	**Characteristics**
o **Periodontitis**	o None o Mild o Moderate o Severe
Date of most recent dental visit (with periodontal tx)	_____ *day/month/year*
Response to periodontal tx.	o Poor o Fair o Good o Excellent
o **Caries**	o None o 1 tooth o > 1 tooth o Risk Factor: Poor oral hygiene o Risk Factor: Excess sugar/refined carbohydrate intake o Risk Factor: Oral dryness
o **Oral dryness**	o None o Mild o Moderate o Severe
Mucosal abnormality	o None OR:
o **Candidiasis**	Location:_____ o None o Mild o Moderate o Severe
o **Lichen planus, lichenoid drug reaction**	Location:_____ o None o Mild o Moderate o Severe
o **Ulcer(s),Type:**_____	Location:_____ o None o Mild o Moderate o Severe
o **Other**_____	Location:_____ o None o Mild o Moderate o Severe
Smoking status	o Never o < 0.5 PPD o 0.5 PPD o ≥ 1 PPD o Stopped smoking How long ago?_____
Treatment Completed	
Non-surgical	o Adult prophylaxis o Scaling and Root Planing o Local antibiotic use, name:_____
Surgical	o Gingival surgery o Osseous surgery o Bone graft o Implant placement
Medications prescribed or recommended	o None o Medication: _____ Date prescribed:_____ For condition:_____
Comments/Consult Request	
o For Your Information o Request evaluation for diagnosis of diabetes o Request evaluation of status of diabetes control o Other:_____ _____	

Figure 2. Sample electronic form for sharing information between medical and dental providers.

clinical concepts into computer logic. The goal is to design user interfaces, decision-support alerts, and the exchange of information to serve as tools that support clinical workflows.

Once the referral is made, the EHR assists in assembling the information that both providers have agreed is to be available to the receiving provider and delivers the information at the point of care. Although the technology makes it possible to get the right information to the right person at the right time, it must be emphasized that it is only through careful attention to organizational protocols and clinical workflows in both the medical and dental offices that this flow of information can occur reliably.

To be successful in a large practice setting, this work requires strong clinical leadership, the purpose of which is to create a shared understanding within the organization of the need for standardization as a first step in quality improvement. This is most effective when an evidence-based quality metric can be used to illuminate a quality gap.[19] Providers and support staff are more likely to agree to a standardized protocol if they understand that standardization is a starting point for improvements in which they are encouraged to participate, rather than a solution imposed on them from above.[20] Small practices may require more customized protocols, but success likewise relies on understanding of standardization needs and staff participation in workflow solutions.

Conclusion

Health information technology in itself is insufficient to improve coordination of care and health outcomes. Rather, information technology makes it possible for providers to improve care if they can redesign the way information is used to reduce fragmentation of services, particularly when care is delivered across a variety of settings. As noted above, evidence suggests that fragmented care between medicine and dentistry can make treatment of patients with diabetes and periodontal disease less effective.

For care coordination to be successful, primary care providers in medicine and dentistry must be accountable for establishing relationships with their counterparts and setting up an infrastructure for tracking patients whom they send to each other for consultation. Work in other

specialties suggests that this type of care coordination requires organizational agreements that take into account the perspectives and needs of both types of providers. Finally, it requires the type of interconnectivity outlined here as an HIE.

It is important to note that a certified EHR is not an absolute requirement for the HIE as described here. Other sources of electronic data in structured format, such as a disease registry, billing system, or imaging software system, might be configured to contribute data for an HIE.[21] However, the HIE is a requirement for meaningful use of the EHR, and the national HIE infrastructure currently under construction is designed to connect certified EHRs.[3,9]

For more than a decade, medical practices across the country have familiarized themselves with the principles of population management of chronic illness using diabetes as an example.[22] The clinical standard of care for this model includes ensuring that patients with diabetes receive routine eye care and are screened for peripheral neuropathy in their feet on a yearly basis, both of which involve care coordination with non-primary care specialties.

Dental care can be similarly included in the network of care for patients with diabetes.[21] The model presented in this article includes a workflow for interprofessional care by physicians and dentists with suggested key datasets that can be modified as needed and validated by its users. It is hoped that this model can be extended to the management of other diseases with oral and systemic interactions currently at high risk for being lost in the gap between medicine and dentistry.

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