1. Title Page

E-Health Records to Improve Care for Patients with Chronic Illnesses

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2. Structured Abstract of 250 words.

<u>Purpose.</u> In this randomized clinical trial, the impact of two clinical decision support approaches for dentists to improve quality and safety of dental care for those with medically complex conditions were compared.
<u>Scope.</u> Dentists must be vigilant in adapting care for patients with medically complex conditions to ensure quality and safety of care and can do so with health information technology.
<u>Methods.</u> Fifteen dental clinics from HealthPartners and 102 dental care providers were randomly assigned to one of three groups to evaluate the impact of two clinical decision support approaches for patients with medically complex conditions during 6-months before implementation and 12-months after. Provider activation and alerts through electronic dental records was compared to patient activation through personal health records to alert their dental care provider to review their personalized care guidelines.
<u>Results.</u> Participants in both the provider and patient activation groups increased use of the system during the first six months to access the guidelines for all patients. They also improved the accuracy of documenting medical history and use of preventive care as recommended in the guidelines (P < .05). However, it did not have an impact on patient complications between groups, which were relatively low. Provider activation was more effective in promoting accessing the guidelines than was patient activation. However, providers did not sustain their high level of use of the system.
<u>Key Words.</u> Informatics; information dissemination; diagnostic errors; medically complex patients, electronic dental records; electronic medical records; decision making; randomized controlled trial; practice guidelines; quality of care.

3. Purpose: Objectives of the Study.

The primary goal of this proposal is to conduct a randomized clinical trial to evaluate the effectiveness of an integrated electronic health record system that includes a eMedical Record (EMR), eDental Record (EDR), and a Personal eHealth Record (PHR) to improve the quality and safety of dental care for patients with chronic illnesses. The current study has 3 specific aims;

Aim 1- Determine the impact of Integrated Electronic Health Record based interventions toward changing Dentist access to clinical guidelines for identified patients

Aim 2- Determine the impact of Integrated Electronic Health Record-based interventions changing Dentist behavior upon the frequency of condition-specific medical review and appropriate action at dental visit for identified patients.

Aim 3- Determine the impact of an Integrated Electronic Health Record-based interventions upon the frequency of complications and utilization of emergency care for identified patients.

In this final report, we present the results of the landmark study that integrates medical, dental and patient health information technology to improve the dental care of patients with medically complex conditions.

4. Scope: Background, context, settings, participants, incidence, prevalence.

Background. Dental providers are treating patients with medically complex conditions with increasing frequency. This is due, in part, to the growing population of older adults; the increased prevalence of medical conditions such as heart disease, diabetes and lung disease; and an increased use of medications. Each of these has implications for ensuring safe and effective care.[1-5] Patients with specific medical conditions may be at increased risk of developing periodontal disease, caries and medical complications (such as heart attack and stroke) during or after dental treatment.[4-7] The U.S. surgeon general's 2000 report on oral health in America highlights important interactions between oral disease and other medical conditions, as well as the need for dentists to recognize and follow evidence-based clinical guidelines when caring for patients.[1] Furthermore, the 1995 Institute of Medicine report on dentistry calls for more links between dentistry and medicine and the need for better training of dentists in caring for patients with medical conditions.[2] To facilitate improvements in the quality of care, organizations such as the American Academy of Oral Medicine, Edmonds, Wash., have developed clinical care guidelines for dental care providers in treating patients with medically complex conditions.[8]

Context. Chronic illnesses such as heart disease, diabetes, cancer, and lung disease comprise most illnesses that present to physicians as well as dentists; and as the population ages, the prevalence of these conditions is increasing. Patients with these chronic medical conditions have significant dental care implications that include not only the increased risk of dental problems such as periodontal disease and caries but also the possibility of medical complications that arise during or after treatment. Baum (2007) recently reviewed the importance of dentists' understanding of medical conditions and the problems associated with the current lack of training in medicine in dental schools.[6] He states that dentists' training is lacking in the understanding of "enough medicine to treat their patients who have chronic illnesses, a population that continues to increase in size." Only five of the current dental schools spend more the 1% of their instructional time on general medical emergencies, and little time in these curricula is focused on how to manage medically compromised patients.[6] This has lead to problems for dentists in identifying medical problems during routine dental care as well as modifying their dental care to take these conditions into account.

Both the *1995 Institute of Medicine Report on Dentistry* and the *U.S. Surgeon General's 2000 Report on Oral Health in America* call for more links between dentistry and medicine and the need to better train dentists on special considerations in managing patients with medical conditions.[1-2] The 1995 report concludes that "dental practitioners will use more medical knowledge in the future and will need to work more closely with other health professionals. Meeting the needs of an aging population with more complex health problems will require that dental professionals have more comprehensive medical knowledge…and that the dental profession will and should become more closely integrated with medicine and the health care system on all levels: education,

research, and patient care." [1-2] They also highlight the important interactions between oral disease, particularly periodontal disease and oral infections, with diseases such as coronary heart disease, bacterial pneumonia, diabetes, and stroke.

Despite the availability of guidelines, use of this information at the point of care can be limited for several reasons, including the inability to identify patients with medical conditions, the difficulty in implementing guidelines at the point of care, and the challenge of translating guidelines into specific changes in clinical protocols.[9-12] The emergence of health information technology systems such as electronic health records (EHRs) has the potential to improve the quality and safety of medical and dental care, particularly for patients with serious medical conditions. Clinical decision support (CDS) systems involve interactive computer software, designed to assist physicians and other health care professionals with decision-making tasks, such as determining a diagnosis or treatment strategies. CDS modules can be designed to be embedded in EHRs to alert health care providers to suitable modifications in clinical care and patients' self-care.[13-16] CDS also enhances communication between health care providers and patients and facilitates the exchange of patients' health information between and among the teams of health care providers involved in patient care.

The potential for CDS to improve health care will be enhanced if clinicians are given pertinent patient-specific information via electronic reminders activated at the point of care to encourage changes in clinical protocols when necessary. Several EHR systems, including electronic medical records (EMRs), electronic dental records (EDRs) and personal health records (PHRs) can contribute valuable information to CDS. When these diverse health information technology sources are integrated, a more complete picture of a patient's health care status emerges. Furthermore, CDS can assist the health care professional in developing specific and personalized treatment recommendations that take into account a patient's medical or dental conditions.

Setting. The setting was HealthPartners, a large upper Midwestern integrated health system that consists of a dental group, a medical group, a hospital system, a health plan and a dental plan. The HealthPartners Dental Group (HPDG) provides both pre-paid and fee-for-service dental and oral care services in 17 HealthPartners dental clinics. The HPDG provides care for approximately 100,000 members. HPDG is a staff model group practice of more than 55 dentists, including specialists in oral surgery, periodontics, prosthodontics, and pediatric dentistry. The practice also has a staff of more than 75 hygienists, and 110 dental assistants.

Participants. Among 59,147 HPDG patients, the 10,890 patients (18.4 percent) who had one or more of the four medical conditions (identified from the EMR) and had a dental visit at HPDG during the study period were included (Table 1). The condition identified most frequently was "possible xerostomia" (n = 6,928), followed by diabetes (n = 4,442), COPD (n = 1,484) and congestive heart failure (n = 854). Many patients had more than one of these conditions (n = 2,818 [25.8 percent]). Characteristics of the dental care providers and volume of services delivered were similar among the three groups (Table 1).

Table 1. Characteristics of the study population in each group (n=10,890 out of 59,147)(18.4% of dental patients were included)			
Characteristic	Provider activation	Patient activation	Usual care
Clinics	5	5	5
Providers*	31	33	38
Types of providers (%)			
Dentist	13 (42%)	13 (39%)	14 (37%)
Hygienist	18 (58%)	20 (61%)	24 (63%)
Range in the number of providers per clinic	5-8	5-8	4-11
Total number of patients with condition seen during the 18-month study period**	19,221	18,494	21,432
Number of patients seen with condition (%) during the 18-month study period			
Any	3,536 (18%)	2,979 (16%)	4,375 (20%)
Diabetes mellitus	1,444 (8%)	1,271 (7%)	1,727 (8%)
Xerostomia	2,256 (12%)	1,872 (10%)	2,800 (13%)
Chronic obstructive pulmonary disease	466 (2%)	383 (2%)	635 (3%)
Congestive heart failure	258 (1%)	200 (1%)	396 (2%)

<u>Incidence and Prevalence.</u> Although all chronic illnesses are important to consider in routine dental care, the four medical conditions of diabetes, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and conditions and medications causing xerostomia were selected for this study because of the profound effect they can have on the quality and safety of dental care if they are neglected and the ability to improve them through both patient and dental interventions. Little et al[29] provide an excellent summary of these conditions and their dental implications.

Diabetes mellitus is a common disease affecting about 7% of the population and has many concomitant oral manifestations that impact dental care.[30] It is a syndrome of abnormal carbohydrate, fat, and protein metabolism that results in acute and chronic complications due to the absolute or relative lack of insulin. There are three general categories of diabetes: type 1, which results from an absolute insulin deficiency; type 2, which is the result of insulin resistance and an insulin secretory defect; and gestational, abnormal glucose tolerance during pregnancy. Diabetes develops in people of all ages, although in greater frequency in African-Americans and Hispanics, and its prevalence has increased dramatically over the past several decades. [30] About one-third of adults with diabetes in the United States are undiagnosed, and dental preventive care among patients with diabetes falls below national health objective standards.[30] Oral adverse events of diabetest is often made on the basis of a host of systemic and oral signs and symptoms, including oral gingivitis and periodontitis, recurrent oral fungal infections, and impaired wound healing. Dental professionals can play an important role in diagnosing and managing patients with diabetes as well as changing their care to consider the risks associated with diabetes. These patients often have xerostomia, increased caries and periodontal disease, *Candida albicans*, oral lichen planus, and burning mouth syndrome.[31-32] Increased efforts towards oral hygiene are paramount to management. Although diabetes patients are less likely to have regular dental exams, these exams occur more frequently when the dentist is aware of the patient's diabetes status.[32]

CHF represents a symptom complex that can be caused by a number of specific disease processes. The three most common causes are hypertensive disease (the dominant cause, preceding cardiac failure in 75% of cases), cardiac valvular disease, and coronary artherosclerotic heart disease and its complications.[25] Other causes include thyrotoxicosis, rheumatic fever, congenital heart disease, severe anemia, COPD, and pulmonary hypertension.[1-3] CHF is one of the most common causes of death in the United States.[33-34] Of the more than 2 million Americans with CHF, 50% die within 5 years.[33-34] Patients with CHF need special attention during dental care, including avoiding procedures that can strain the heart, use of adequate pain control, monitoring blood pressure, shortened visits, and a cautious eye to possible complications.[6,29] They also need special attention regarding preventing oral infections and periodontal disease that may contribute to further cardiac problems.

COPD is a slowly progressive disease of the airways characterized by a gradual loss of lung function.[29] COPD includes chronic bronchitis, chronic obstructive bronchitis, or emphysema, and combinations of these conditions and can lead to pneumonia, heart disease, and death. They represent the fourth leading cause of death in the United States, with symptoms ranging from chronic cough and sputum production to severe disabling shortness of breath. In some individuals, chronic cough and sputum production are the first signs that they are at risk for developing the airflow obstruction and shortness of breath characteristic of COPD. In others, shortness of breath may be the first indication of the disease. The diagnosis of COPD is confirmed by the presence of airway obstruction on testing with spirometry. Patients with COPD need special attention similar to patients with CHF during dental care, including avoiding procedures that can limit breathing, cardiovascular strain, use of adequate pain control, shortened visits, and a cautious eye to possible complications. They also need special attention regarding preventing oral infections and periodontal disease, which may contribute to pneumonia and complications.[6,29]

Conditions or medications causing xerostomia. Xerostomia affects about 25% of the population and is largely related to either autoimmune salivary gland disease or medication that a patient is taking.[35] The patient also may experience burning of the tissues, irritation of the tongue, and painful ulcerations. Xerostomia increases susceptibility to caries, erosion, and dentin hypersensitivity. Many commonly prescribed medications can decrease salivary function, such as antihistamines, antidepressants, antipsychotics, antihypertensives, anti-

inflammatories, diuretics, sedatives, and narcotics; it can also be the result of Sjögren's syndrome, an immune system disorder in which white blood cells attack the moisture-producing glands.[36] Various other conditions also may cause xerostomia, including diabetes, lupus, kidney diseases, stress, anxiety, depression, nutritional deficiencies, and a dysfunction of the immune system, such as that caused by HIV/AIDS. Furthermore, cancer radiation therapy on or near the salivary glands can temporarily or permanently damage the salivary glands. Prolonged reduction of saliva can lead to increased decay and mouth ulceration, an increased susceptibility to infection, psychological distress, physical discomfort, and social embarrassment.[6,29] With xerostomia, there is an increase in dental caries, particularly cervical, proximal, and in the roots; cracking and fissuring of the tongue; frothy saliva; ulceration of oral mucosa; no pooling of saliva in the floor of the mouth; and recurrent oral *Candida* infections.

5. Methods: Study Design, Data Sources/Collection, Interventions, Measures, Limitations.

Study design.
We conducted a three-arm, two-year, prospective, randomized clinical trial within the HealthPartners Dental Group (HPDG). HPDG is part of a large multi-specialty integrated health care delivery system that includes dental clinics, medical clinics, and hospitals with an integrated electronic health record. The study used privacy and security methods that were approved by the HealthPartners institutional review board and consistent with the Health Insurance Portability and Privacy Act[17] and federal guidelines. Fifteen dental clinics in the HPDG were randomly assigned to one of three groups:

Provider activation group. Dentists and hygienists randomized to this group received alerts in the EDRs when patients scheduled for dental appointments had one of the targeted medical conditions. These alerts notified the providers of their patients' chronic health conditions and provided a link to customized, condition-specific, evidence-based care guidelines that specifically addressed implications for the dental encounter.

Patient activation group. Patients with upcoming dental appointments who had one of the targeted medical conditions received a notification from HPDG before the visit. This was done via the patient's secure e-mail in his or her PHR or via a mailed letter if he or she was not registered for an e-mail in the PHR. The notification indicated the possible presence of the medical condition and encouraged the patient to discuss it with his or her dental care provider at the upcoming appointment and ask him or her to review the patient's personalized care guidelines by clicking the medical alert link in the EDR.

Control group. Patients in the control group received usual care. Although dental providers had access to general Web-based clinical care guidelines, neither patients nor providers received alerts about a patient's medical status or personalized care guidelines.

Two HPDG clinics assigned to the usual care arm were excluded from the analysis: one clinic provided specialty care only, and patient demographics of the other clinic could not be matched for randomization purposes. The provider activation group clinics included 32 dental providers. The patient activation group clinics included 38 providers. The control group clinics included 39 providers. Seven providers who were not actively employed by HPDG during the entire study period or who filled temporary positions and were not involved in all phases of the study were excluded from data analysis.

Data Sources/Collection/ Analysis
Data Sources. All patients with at least one of four medical conditions and an upcoming dental visit were identified according to a validated electronic algorithm that used data from HeathPartners' registries that were established from EMRs and claims databases. The selected medical conditions for this study were based on their prevalence, their potential for complications and the need to modify treatment to improve quality and safety. The conditions were identified from data in the EMR, and included diabetes mellitus; congestive heart failure; chronic obstructive pulmonary disease; and xerostomia resulting from use of medications.[7,8,18-22]

Data Collection. The CDS integrated data from the EMRs, EDRs, PHRs and administrative databases to answer the following question: "Can targeted dental care provider activation strategies or patient activation strategies that use CDS with electronic alerts increase utilization of patient-specific care guidelines at the point of care?"

Three primary outcomes were examined: 1) frequency of accessing guidelines for identified patients; 2) frequency of condition-specific medical review and appropriate action at dental visit, 3) frequency of adverse events and utilization of emergency care. Table 2 describes the outcome measures as benchmarks, estimated current status of dentists and patients meeting the benchmark, and expected behavior after the intervention.

Table 2, Outcome measures, benchmarks, and hypothesized behavioral after both interventions. The outcome measures used to measure impact of the interventions, the percent of patients who currently meet the benchmark, and the hypothesized target of the benchmark to achieve success for the intervention. These are all estimates based on preliminary data.		
Measure outcome/ benchmark for Specific Aim 1.	% of dentists/ patients who currently meet benchmark (estimates based on population with condition)	Hypothesized target for benchmark (% of patients)
Dentist document medical history review and chairside actions taken in EDR	20%	60%
Visits to hygienist at least every 6 months (2 per year) as noted in the EDR	20%	60%
Oral Hygiene Index of < 1.0 as noted in the EDR	30%	60%
Utilization of emergency dental or medical care for problem	20%	10%

1. Frequency of accessing the guidelines. The three primary outcomes included hits on Web site for all patients, percentage of unique providers who access the guidelines, and levels of acceptability and satisfaction of the CDS qualitative and quantitative survey and focus group approach. Dental providers were asked about a standard list of questions to rate the features in each CDS with regard to their functionality, usefulness, and acceptability. In the focus groups of three to five dental providers, the features were reviewed and scenarios developed to "stretch" the boundaries outside of an average or inexperienced user and challenge the system's features. Content testing ensured that each word and image on the systemwas appropriate, spelled correctly, and used as intended. Suggested modifications to the infrastructure was discussed with the whole investigative team.

2. Medical History Documentation Rates. It was expected that once a dentist is alerted of a specific patient's medical condition, s/he will change chair-side procedures to minimize complications. The documentation of changes to the medical history were one of the main dependent variables of interest. Documentation of care was coded for each patient as a 0 (no error) or 1 (error). To be classified as NOT having followed care, the dentist must not have document in the EDR that the recommended action had occurred.

3. Preventive Visit and Follow-up Care Rates. Frequency of recall for preventive services and follow-up care was one of the main dependent variables of interest because regular recall for monitoring is consistently recommended by the guidelines regardless of condition(s) experienced. It was expected that the alerts would encourage patients to meet recommended oral hygiene visits as noted in the EDR and, thus, improve oral hygiene and the potential for complications from oral infections. Oral hygiene care was coded for each patient as a 0 (met criteria for adequate care) or 1 (did not meet criteria for adequate care). To be classified as meeting criteria for care, the patient must be seen by the hygienist at least a mean of twice per year.

4. Adverse Events and Emergency Service Utilization. Adverse events and direct emergency service utilization provided a measure of resource use associated with dental care and complications from the medical condition. Specific ER visits to the dentist and medical providers were derived from HP's dental administrative claims system.

Analysis. The randomization process and clinic allocation was concealed through a computer-generated randomization program. Our analytic focus was frequency and proportion of providers who accessed the personalized recommendations on the secure Web site for patients with one or more of the study conditions. We collected the outcomes during the three phases of the study: a static pre-intervention six-month period, a baseline to six-month activation period and a six- to 12-month follow-up period.

The focus of analysis was the dental provider. The first outcome was a discreet count of the number of times he or she accessed the CDS system (that is, hits on the guidelines Web pages), regardless of whether access

occurred for a patient with a condition of interest. The second two outcomes were dichotomous 1) the provider used the Web site [yes or no] and 2) the provider used the Web site for a patient with no condition of interest [yes or no]). Multilevel analysis was used to account for the cluster randomization design of providers within clinics and repeated measures over time (i.e., the three phases). We fit a generalized linear model with Poisson distribution and a log link for frequency outcomes (rate ratio [RR]) and fit a binomial distribution with logit link for the second two outcomes (odds ratio [OR]). We estimated the post-implementation effect for both intervention groups by using pre-implementation as the reference group. We tested the initial effectiveness of the intervention by evaluating it across time during each month of the first six months after initial implementation of the study in relation to the control group. We tested intervention sustainability by evaluating the intervention during each month of the six- to 12-month post-implementation period in relation to the control group. In all of the proposed analyses, we tested a null hypothesis of no statistical relationship between the independent and dependent variables of interest at $\alpha = .05$.

Interventions

The two CDS interventions—designed to encourage use of clinical care guidelines for complex medical conditions—consisted of two different activation strategies. The first was integrated into the dentist's EDR and the second was integrated into the patient's PHR. The results of these two activation strategies were compared with those of the usual care (control) group.[7,8] The two active interventions included;

Provider activation group. Dentists and hygienists received alerts in the EDRs when patients scheduled for dental appointments had one of the targeted medical conditions. These alerts notified the providers of their patients' chronic health conditions and provided a link to personalized, condition-specific, evidence-based care guidelines that specifically addressed implications for the dental encounter.

Patient activation group. Patients with upcoming dental appointments who had one of the targeted medical conditions received a notification from HPDG before the visit. This was done via the patient's secure e-mail in his or her PHR or via a mailed letter if he or she was not registered for an e-mail in the PHR. The notification indicated the possible presence of the medical condition and encouraged the patient to discuss it with his or her dental care provider at the upcoming appointment and ask him or her to review the patient's personalized care guidelines by clicking the medical alert link in the EDR.

Dental providers in all study arms could access the non-personalized Web-based clinical care guidelines through a link embedded in the EDR (Figure 2). The Web-based guidelines were introduced in two phases. Six months before any intervention, all clinics were given access to a static Web page that provided the clinical care guidelines for all four conditions. The two CDS interventions were then implemented as described above and followed up participants for 12 months.

The new care guidelines were introduced in a newsletter to dental care providers informing them that they were available to all clinics through the Guidelines web site. All providers in both intervention groups were masked to the study protocol. No group was aware that other clinics also received alerts and personalized recommendations in the EDR for specific patients, Because each intervention was implemented in different clinics and few dentists or hygienists crossed over to other clinics, the masking of the groups across the duration of the study was able to be maintained.

Clinical care guidelines. The recommendations for modifications in the care of dental patients who had one of the four medical conditions were based on the clinical guidelines of the American Academy of Oral Medicine Guidelines Committee; The These guidelines were adapted for use by HPDG in collaboration with one of the authors (N.R.).[7,8] The American Academy of Oral Medicine's clinical guidelines integrate scientific evidence with practical clinical experience.

Table 3 provides a summary of the clinical care recommendations; however, the detailed personalized care guidelines are divided into recommendations for patient evaluation, changes in treatment and patient's self-management. In addition, the complete care guidelines include a general overview of the four conditions of interest, the effect of the conditions on systemic health and oral health, and clinical recommendations for safe and effective dental care. The care guidelines needed to be brief enough to implement at the point of care but specific enough to have a meaningful effect on care. Once completed, they were reviewed carefully and edited

by the HPDG Guidelines Committee and approved for implementation in the HPDG's EDRs. In addition, we modified the guidelines to accommodate a Web-based format (Figure 1).

Table 3. Evidence-Based Guidelines for Medical Conditions in this study.			
Medical condition	**Estimated adult prevalence**	**Intervention (alert and rationale) to dentist and patient to reduce risk of problems**	**Goal of intervention**
Diabetes	7%	• Review diabetes treatment and status at visit. Maintain adequate dietary and fluid intake and prevent postsurgical infection • Daily oral hygiene and visits every 6 months • Monitor oral hygiene status	• Reduce periodontal, caries and oral infection risk
Xerostomia	10%, with 24% in people >65 years of age	• Review saliva production at each visit • Prescription for saliva substitute/fluoride • Daily oral hygiene and visits every 6 months	• Reduce periodontal, caries and oral infection risk
Congestive heart failure	2-3%	• Measures to reduce cardiac strain while receiving dental care (e.g. short visits, upright, less stress) • Daily oral hygiene and visits every 6 months	• Reduce risk of cardiac problems at dental visit. • Reduce periodontal, caries, oral infection risk
Chronic obstructive pulmonary disease	4-5%	• Review history of concurrent heart disease • Avoid use of barbiturates, narcotics, anticholinergics • Short visit, upright position, avoid use of rubber dam • Avoid nitrous oxide-oxygen inhalation sedation with severe chronic obstructive pulmonary disease and emphysema • Daily oral hygiene and visits every 6 months • Improved oral hygiene self care	• Reduce risk of compromised air flow and pneumonia • Reduce periodontal, caries and oral infection risk

Measures

Three primary measures were examined: 1) frequency of accessing guidelines for identified patients; 2) frequency of condition-specific medical review and appropriate action (preventive care) at dental visit, 3) frequency of adverse events and utilization of emergency care. The primary measures of interest regarding guidelines use of clinical guidelines were as follows:

- *Total use of guidelines.* The overall frequency with which providers accessed the guidelines Web site via the EDR for any patient;
- *Targeted use of guidelines.* the proportion of providers who accessed the personalized care guidelines in general and for targeted patients at the point of care (that is, those identified as having one or more of the four conditions of interest, with alerts provided in the EDR).
- *Ongoing use of guidelines.* The proportion of providers who continued to access the Web-based guidelines throughout the study period.

The specific behavior of dental care providers and patients' clinical outcome data were also evaluated. These primary measures for these outcomes include;

- *Medical History Documentation Rates.* It was expected that once a dentist is alerted of a specific patient's medical condition, he or she will change his chair-side procedures to minimize complications. Documentation of care was coded for each patient as a 0 (no error) or 1 (error). To be classified as NOT having followed care, the dentist must not document in the EDR that the recommended action had occurred.

- *Preventative Care Rates.* It is expected that the alerts will encourage patients to meet recommended oral hygiene and preventative visits as noted in the EDR and, thus, improve oral hygiene and the potential for complications from oral infections. Oral hygiene care was coded for each patient as a 0 (met criteria for adequate care) or 1 (did not meet criteria for adequate care). To be classified as meeting criteria for care, the patient must be seen by the hygienist at least a mean of twice per year.

The specific patients' clinical outcome data were also evaluated. These primary measures for these outcomes include;

- *Dental Adverse Events.* Specific ER visits to the dentist providers are derived from HP's dental administrative claims system.

- *Medical Adverse Events.* Specific ER visits to the medical providers are derived from HP's medical administrative claims system.

The characteristics of providers and the volume of services provided (that is, specific procedures coded by each dental care provider) among intervention clinics were compared to ensure that goals for randomization were met. This included the percent of patients with the chronic medical condition who are receiving care for dental preventative care, the percent and frequency of eligible providers and patients within the practices who accessed the customized decision support. This project is also gathering AHRQ- funded CAHPS® Clinician & Group Survey for the dental plan. The data is presented according to frequency distributions and means ($\pm$ standard deviation).

Limitations
Despite the positive results of this study, one-half of the hits on the clinical care guidelines Web site occurred during appointments with patients who were not included in the analysis of the study. This may be due to the fact that many of the HPDG patients were not part of the medical group or health plan and, thus, identifying their medical conditions through the EMR and claims databases and including them in the study was not possible. This finding suggests that the alerts heightened the dental providers awareness of guidelines and encouraged their use with all patients even if they did not receive an alert. Some hits also may have occurred randomly by providers who are interested in the guidelines. In addition, there may have been some crossover between study arms because dental care providers sometimes work in a clinic other than their primary clinic. There also may have been crossover of a few patients between clinics, which might have influenced the outcomes. However, in analyzing the data, we found that these scenarios occurred infrequently. Thus, we believe that most dental care providers in this study used the CDS as it was intended.

Some limitations also were inherent in the interventions. Dental provider's use of the CDS, regardless of the intervention group, was not sustained after the first six months. This suggests that they did not need to repeatedly review the care guidelines to understand and implement them or they may have developed "alert fatigue," which can occur when one becomes accustomed to seeing flashing alerts and pays less attention to them. Although the CDS triggered an increase in dental provider's' use of the care guidelines with an initial response rate that ranged from 79 to 90 percent of all dental care providers, this was not sustained during the last three months of the study. It is also possible that in the patient activation group, some patients may not have reminded their providers about their conditions despite being notified to do so. Despite this, 79 percent of dental care providers in the patient activation group accessed the care guidelines at least once during the 12-month post-implementation period.

Thus, we need to determine which additional CDS components (such as EDR-embedded office notes and scripts) will result in an increase in the percentage of dental care providers who use the system and which factors will ensure regular use of care guidelines across time. It is possible that by combining patient and provider activation strategies, more providers will be motivated to access the guidelines. Furthermore, embedding guidelines in progress notes in the EDR or providing a script of step-by-step treatment modifications for providers to follow may increase use and sustainability. These are possible topics for future research.

We also need to point out that an increased review of care guidelines will not necessarily result in changes in care or in improved clinical outcomes, such as decreased complications and improved periodontal and dental status. We also need to adapt these CDS approaches to improve their transferability to more dental care providers in small practices while maintaining a high level of acceptability to all types of dental providers. Further analysis is required to evaluate changes in care and the effect of CDS on patient-centered outcomes.

6. Results: Principal Findings, Outcomes, Discussion, Conclusions, Significance, Implications.

The principal findings of the study include;
1. The development and implementation of evidence based guidelines improved safety and quality of dental care in patients with medical conditions.
2. Reminder alerts to both dentists and patients increase utilization of care guidelines by 440% and 221%, respectively, from baseline, while the control group had no increase;
3. Both provider and patient alerts had a generalizable, sustainable effect of increasing the rate at which providers reference care guidelines for all patients compared with usual care and;
4. Automated provider alerts in the EDR are more effective at encouraging the use of care guidelines than personalized alerts sent to patients.
5. The CDS triggered a response by about 79% of all dental providers, leaving only 21% as non-responsive to the system.
6. There was a clear trend towards increasing the frequency of correcting errors in medical history reconciliation by dental providers as triggered by the CDS.
7. The CDS increased the use of preventive dental encounters from pre- to post- intervention periods per patient as suggested by the guidelines.
8. The CDS did not reduce the number of dental or medical complications per patient per year.

Outcomes.
Figure 2 presents the mean number of Web site hits per provider in the provider activation group, patient activation group and control group. Figure 3 presents the percentage of providers with a Web site hit during the 18-month study period (that is, the six-month period before implementation of the CDS system and the 12-month period after implementation of the system). Table 4 presents the total number of Web site hits; the mean number of hits per provider; and the total number of users during the pre-implementation phase, the first six months after implementation of the CDS system and the second six months after implementation (that is, months six to 12).

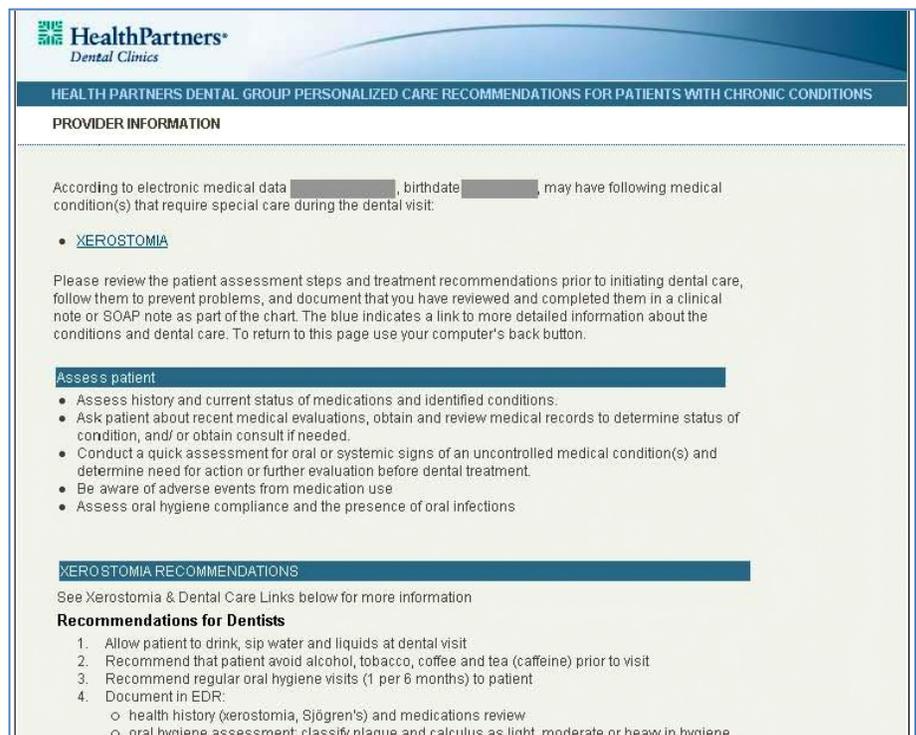| Table 4. Utilization trial of the eDent clinical decision support system by dental providers in the Health Partners Dental Group before and after implementation of the alerts (n=101 dental providers)			
	Pre-implementation (6 months before)	Post-implementation (0 to 6 months)	Post-implementation for sustainability (6 to 12 months)
Provider Activation group			
Number of hits on Web site	53	240	88
Number of hits on Web site per provider (% increase from baseline)	1.7	7.7 (357%*)	2.8 (67%*)
Number of providers logging into Web site (total n=31)	22	28	20
Percent of providers logging into Web site (odds ratio with respect from baseline, 95% CI)	71%	90% (3.83, 1.72-8.49*)	65% (0.74, 0.44-1.26)
Percent of hits done in patients with condition (odds ratio with respect from baseline, 95% CI)	0%	73%	63% (0.62, 0.45-0.86)
Intervention period effect of number of hits on web site (95% CI)	NA	4.7 (2.6-8.7)*	2.0 (1.3-3.3)*
Intervention-period effect of users logging into web site (95% CI)	NA	4.4 (1.6-12.1)*	1.7 (.98-2.9)
Intervention-period effect of hits done in patients with condition (95% CI)	NA	NA	0.94 (0.31-2.84)
Patient Activation group			
Number of hits on Web	58	131	53
Mean number of hits on Web site per provider (% increase from baseline)	1.8	4.0 (220%)	1.6
Number of users logging into Web site (total n=33)	22	26	18
Percent of users logging into Web site (odds ratio from baseline, 95% CI)	67%	79%(1.86, 1.10-4.82*)	55% (0.60, 0.52-3.53)
Percent of hits done in patients with	2%	40%	34%(0.81, 0.57-1.15)

condition (odds ratio with respect from 0-6 months of implementation)			
Intervention-period effect of number of hits on Web site (95% CI)	NA	2.3 (1.5-3.6)*	1.1(0.7-1.8)
Intervention-period effect of users logging into Web site (95% CI)	NA	2.12 (0.94-4.83)	1.36 (0.52-3.53)
Intervention-period effect of hits done in patients with condition (95% CI)	NA	NA	1.21 (0.40-3.69)
Control group with usual care			
Number of hits on Web site	64	62	52
Number of hits on Web site per provider	1.7	1.7	1.4
Number of users logging into Web site (total n=38)	28	27	21
Percent of users logging into Web site (odds ratio with respect from baseline, 95% CI)	74%	71% (0.87, 0.46-1.66)	55%(0.44, 0.40-0.49*)
Percent of hits for patients with condition (odds ratio from baseline, 95% CI)	6%	40%	31% (0.66, 0.23-1.90)

The intervention-period effect of provider activation resulted in an increase in the number of hits on the Web site during the first six month of CDS activation, as well as an increase in the number of providers using the system; however, only the number of hits on the Web site was sustained during the second six months of activation. The intervention-period effect of patient activation resulted in an increase in the number of hits during the first six months of CDS activation but not in the number of users of the Web site. After nine months, provider use of the system—regardless of the intervention group—returned to baseline levels despite the continued receipt of electronic alerts in both activation groups (Figure 3).

1. The Development of Evidence-Based Guidelines .
As part of this study, the research team and consultant, Dr. Nelson Rhodus, have developed the document *Clinical Guidelines for Medically Compromised Patients,* which recommends alterations of routine dental care procedures to prevent complications and improve the patient's overall and oral health. [29] Figure 1 is a screen shot of these guidelines. These care changes fall into three categories; 1) Changes in both home oral hygiene procedures and oral hygiene visits to reduce infections, 2) Changes in dental care protocols to minimize complications, and 3) Increase awareness of emergencies that can arise during dental care. Increased oral hygiene visits and improved oral hygiene self-care can reduce oral infections, caries, and periodontal disease in patients with complicating medical conditions. These efforts are also important to reduce oral infections that can affect or lead to systemic

Fig. 1 illustrates a screen shot of one of the clinical guidelines

infections or complications in chronic illnesses, particularly immune-compromised patients. Furthermore, dentists managing patients with these and other chronic illnesses also need to be prepared to deal with medical emergencies and complications from the condition that could arise during or after a dental visit. In this study, dentists are alerted of medically compromised patients and the measures needed at the point of care. In

the proposed study, we evaluated two different strategies to increase the percentage of dental providers who routinely use these clinical guidelines.

For example, with CHF, dentists should consider the following actions:

1) Dentists need to allow for breaks and shorter appointments for patients at certain times of day.
2) If surgical procedures are planned or the patient develops an oral infection, dehydration must be prevented, because thrombosis may occur, causing infarction of organs or stroke. Avoid aggressive surgical procedures in patients with class IV CHF.
3) Patients taking digitalis and other heart medications are prone to nausea and vomiting during dental treatment. Procedures that cause gagging should thus be done with extra care.
4) If pulmonary congestion develops while the patient is in a supine chair position, the patient should be raised to an upright chair position for the remaining dental treatment.
5) If a patient complains of weakness or fatigue during the dental appointment, the appointment should be terminated and the patient rescheduled.
6) Local anesthetic with 1:100,000 epinephrine should be used, except in patients with severe arrhythmias, while nitrous oxide-oxygen inhalation sedation should be used with caution.
7) Drugs commonly used to treat CHF cause a wide range of side effects that may affect dental treatment, including xerostomia, arrhythmias, nausea, vomiting, anorexia, blurred or yellow vision, headache, weakness, orthostatic hypotension, dehydration, drowsiness, or dizziness.
8) Dentists need to follow up with patients with chronic illness because they have a higher potential for oral complications, including infection, spontaneous gingival bleeding, and ecchymoses.

Figure 2. Total hits on the guidelines Web site per dental providers at pre- and post-implementation of the system for each of the three groups.
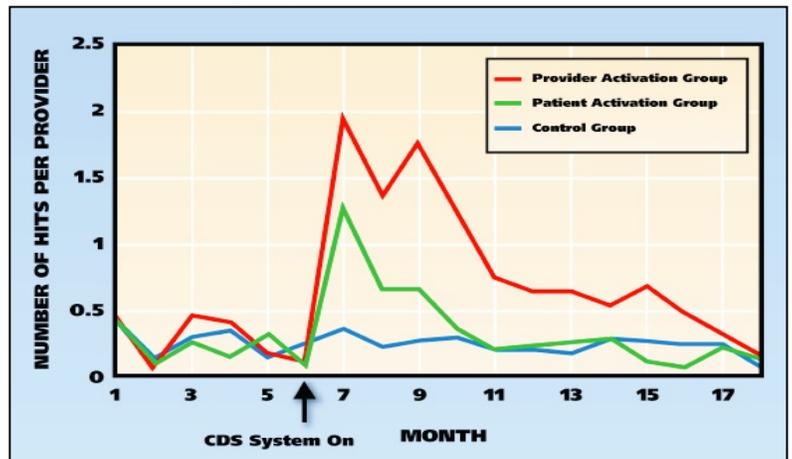

Figure 3. The percentage of providers with a Web site hit during the 18-month study period of the system for each of the three groups.

2. Accessing Dental Care Guidelines for Medically Compromised Patients.
The results demonstrated that the use of CDS significantly increased dentist review and use of personalized clinical guidelines. Figure 2 shows that:

1) Reminder alerts to both dentists and patients increase utilization of care guidelines by 440% and 221%, respectively, from baseline, while the control group had no increase;

2) Both provider and patient alerts had a generalizable, sustainable effect of increasing the rate at which providers reference care guidelines for all patients compared with usual care and;

3) Automated provider alerts in the EDR are more effective at encouraging the use of care guidelines than personalized alerts sent to patients. In addition, Table 5 demonstrates that the efficacy of different components of CDS can be delineated by this study of presenting the guidelines to the dentists and range from 9% use with Web-based availability with announcements to 79% with provider alerts in the EDR.
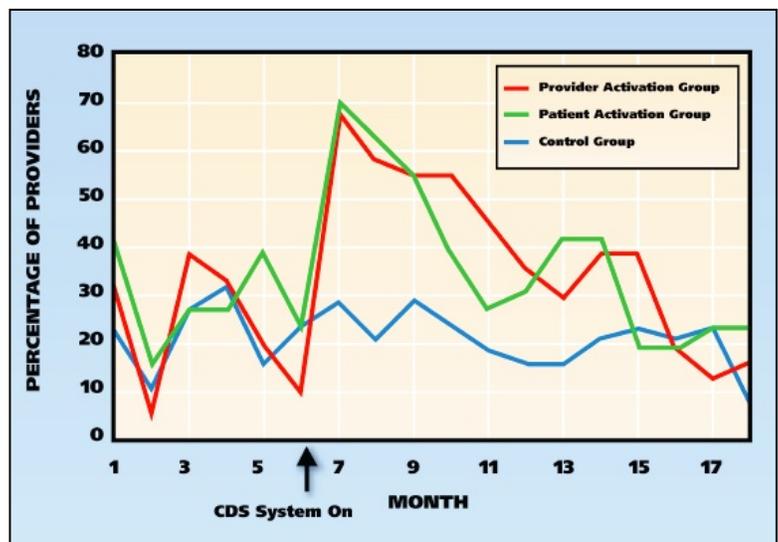
Table 5. Estimated efficacy of different components of CDS that can drive the use of clinical guidelines.

Component to encourage use	Description and rationale	Efficacy in accessing /utilizing guidelines
Distribute paper-based guidelines	Dentists given paper guidelines and posted in clinic	5%[1]
Distribute Web-based electronic guidelines	Dentist made aware of Web-based guidelines available through link on EDR	9%[2]
Patient mailed/emailed information	Patients mailed or emailed information about their condition and dentists alerted to encourage review of guidelines	14%[2,3]
Dentist alert only in EDR	Dentist made aware of Web-based guidelines for each patient through flashing alert on EDR	70%[2]
Dentist alert in EDR with progress note insertion	Dentist made aware of personalized guidelines for each with flashing alert and automatic insertion of guidelines in progress notes	80%[4]
Dentist alert in EDR with required pop-up script	Dentist alert in EDR, with required pop-up script to follow and document use of personalized recommendations	90%[4]

[1]Based on literature; [2]Based on eDent CDS study noted above; [3]Only 20% of patients opened the email sent to them.[4] hypothesized.

3. Medical History Documentation. There was a clear trend towards increasing the frequency of correcting errors in the medical history reporting but difference were not significant (Table 6). The lack of different reflected the fact that there were very few errors in the original medical history documentation before alerts.

Table 6. Medical history reconciliation and subsequent correction of medical records to be accurate as a result of the clinical decision support software. *

	Rate estimates*			Pair wise group comparisons OR (95%CI), p	
	Control	EDR	PHR	EDR vs CON	PHR vs CON
DM	64/330 (19%)	67/357 (19%)	43/242 (18%)	0.96 (.66, 1.40), p=.83	.90 (.62, 1.30), p=.57
COPD	6/371 (1.6%)	8/304 (2.6%)	4/247 (1.6%)	1.64 (.50,5.33), p=.41	.99 (.28, 3.48), p=.99
CHF	11/141 (8%)	12/99 (12%)	11/74 (15%)	1.84 (.55, 6.1) p=.32	2.35 (.88, 6.3), p=.09

*Frequency correction of medical history to be accurate in dental records

4. Preventive Care Rates. The CDS increased the use of preventive dental encounters during pre and post intervention periods per patient as suggested by the guidelines (Table 7). The change in preventive encounters improved in each of the 3 groups reflecting a generalized effect of the guidelines for all dental patients with medically complex conditions. However, the CDS groups both had significantly higher preventive care rates compared to the control.

Table 7. Average of preventive dental encounters during pre and post intervention periods per patient ***

	Rate estimates*			Pair wise group comparisons of pre-post change OR (95%CI), p	
	Control	EDR	PHR	EDR vs CON	PHR vs CON
DM Pre	1.45	1.36	1.39		
Post	1.41	1.44	1.43		
Post-pre ratio	.97	1.06	1.03	1.08 (1.02, 1.14), p=.006	1.05 (.99, 1.13), p=.12
COPD Pre	1.45	1.29	1.33		
Post	1.37	1.32	1.41		
Post-pre ratio	.94	1.02	1.06	1.08 (1.02, 1.14), p=.01	1.11 (1.0, 1.24), p=.046
CHF Pre	1.51	1.32	1.37		
Post	1.51	1.47	1.47		
Post-pre ratio	1.00	1.11	1.07	1.11 (.98, 1.26), p=.11	1.07 (.96, 1.20), p=.22

*Dental utilization of patients activated through the intervention was identified for the pre (06Jul08 to 06Jul09) and post (06Jul09 to 06Jul10) intervention period. Only patients with dental utilization in the pre intervention period were analyzed. Dental preventive encounters and periodontic encounters were identified by specific procedure codes. Dental utilization encounters are assigned to the

clinic of intervention activation. Average number of encounters during each period was modeled with poison regression model, using GENMOD to account for clinic clustering

5. Dental and Medical Adverse Events. The CDS did not reduce the number of dental or medical complications per patient per year (Table 8). This was measured by any urgent care, emergency, or inpatient care related to the condition. Although there was any increase frequency in complications related to their medical condition in each group, there was no significant differences between groups. This was perhaps due to the low rate estimates of complications for the overall population.

Table 8. Average number of medical and dental complications per person year as measured by any urgent care, emergency, or inpatient care related to the condition.* (Mean fu time in days, pre is 359 and post 245 days					
	Rate estimates*			Pair wise group comparisons OR (95%CI), p	
	Control	EDR	PHR	EDR vs CON	PHR vs CON
Average number of medical complications per person year*					
DM Pre Post Post-pre ratio	.39 .55 1.41	.50 .82 1.64	.34 .48 1.41	1.19 (.87, 1.62), p=.27	1.02 (.73, 1.44)p=.90
COPD Pre Post Post-pre ratio	.30 .39 1.30	.64 1.04 1.63	.26 .46 1.77	1.22 (.93, 1.60), p=.16	1.36 (.97, 1.92)p=.07
CHF Pre Post Post-pre ratio	2.66 4.78 1.80	3.14 5.01 1.60	2.07 3.41 1.65	.89 (.58, 1.36), p=.59	.92 (.49, 1.73), p=.79
Average number of dental complications per person year*					
DM Pre Post Post-pre ratio	.55 .55 1.00	.51 .53 1.04	.52 .43 .83	1.04 (.76, 1.42), p=.81	.83 (.65, 1.05), p=.13
COPD Pre Post Post-pre ratio	1.05 .92 .88	1.13 .93 .82	1.02 .69 .68	.93 (.66, 1.31), p=.67	.77 (.62, .97), p=.02
CHF Pre Post Post-pre ratio	.84 .70 .83	.98 .72 .73	1.00 .78 .78	.89 (.45, 1.76), p=.73	.93 (.51, 1.69), p=.82

* Dental complications were identified by service code 0140. Medical complications were identified by claims registry (VDW), as any inpatient, emergency or urgent care encounter. Follow up time was defined as the time from first dental encounter in the pre intervention period to the activation encounter and in the post intervention period was defined as the time from activation encounter and end of the study. Average number of medical complications during each follow period was model with a poison regression model, using GENMOD to account for clinic clustering and follow up time through an offset parameter. Patients were included in the analysis if they had an encounter in the pre-intervention period and were identified in the medical registry to have the condition. Similar procedure was done for dental complications

Discussion.
The results of this study demonstrate that use of CDS, in which providers are alerted through EDRs or patients are alerted through PHRs, can improve dental providers' review of clinical care guidelines for patients with medically complex conditions, improve medication reconciliation, and preventive care. However, in this study, medical or dental complications as indicated by urgent care, emergency care, or inpatient hospitalization related to their condition were not different between groups. Because all providers were masked to the study protocol, we can attribute this effect to the CDS. Furthermore, both the provider and patient alerts resulted in a generalized effect in increasing the rate at which providers reviewed care guidelines for all patients in the clinics even if the patient was not part of the study.

However, it is important to note that dental providers' use of the CDS system declined after the first six months despite the continued use of alerts. This suggests that dentists and hygienists either did not feel the need to continue reviewing the clinical care guidelines or the alerts became less effective.

Finally, we found that the provider activation approach was more effective—and perhaps more efficient and predictable—than the patient activation approach with regard to accessing the guidelines. Approximately the same number of providers in both groups (about 70 to 80%) accessed the Web site of the clinical care guidelines, yet the provider activation approach resulted in more hits per provider than did the patient activation approach, suggesting a higher efficiency.

Meeting the needs of an aging population with more complex health problems requires dental care professionals to have more comprehensive medical knowledge. In addition, Dentistry needs to become more closely integrated with medicine and the health care system on all levels: education, research and patient care.[1-6] In 2007, Baum[6] explored the problems associated with the lack of education about medical conditions in dental schools. He stated that "dental students need to know enough medicine to treat their patients who have chronic systemic illnesses, a population that continues to increase in size."[6]

However, few accredited U.S. dental schools spend more than 1 percent of instructional time on managing general medical emergencies, and little time is devoted to teaching students how to care for patients with medically complex conditions.[2] This has led to challenges in identifying medical problems during routine dental care, as well as in modifying dental care to account for these conditions. Complex medical conditions such as diabetes and heart disease can affect the quality and safety of dental care if they are neglected.[18-21] For example, diabetes increases the risk of developing periodontal disease, and patients with congestive heart failure need special treatment during dental care to prevent a cardiac event (Table 3).

Clinical care guidelines have been developed to support evidence-based dentistry and improve implementation of care guidelines. However, distributing and promoting guidelines alone does not ensure a change in clinical practice.[9,10] van Wijk and colleagues[10] reviewed 59 published evaluations of clinical guidelines in medicine and concluded that although guidelines could improve clinical practice, their use and the extent of improvements varied considerably. Bero and colleagues[12] examined systematic reviews of strategies for disseminating and implementing research findings. They concluded that the passive dissemination of information and care recommendations such as publication of consensus conference proceedings in professional journals or mailing of educational materials, generally is ineffective or results in only small changes in practice.

Sandberg and colleagues[23] reported a similar pattern in a study of the oral health of patients with diabetes. They observed that 85 percent of patients had never received information about the relationship between diabetes and oral health, and that 83 percent of patients were unaware of the link. These authors also reported that 48 percent of patients believed that the dentist or dental hygienist did not know of their diabetic condition. Despite these findings, passive approaches remain the most common method of disseminating clinical care guidelines among professional bodies and health care organizations.[24]

The results of our study show that use of active strategies such as CDS to implement care guidelines is more effective in changing clinical practice, and the more intensive efforts (such as electronic alerts) generally are more successful.[12] Even reminding dental care providers of the need to review medical conditions in the patient's dental record can be associated with changes in the dentist's treatment of these patients.[14-16]

Conclusions
Our research findings support the use of CDS systems by dental care providers through EMRs, EDRs and PHRs to enhance decision making and improve the quality and safety of care for patients with medically complex conditions. During the first six months of CDS implementation, the provider and patient activation approaches resulted in a generalized effect of increasing the rate at which providers reviewed care guidelines, identified medical conditions accurately, and increase preventative care for all patients.

Significance
Future dental care delivery systems and EDRs should expand the use of CDS at the point of care to help dental care professionals integrate medical knowledge into routine clinical practice. There may also be a need to determine which additional CDS components will increase the percentage of dental providers who use it and improve transferability and scalability of a system to more dental providers while maintaining high acceptability. Thus, we have submitted an additional grants application to employ two new innovative strategies designed to

increase utilization of the CDS: 1) a **Passive Notes CDS** that utilizes both dentist and patient reminders with automatic documentation of personalized guidelines in the progress notes and 2) an **Active Script CDS** that utilizes an active script to require action by dentists to guide them in compliance with and document guidelines in the EDR.

Implications

If quality and safety of care can be improved, several billion dollars in health care costs and their associated morbidity and mortality might be averted each year in the United States alone. For feedback to be effective in altering behavior, it needs to be tailored to the conditions of the task on which performance is assessed.[57] Simple outcome feedback is often only weakly related to improvements in performance, for single judgments as well as more complex problem-solving and decision-making tasks.[58-59] In health care as well, feedback has been shown to be most effective in changing clinician behaviors when it is keyed to specific components in diagnostic and patient-management tasks.

Dissemination of this knowledge through publications and at appropriate professional meetings through abstracts are in process. The project resulting in the coverage story for the Journal of American Dental Association (Fricton, 2011). Several other publications are in process. We are also converting the software to be part of Health Partners Dental Group. The subsequent grant submission also using Minnesota's health information exchange organization to disseminate the CDS to dentists in the community. Because of the anticipated connection between safety and quality of dental care in patients with chronic illness and increased long-term costs and widespread interest in EDRs and PHRs, we anticipate avid interests in results and rapid dissemination of effective intervention strategies that improve this care.

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7. List of Publications and Products resulting from this project

Four abstracts have been presented, 3 publications have been published, 2 grants are pending, and 4 papers are in progress. They include:
Manuscripts

1. Rhodus NL, Miller CS. *Clinician's Guide to Treatment of Medically Complex Dental Patients.* 4th ed. Edmonds, Washington: American Academy of Oral Medicine; 2009.
2. Fricton, J, Davies D. Personal Health Records to Improve Health Information Exchange and Patient Safety in Advances in Patient Safety: New Directions and Alternative Approaches in Henriksen, K Battles, JB, Keyes, MA, Grady, ML, Grady, ML, editors. AHRQ, 2008. p. 55-64
3. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, VazquezBenitez GX, Durand EC, Thoele MJ, Enstad CJ, Rhodus NL. Electronic Health Records Improve the Use of Clinical Care Guidelines for Medically Complex Patients. *Journal of the American Dental Association*, 2011 (142)10:123-142. (Cover article)

Abstracts

4. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, Durand EC, Thoele MJ, Huntley C, Godlevsky O, Enstad CJ, Rhodus, N (Abstract) Electronic Health Records to Improve Care of Patients with Medical Conditions. *American Association of Dental Research* Meeting, 2009.
5. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, Durand EC, Thoele MJ, Huntley C, Godlevsky O (Abstract). Electronic Health Records to Improve Care of Patients with Medical Conditions. *American Association of Dental Research Meeting*, #129068, 2010.
6. Fricton, J1,2; Rindal, B1; Rush, W1; Flottemesch, T1; Enstad, C1;Thoele, MJ1; Durand, E1; Rhodus, NL. Comparative Effectiveness of Provider Activation Strategies Using Electronic Health Records to Improve Quality and Safety of Dental Care for Patients with Medical Conditions (Abstract). *AHRQ Annual Meeting*, 2011
7. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, Vazquez Benitez G, Jorgenson P. Enstad CJ, Durand EU, Huntley CL, Rhodus NL, DMD. Effectiveness of Using e-Health Records to Improve Dental Care for Medically Compromised Patients. (Abstract). *HealthPartners Research Foundation Celebration of Research.* 2011.

Manuscripts in Progress

8. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, VazquezBenitez GX, Durand EC, Thoele MJ, Enstad CJ, Rhodus NL. Effectiveness of Electronic Health Records to Improve Quality of Dental Care for Medically

Compromised Patients. (In Progress)

9. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, VazquezBenitez GX, Durand EC, Thoele MJ, Enstad CJ, Rhodus NL. The effect of electronic health records on emergency visits in medically compromised patients. (In Progress)

10. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, VazquezBenitez GX, Durand EC, Thoele MJ, Enstad CJ, Rhodus NL. The effect of electronic health records in changing dentist behavior for patients with Xerostomia.(In Progress).

11. Fricton JR, Rindal DB, Rush WA, Flottemesch TJ, VazquezBenitez GX, Durand EC, Thoele MJ, Enstad CJ, Rhodus NL. The development of clinical decision support to improve dental care for Medically Complex Patients.(In Progress)

<u>Grants Pending</u>

Decision Support to Improve Dental Care for Medically Compromised Patients (Fricton)
Contract Number:1R18HS020846-01   Source: NIH/AHRQ
Role on Project: PI   01/25/2012 – 01/28/2017
The major goal of this project is to conduct a randomized controlled trial of the efficacy of different forms of clinical decision support to involve community dentists in improving quality and safety of dental care for medically compromised patients.

Understanding Personal Health Information Management Using Consumer Research Network (Fricton)
Contract Number: 1R01HS021237-01   Source: NIH/AHRQ
Role on Project: PI   02/01/2012 – 01/31/2017
The primary goal of this proposal is to determine what factors drive adoption and successful use of consumer health information technology (CHIT) and, subsequently, derive "best practices" to optimize an individual's personal health information management (PHIM) and inform those who design and implement CHIT.