

Screening for cardiovascular risk factors in a dental setting

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Cardiovascular disease (CVD) is among the primary causes of mortality worldwide and has been the leading cause of death in the United States for more than one century. CVD also is the primary hospital discharge diagnosis and one of the principal indicators of disease morbidity, and it is associated with the greatest increase (> 8 percent) in health care expenditures from 1987 to 2000.¹ Furthermore, the economic impact of CVD is likely to continue to increase, with projected indirect and direct costs estimated at more than \$403 billion for 2006.¹

CORONARY HEART DISEASE RISK FACTORS

Disease prevention strategies are based on the premise that control or prevention of identified risk factors could have a favorable impact on the incidence of a disease. The first step in such strategies is to identify people at risk. The primary, modifiable risk factors associated with coronary heart disease (CHD), which accounts for 53 percent of deaths due to CVD, are well-recognized and have received con-

ABSTRACT



Background. The authors assessed the utilization of oral health care professionals (OHCPs) as a resource for identifying patients who were unaware of their increased risk of developing cardiovascular disease (CVD).

Methods. OHCPs administered a CVD risk-screening questionnaire, measured blood pressure and tested cholesterol levels, high-density lipoprotein levels and hemoglobin A1c (H_{gA}_{1c}) levels using “finger-stick” blood testing in 100 patients treated in a dental school clinic who were unaware of their CVD risk status. The authors determined the prevalence of specific risk factors (that is, smoking and abnormal levels of systolic blood pressure, lipids, body mass index and H_{gA}_{1c}) and calculated Framingham 10-year coronary heart disease (CHD) risk scores.

Results. Seventeen percent of the 100 patients (35 percent of men, 5 percent of women) had an increased global risk of experiencing a CHD event within 10 years (Framingham risk score > 10 percent). Seventy-three percent of participants had one or more risk factors and 31 percent had two or more risk factors present. More men than women had low levels of high-density lipoprotein (45 percent [18/40] of men versus 3.3 percent [2/60] of women; *P* < .0001). The mean Framingham CHD risk score increased with increasing risk factor burden.

Conclusions. OHCPs identified patients with an increased CHD risk who could benefit from primary prevention activities. A substantial proportion of study patients who were unaware of their risk status were at an increased risk of experiencing a CHD event within 10 years. OHCPs could contribute to public health CHD control efforts.

Key Words. Coronary heart disease; risk assessment; cardiovascular diseases.

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siderable attention in the literature. In a recent 52-country case-control study (the INTERHEART study), researchers found that nine well-recognized, potentially modifiable CHD risk factors were prevalent and ranked consistently across sex, race/ethnicity and geographical region, and they collectively accounted for more than 90 percent of the population-attributable risk of experiencing an initial acute myocardial infarction.²

Additional support for the benefit of controlling specific CHD risk factors recently was suggested by Mensah and colleagues,³ who compared the sex-specific relative risk of dying for the three major risk factors (that is, smoking, hypertension, hypercholesterolemia) by using data from the Second National Health and Nutrition Examination Survey (NHANES II), the largest population-based probability sample, and 17-year follow-up mortality data. Among CHD-associated deaths, 70 percent of deaths in women and 48 percent of deaths in men could have been prevented if the three major risk factors had not been present.³

Data from the Third NHANES (NHANES III) indicate that 75 percent of adults, irrespective of CHD history, met the accepted risk criteria for at least one of the three major risk factors.⁴ More disturbing is the evidence that a substantial proportion of people who have CHD risk factors are unaware of their risk status or are inadequately treated.⁵ NHANES data indicate that almost one-third to three-quarters of all adults have CHD risk factors that are undiagnosed, with the actual percentage depending on insurance status and the risk factor of interest.⁴ The seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure revealed that one in four adults is hypertensive and that in the majority of these people, the condition is not controlled.⁵

As the population ages, the incidence and prevalence of chronic diseases are expected to increase steadily, and the development of more effective control and prevention strategies will become more critical. Effective measures to control disease morbidity and mortality begin with the identification of people at an increased risk of developing a disease based on well-recognized, disease-specific risk factors. The National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults recommends the determina-

tion of short-term (that is, within 10 years) CHD risk as a means of assessing the need for intervention and/or prevention strategies.⁶

The Framingham risk score, a series of prediction equations developed from the longitudinal Framingham Heart Study, is the most widely applied, well-recognized and validated tool for assessing the increased risk of experiencing a severe CHD event (myocardial infarction or death) within 10 years.⁷⁻¹¹ The Framingham calculation estimates the absolute 10-year risk of developing CHD, such that a 10 percent Framingham risk score means a patient has a 10 percent likelihood of experiencing a CHD event within 10 years. Risk categories are defined as low risk (< 10 percent) intermediate risk (10 to 20 percent) and high risk (> 20 percent).⁷ Applying the Framingham risk calculations to the most recently available NHANES data at the time of the analysis (1999-2002), Glick and Greenberg¹² determined the proportion of asymptomatic people unaware of their increased risk of developing CHD whose increased risk theoretically could be identified by oral health care professionals (OHCPs). Among men 40 years and older with no reported history of CHD risk or a CVD event who had not seen a physician in the preceding 12 months but had seen a dentist during that time, 18.3 percent were found to be at an increased global risk (that is, risk score > 10 percent) of experiencing a severe CHD event within 10 years.¹² These data suggest that OHCPs can play an important role in identifying patients who may benefit from primary prevention of CHD.

OHCPs routinely treat patients who do not have signs and symptoms of systemic disease. In contrast, patients are more likely to visit their physicians with clinical manifestations of systemic disease. Data from the National Center for Health Statistics¹³ for 2004 indicate that 58 percent of men older than 18 years visited their dentist that year, suggesting the potential for a significant public health impact.

As a follow-up to the theoretical calculations

ABBREVIATION KEY. **CHD:** Coronary heart disease. **CVD:** Cardiovascular disease. **NHANES II:** Second National Health and Nutrition Examination Survey. **NHANES III:** Third National Health and Nutrition Examination Survey. **OHCP:** Oral health care professional. **UMDNJ:** University of Medicine and Dentistry of New Jersey.

from NHANES data, we conducted a clinic-based pilot study to determine if OHCPs could identify CHD risk among patients who were unaware of their risk status. OHCPs applied a practical cardiovascular risk screening method among patients with no previously diagnosed specific risk factors for CVD; no history of heart attack, stroke, angina, hypertension or diabetes; and no visits to a physician in the previous 12 months.

PATIENTS AND METHODS

This pilot study was approved by the Institutional Review Board of the University of Medicine and Dentistry of New Jersey (UMDNJ), Newark. Recruitment began in January 2005 and took place once a week during a seven-month period. We recruited all study patients from the adult oral health clinics of the UMDNJ, New Jersey Dental School. On average, 35 percent of patients visiting the clinic met the study eligibility criteria.

Eligibility criteria included the following: 40 years or older; no reported history of hypertension or medication use for hypertension; no reported history of heart attack, stroke, diabetes or high cholesterol levels; and no visits to a physician in the previous 12 months. We enrolled a consecutive sample of 100 eligible patients who signed a written consent form. A sample size of 100 allowed for 95 percent confidence intervals (CIs) to within ± 8 percent across a range of risk prevalence estimates.

Data collection included blood pressure measurement; chairside measurement of total cholesterol levels, high-density lipoprotein levels and hemoglobin A_{1c} (HbA_{1c}) levels; and participants' completion of a cardiovascular risk screening questionnaire. The questionnaire covered the presence of well-recognized risk factors for CVD, a history of medical care and family history relevant to CVD, smoking history, exercise patterns and anthropometric measurements (height and weight).

The clinical investigators (J.G., P.W.D., N.R.C., M.C.) used "finger-stick" blood testing to measure cholesterol and HbA_{1c} levels chairside. They used a validated portable whole blood test system (CardioChek, Polymer Technology Systems, Indianapolis) to assess total plasma cholesterol and high-density lipoprotein levels and a monitoring kit (A1cNow, METRIKA, Sunnyvale, Calif.) to measure HbA_{1c} levels as a marker of uncontrolled diabetes. All measurements are accurate to ± 2 percent. All test results were available within 10 minutes.

We calculated the 10-year Framingham risk score for each participant and determined the prevalence of risk factors (hypertension, hypercholesterolemia, low levels of high-density lipoprotein, obesity, smoking and abnormal HbA_{1c} levels). For each participant, we categorized the burden of risk factors present into zero, one, two, or three or more and calculated an overall mean Framingham risk score from the individual risk scores in each category of risk burden.

Clinically abnormal risk factor levels were as follows: elevated systolic blood pressure (≥ 140 millimeters of mercury⁵), elevated total cholesterol level (≥ 240 milligrams per deciliter⁶), below-normal high-density lipoprotein level (≤ 40 mg/dL¹⁴) and above-normal HbA_{1c} levels (≥ 7.0 percent).¹⁵ Although HbA_{1c} is not used to diagnose diabetes mellitus, we used this measurement as an indication of possible abnormal glucose metabolism. We defined obesity as a body mass index (weight in kilograms divided by height in meters squared) of 30 or greater.¹⁶

The clinician generated a medical referral if clinically abnormal levels were detected for any of the risk factors measured or if the patient's Framingham risk score was greater than 10 percent. We used χ^2 and Fisher exact test, as appropriate, to test for statistical differences in the distribution of risk factors of interest. We analyzed all data by using statistical software (SAS statistical software for Windows, version 9.1, SAS Institute, Cary, N.C.).

RESULTS

Thirty-five percent of adult clinic patients were eligible and 95 percent of these patients agreed to participate. Of the 100 patients enrolled in the study, 60 percent were female and 40 percent were male. The racial/ethnic distribution of the 98 participants who reported this information was as follows: 39 percent ($n = 38$) were white, 33 percent ($n = 32$) were African-American, 19 percent ($n = 19$) were Hispanic, 4 percent ($n = 4$) were Asian and 5 percent ($n = 5$) were "other." The majority of the 100 participants (88 percent) were 40 to 69 years of age; 44 percent were 40 to 49 years of age, 32 percent were 50 to 59 years of age and 12 percent were 60 to 69 years of age.

Seventeen percent of the 100 participants had a 10-year Framingham risk score of greater than 10 percent. This group can be divided into two risk classes: 14 percent (95 percent CI = 7.1 to 20.9) were at moderate, above-average risk (> 10

percent risk and < 20 percent risk) and 3 percent (95 percent CI = 0.6 to 8.5) were at high risk (≥ 20 percent risk). Among the 17 participants with an increased global risk, 47 percent (n = 8) were black, 35 percent (n = 6) were white and 18 percent (n = 3) were Hispanic. Thirty-five percent (14/40) of men and 5 percent (3/60) of women had a Framingham risk score greater than 10 percent (Table 1).

Seventy-three percent of the 100 participants (95 percent CI = 64.3 to 81.7) had at least one of the risk factors present (that is, high systolic blood pressure, high cholesterol levels, low levels of high-density lipoprotein, obesity, smoking or high HgA_{1c} levels); 31 percent had two or more risk factors present. Fifty-two percent of the 100 participants (95 percent CI = 42.2 to 61.8) had at least one of the three major risk factors present (that is, high blood pressure, high cholesterol levels, smoking).

Hypertension was the most common risk factor among the 100 study participants (28 percent), followed closely by obesity (27 percent). Only two patients had abnormally high HgA_{1c} levels. Table 2 shows the distribution of specific risk factors by sex. Obesity was the most common risk factor among women (32 percent), while smoking was the most common risk factor among men (30 percent). A significantly greater proportion of men than women had clinically low levels of high-density lipoprotein; there was no difference by sex for any other risk factor.

Table 3 shows the prevalence of specific cardiovascular risk factors (high blood pressure, high cholesterol level, obesity, smoking) for the study population and for people across the country, as reflected by national data (1999-2004) from the

TABLE 1

Demographic distribution of patients with Framingham risk score greater than 10 percent.	
VARIABLE	NO. (% OF PATIENTS)
Sex	
Male (n = 40)	14 (35.0)
Female (n = 60)	3 (5.0)
Race/Ethnicity*	
African-American (n = 32)	8 (25.0)
White (n = 38)	6 (15.8)
Hispanic (n = 19)	3 (15.8)
Asian (n = 4)	0
Other (n = 5)	0
Age Group (Years)	
40-60 (n = 76)	6 (7.9)
> 60 (n = 24)	11 (45.8)

* Data were missing for two patients.

TABLE 2

Distribution of abnormal levels of individual risk factors, by sex.			
RISK FACTOR	NO. (% OF MEN (n = 40))	NO. (% OF WOMEN (n = 60))	P VALUE*
Systolic Blood Pressure (mm Hg†)			
≥ 140	13 (32.5)	15 (25.0)	.42
≤ 139	27 (67.5)	45 (75.0)	
Cholesterol Level (mg/dL‡)			
≥ 240	3 (7.5)	11 (18.3)	.13
≤ 239	37 (92.5)	49 (81.7)	
High-density Lipoprotein Level (mg/dL)			
≤ 40	18 (45.0)	2 (3.3)	.0001
≥ 41	22 (55.0)	58 (96.7)	
Body Mass Index§			
≥ 30	8 (21.1)	19 (31.7)	.25
< 30	30 (78.9)	41 (68.3)	
Smoking			
Yes	12 (30.0)	11 (18.3)	.17
No	28 (70.0)	49 (81.7)	
Hemoglobin A_{1c} Level (Percent)			
≥ 7.0	1 (2.5)	1 (1.7)	.79
≤ 6.9	39 (97.5)	59 (98.3)	

* Based on χ^2 or Fisher exact test, as appropriate.
 † mm Hg: Millimeters of mercury.
 ‡ mg/dL: Milligrams per deciliter.
 § Data were missing for two men.

National Center for Health Statistics.¹³ The national data serve as a descriptive comparison to show that our pilot study sample is not at a higher risk of developing CVD on the basis of the prevalence of specific risk factors, except for the prevalence of smoking among men.

TABLE 3

Prevalence of cardiovascular risk factors in pilot study and national data.

RISK FACTOR	PERCENTAGE OF PARTICIPANTS WITH RISK FACTOR	
	Pilot Study (N = 100)*	National Data†
High Blood Pressure‡		
Men	32.5	31.3
Women	25.0	40.4
High Cholesterol Levels§		
Men	7.5	15.9
Women	17.3	24.4
Obesity¶		
Men	21.1	29.9
Women	31.7	34.5
Current Smoker		
Men	30.0	17.4
Women	18.3	13.9

* University of Medicine and Dentistry of New Jersey, New Jersey Dental School, Newark, pilot study data include patients 40 to 84 years of age.
 † National Center for Health Statistics data include people 45 to 74 years of age with and without known risk factors.¹³
 ‡ High blood pressure defined as systolic pressure ≥ 140 millimeters of mercury.
 § High cholesterol level defined as ≥ 240 milligrams per deciliter.
 ¶ Obesity defined as body mass index ≥ 30.

TABLE 4

Mean 10-year Framingham risk score, by number of conventional risk factors for men* 40 years and older.†

NO. OF RISK FACTORS	MEAN FRAMINGHAM RISK SCORE‡ (95 PERCENT CI§¶)
Zero	3.7 (-2.1-9.4)
One	6.5 (4.6-8.4)
Two	9.0 (4.2-12.9)
Three or More	11.0 (1.8-20.2)

* Women were not included, because only three had a risk score greater than 10 percent.
 † Three patients were eliminated who had a risk score greater than 10 percent on the basis of age alone.
 ‡ Risk categories defined as low risk (< 10 percent), intermediate risk (10 to 20 percent) and high risk (> 20 percent).⁷
 § CI: Confidence interval.
 ¶ Only two patients had four risk factors; therefore, confidence intervals were extremely large owing to the large t value associated with the small degrees of freedom.

We calculated the mean 10-year Framingham CHD risk score by number of risk factors for men only, because only three women had a risk score greater than 10 percent. As shown in Table 4, the mean 10-year Framingham risk score increased with an increasing number of conventional risk factors present (from 3.7 to 11.0).

DISCUSSION

The results of this clinic-based pilot study demonstrate that OHCPs can facilitate the identifica-

tion of people at an increased global risk of experiencing a CVD event within the next 10 years (that is, Framingham CHD risk score > 10 percent). Seventeen percent of the study patients unaware of their risk status (that is, they reported no history of CHD, heart attack, stroke or angina and reported no previous diagnosis of hypertension or high cholesterol levels) had a Framingham risk score greater than 10 percent. Thirty-five percent (14/40) of men had an increased global CHD risk compared with 5 percent (3/60) of women. Using 1999-2002 NHANES data, Glick and Greenberg¹² recently reported an 18 percent increased global risk among men 40 years and older who had no reported risk factors of interest and who had not seen a physician in the previous 12 months but had seen a dentist. The higher rate of increased global CHD risk among men in this clinic-based pilot study likely is due to confounding by age; 32 percent of the men in our study were 60 years or older compared with 17 percent of men in the NHANES-based study.

Although ample data indicate the high prevalence of conventional CHD risk factors among patients who have experienced a CHD event, our study revealed a high risk factor prevalence in asymptomatic patients who were unaware of their increased CHD risk. In this inner-city dental clinic population of asymptomatic patients with no history of CVD, almost three-quarters of the study population had at least one of the specific risk factors of interest (that is, smoking, hypertension, hypercholesterolemia, low levels of high-density lipoprotein, obesity or abnormal HgA_{1c} measurements) and nearly one-third had two or more conventional risk factors. These findings are consistent with the reported 80 to 100 percent prevalence rate of conventional risk factors (smoking, diabetes, hyperlipidemia, hypertension, obesity) among people with a wide spectrum of CHD, including those with myocardial infarction.¹⁷⁻¹⁹

In a recent case-control study, Yusuf and colleagues² reported the prevalence of modifiable CHD risk factors consistently across sex, race/ethnicity and geographical location in patients

with acute myocardial infarction, suggesting a consistent global pattern. Given that almost three-quarters of the patient population in our clinic-based study were unaware of their risk factor status, identifying a patient's risk factor status is a critical step in the approach to preventing CHD. Although these data are from an inner-city population, thus limiting generalizability of the results, national data suggest that this study population does not represent a select group of people with a high CHD risk factor prevalence.

Against this backdrop of a high CHD risk factor prevalence, the Centers for Disease Control and Prevention reported a decline in the prevalence of "no known" major risk factors (that is, high cholesterol level, diabetes, smoking, obesity, hypertension) among men and women in all racial/ethnic groups and at all educational levels on the basis of data from the Behavioral Risk Factor Surveillance System, a U.S. state-based, random-digit-dialing telephone survey.²⁰ The proportion of people with no known major risk factors was 42 percent among 58,815 adults in 1991, compared with 36 percent among 140,305 adults in 2001, which represents an absolute decrease of 6 percent during the 10-year period.²⁰ Concomitant with this decrease in the prevalence of no known major risk factors, a 10 percent increase occurred in the proportion of people with one or more risk factors: 58 percent in 1991 versus 64 percent in 2001.²⁰ Without expanded efforts toward the early identification of people with adverse, modifiable CHD risk factors, the increasing toll of CHD likely will continue.

In this clinic-based pilot study, we found a difference in the sex-specific risk factor prevalence, with obesity being the most common risk factor among women and smoking the most common risk factor among men. Previous studies of CHD risk factors in people who died of CHD also reported differences in risk factor prevalence according to sex; smoking was the most common risk factor among men and hypertension was the most common risk factor among women.^{2,3} The importance of sex-specific risk factors in asymptomatic people may vary along the spectrum of the natural history of CHD, such that sex-specific CHD prevention and lifestyle modification strategies may be warranted.

Although the optimal time to screen for risk factors has not been clearly established, recent data from the Framingham Heart Study support

the assessment of CHD risk profiles in young adults. Among people with no established conventional risk factors at 50 years of age, the lifetime risk of developing CVD was very low, and the survival time was much greater compared with that for people with a moderate or heavy risk factor burden.²¹ Furthermore, increasing levels of adverse measures of individual risk factors also conferred an increased lifetime risk and decreased years of survival, supporting the importance of early identification of risk factors and early initiation of lifestyle modification with regard to conventional CHD risk factors.¹⁷ Given that the development of CHD risk factors is associated with lifestyles and behaviors that begin early in life and are exacerbated throughout a person's life, early identification of modifiable CHD risk factors coupled with corresponding prevention initiatives can significantly affect disease development.

Consistent with the results of previous studies,²¹ the mean 10-year Framingham CHD risk score among participants in this pilot study increased with the presence of an increasing number of risk factors; the mean risk score ranged from 3.7 percent for people with no risk factors present to 11.0 percent for people with three or more risk factors present. Among participants without CVD, there was an increased lifetime CVD risk and decreased median survival time at 50 years of age among those with two or more major risk factors present compared with those in participants who had no risk factor present.²¹ In addition, we found increasing risk scores and decreasing median survival with increasing adverse levels of individual risk factors, highlighting the importance of assessing individual risk factors along with determining a patient's short-term (that is, within 10 years) global CHD risk.²¹ National data for 1999 through 2001 show that more than 75 percent of men and women 55 to 64 years of age had one or more cardiovascular risk factors (that is, high blood pressure, high cholesterol levels, obesity) present.²⁰

The most effective strategy for controlling the increasing morbidity and mortality associated with CHD likely will require a broad-based public health approach that integrates various health care professionals. Our data demonstrate the feasibility and potential efficacy of routine screening in dental clinics as an additional strategy to identify patients with an increased risk of experiencing a severe CHD event. Using easy, safe and

rapid chairside determinations for conventional CHD risk factors, OHCPs identified 17 percent of 100 asymptomatic inner-city clinic patients as having an increased global 10-year CHD risk and found that 31 percent of the participants had two or more modifiable risk factors.

Thus, integrating OHCPs into CHD prevention efforts could augment the detection of people with an increased global CHD risk and facilitate the early identification of those with adverse levels of modifiable risk factors who could benefit from primary prevention activities. Further studies are needed to evaluate the potential costs and benefits of this strategy, as well as the efficacy and yield (that is, the detection rate of previously undiagnosed, asymptomatic people at high risk of developing CHD) of a more expansive community-based approach.

There also are several feasibility and logistical issues to consider when contemplating the incorporation of OHCPs into an integrated CHD prevention program, including patient acceptance, practitioner willingness to conduct screenings and health insurance reimbursement options. Patient acceptance and provider willingness to conduct these screening tests in a dental setting could be addressed as part of a multicenter trial by using the dental practice-based research networks.

CONCLUSION

This clinic-based study demonstrated the feasibility of using OHCPs to identify people who have an increased risk of developing CHD. However, widespread incorporation of OHCPs into a CHD control program would require the health insurance industry to develop a reimbursement scheme to compensate practitioners for their time and supply costs. A financial feasibility study showing the costs and benefits to the health care insurance industry would greatly enhance the prospects for integrating OHCPs into prevention strategies for chronic disease. Additional data from multicenter trials supporting the efficacy of this approach would help guide the development of novel health care models. ■

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