

Public Health Perspectives on Surveillance for Periodontal Diseases

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Public health surveillance has been defined as the ongoing systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health. Surveillance is an essential element of public health program infrastructure. The desirable attributes of public health surveillance systems are simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and stability. However, surveillance for periodontal diseases is nearly non-existent at state, county, or local levels in the United States. That void largely is the result of the current approach to monitoring periodontal diseases in populations, which generally requires resource-intensive primary collection of clinical data using relatively invasive methods. One potential alternative to that approach to periodontal disease surveillance is the use of self-reported data collected through population surveys. Seventeen identified studies have tested the validity of individual questionnaire items for their sensitivity, specificity, and predictive values positive and negative against a range of clinical operational definitions for periodontitis. No individual items seem to be robust or valid markers for clinically determined periodontitis. However, it is possible that a multivariable statistical modeling approach, which includes variables on signs, symptoms, and established risk factors, could improve the sensitivity and specificity of that approach. An example is given of a model-based approach to public health surveillance that has been effective in quantifying the impact of a public health problem, monitoring trends between and within states, and supporting advocacy and policy development by state and local governments. *J Periodontol* 2007;78:1380-1386.

KEY WORDS

Periodontal diseases; public health surveillance; sensitivity and specificity; validity.

The core functions of a public health program include assessment of the health of the population, comprehensive public health policy development, and assurance that public health services are provided to the population.¹ One essential element of public health program infrastructure is surveillance, which enables all three core functions. Public health surveillance has been defined as the ongoing systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health.²⁻⁴ Data from public health surveillance systems can be used for immediate public health action, program planning and evaluation, and formulating research hypotheses. For example, data from a public health surveillance system can be used to guide immediate action for cases of public health importance; measure the burden of a disease (or other health-related event), including changes in related factors, the identification of populations at high risk, and the identification of new or emerging health concerns; monitor trends in the burden of a disease (or other health-related event), including the detection of epidemics (outbreaks) and pandemics; guide the planning, implementation, and evaluation of programs to prevent and control disease, injury, or adverse exposure; evaluate public policy; detect changes in health practices and the effects of these

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changes; prioritize the allocation of health resources; describe the clinical course of disease; and provide a basis for epidemiologic research.⁵

A public health surveillance system should disseminate health data effectively so that decision makers at all levels can understand the implications of the information. The audiences for these data can include public health practitioners, health care providers, members of affected communities, professional and voluntary organizations, policy makers, the press, and the general public.⁵

The desirable attributes of public health surveillance systems⁵ include

Simplicity: The structure and ease of operation of a surveillance system should be as simple as possible while still meeting its objectives.

Flexibility: A flexible public health surveillance system can adapt to changing information needs or operating conditions with little additional time, personnel, or allocated funds. For example, flexible systems can accommodate new health-related events, changes in case definitions or technology, and variations in funding or reporting sources.

Data quality: The completeness and validity of the data recorded in the public health surveillance system.

Acceptability: The willingness of persons and organizations to participate in the surveillance system.

Sensitivity. The sensitivity of a surveillance system can be considered on two levels. First, at the level of case reporting, sensitivity refers to the proportion of cases of a disease or other health-related event detected by the surveillance system. Second, sensitivity can refer to the ability to detect outbreaks, including the ability to monitor changes in the number of cases over time.

Predictive value positive: The proportion of reported cases that have the health-related event under surveillance.

Representativeness: A public health surveillance system that is representative accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person.

Timeliness: The speed between steps in a public health surveillance system.

Stability: The reliability (i.e., the ability to collect, manage, and provide data properly without failure) and availability (the ability to be operational when it is needed) of the public health surveillance system.

ORAL HEALTH SURVEILLANCE SYSTEMS

Although public health surveillance systems have been in use for decades for a range of health-related

events, their adoption by United States oral health programs is a much more recent development and still is largely in formative stages.⁶ Recognizing the need for oral health surveillance within state dental public health programs, The Association of State and Territorial Dental Directors and the Centers for Disease Control and Prevention's Division of Oral Health developed the National Oral Health Surveillance System (NOHSS).⁷ The NOHSS is designed to help public health programs monitor the burden of oral disease, use of the oral health care delivery system, and the status of community water fluoridation at state and national levels. NOHSS includes indicators of oral health status and information on state dental programs, and it links to other important sources of oral health information. The eight oral health indicators included in the NOHSS are 1) adult dental visits, 2) adult tooth cleaning, 3) adult tooth loss, 4) fluoridation status, 5) child caries experience, 6) child untreated caries, 7) child dental sealants, and 8) cancer of the oral cavity and pharynx. The NOHSS does not include any indicator for periodontal diseases.

SURVEILLANCE FOR PERIODONTAL DISEASES

Periodontal diseases have long been recognized as risk factors for tooth loss and impaired oral functioning and more recently have been implicated in other domains of oral health-related quality of life, pregnancy outcomes, and other organ systems.⁸ The established and suspected adverse effects of periodontal diseases led to the inclusion of a specific United States national objective in Healthy People 2010 (objective 21.5): "Reduce destructive periodontal disease in adults aged 35 to 44 years."⁹ Although a national objective has been established, relatively few dental services are administered and delivered at the national level in the United States. Rather, most dental services are delivered through private dental offices or, to a lesser extent, through state, county, or local dental public health programs. Ideally, those public health programs should be able to monitor disease levels, their distribution, and their trends within their jurisdiction to plan services and policies and evaluate their impact.

However, surveillance for periodontal diseases is nearly non-existent at state, county, or local levels in the United States. That void largely is the result of the current approach to monitoring periodontal diseases in populations, which generally requires primary collection of clinical data using relatively invasive methods. This approach is very resource-intensive, requiring trained and calibrated dental examiners and recorders, sterilized instruments, dental equipment, and infection control protocols. Participants must be recruited and compensated, provide their health

history, and be examined by inserting a periodontal probe into multiple sites around each tooth. Half a century after Russell¹⁰ developed the periodontal index and Ramfjord¹¹ first described the method of measuring clinical attachment level, we still have no consensus on case definitions for disease or the number of teeth or sites that should be examined; however, we continue to use the same general approach to assess the periodontal status of communities. Even the development of clinical indices, such as the community periodontal index,¹²⁻¹⁴ does not eliminate the most difficult and resource-intensive characteristics of this approach to disease surveillance: it still requires recruitment of probability samples of adults, clinical examinations conducted by trained and calibrated dental examiners, attention to infection control and medical considerations, and collection of a large amount of data. This process results in data that are difficult to explain to the public or policy makers and are of suspect validity to the dental practice and research communities.

Because of the resource-intensive and logistically difficult approaches that are used most commonly to monitor periodontal disease in populations, we do not have a system at any jurisdictional level that meets the criteria for public health surveillance. Current approaches are not simple, flexible, timely, or stable. Acceptability of clinical approaches to disease surveillance is diminishing and costs are increasing. Most state, county, or local dental public health programs are unlikely to ever have the necessary resources to establish oral health surveillance systems that require clinical examinations of hundreds or thousands of adults. In an era of tight federal budgets for non-military programs, the sustainability of the oral health clinical component in systems such as the National Health and Nutrition Examination Survey is highly questionable. If we believe periodontal diseases should be prevented, controlled, and monitored in populations, we may need alternative approaches to the primary collection of clinical data.

ALTERNATIVE APPROACHES TO PERIODONTAL DISEASE SURVEILLANCE

There are potential alternatives to the collection of clinical data as the primary approach to periodontal disease surveillance. A few of those approaches are summarized here.

Existing Clinical Data

In theory, surveillance for periodontal diseases could be conducted by collecting data from existing dental records. Dental records should include diagnoses for periodontal diseases for all patients.¹⁵ Unfortunately, patients' periodontal diagnoses frequently are not recorded in dental charts,¹⁶⁻¹⁸ which limits their useful-

ness for surveillance purposes. In addition, dental services in the United States are delivered largely in small, private practice settings with no uniform method for data recording, no accepted diagnostic codes, and no established network to facilitate electronic data collection. The periodontal status of persons with limited access or use of dental services largely would be outside the sample frame of an office-based surveillance system; however, those with lower rates of dental care use may be at particularly high risk for periodontitis.^{19,20}

Administrative or Insurance Claims Data

At least one study²¹ has examined the usefulness of dental insurance claims data for oral health surveillance, although those data proved less useful than community measures of socioeconomic status in identifying pediatric communities at high risk for dental caries. The use of claims data for surveillance of periodontal diseases presents even greater challenges than for dental caries surveillance. Clinical periodontal status may have little association with the use of dental services among low-income adults,²² and persons experiencing the highest incidence of periodontal attachment loss, may, in fact, be those who are least likely to use dental services.¹⁹ Therefore, surveillance systems that rely on administrative claims data may miss the portions of the population with the highest rates of disease and may have utilization measures that bear little relationship to periodontal status.

Sentinel Surveillance

Sentinel surveillance systems involve a limited number of selected reporting sites, reports from which may be generalizable to the whole population.²³ The most common design involves enrolling health care providers who agree to report on the rates of a specific health condition for a designated period of time. This type of surveillance system is particularly useful for common conditions where complete case counting is not necessary and where public health action is not taken in response to individual reported cases. Some examples of health-related events monitored by this type of approach in the United States include influenza,²⁴ sexually transmitted diseases,²⁵ and the capacity of the blood supply.²⁶ Periodontal diseases seem to be well suited for such an approach to surveillance. There are some examples of dental practice-based surveillance systems that collected data on the prevalence of coronal and root surface caries and other selected conditions.²⁷ However, a May 2006 search of the PubMed database of biomedical literature published since the 1950s, using the medical subject headings of "sentinel surveillance" and "periodontal diseases" or "periodontitis," yielded not a single citation. Development of a sentinel surveillance system

for periodontal diseases or other oral health conditions would require a substantial investment in infrastructure; so far, there seems to be few health authorities that are interested or able to make that investment.

Self-Report

One potential approach to surveillance for health-related events is the use of self-reported data. In such a system, a representative sample of the target population is selected and is asked about diseases, health-related behaviors, or other characteristics. Self-reported data can be collected through a wide variety of modes, including telephone-based surveys, mail-based or school-based self-completed paper-and-pencil questionnaires, Web-based surveys, or face-to-face interviewer-administered surveys. Self-report is used widely for surveillance of health behaviors, such as tobacco use,^{28,29} physical activity,³⁰ and use of cancer screening,^{31,32} and health conditions, such as high blood pressure³³ or arthritis.³⁴ Compared with other approaches to surveillance for health conditions, the primary advantages of self-report for surveillance purposes are 1) it is much less expensive than surveillance systems that rely on primary data collection by clinicians; 2) it collects data in a more consistent and complete fashion than systems based on record reviews and abstracting; 3) it can yield a more representative sample of the target population than sentinel site-based surveillance; 4) it can include persons who do not have health care insurance or do not use health services; and 5) it can produce more timely data than clinical surveys that require multiple data collection sites. Perhaps the major concerns regarding self-reported surveillance data are the reliability and validity of the estimates. There is fairly compelling evidence that self-reports for a number of health behaviors and health states can be collected with high reliability and validity.³⁵⁻³⁹

Self-Reported Measures of Periodontal Diseases

The use of self-reported measures to monitor periodontal status presents unique challenges: 1) the most common forms of periodontal diseases typically are asymptomatic,⁴⁰ so persons with these diseases may be unaware of their periodontal status; and 2) some of the groups at greatest risk for periodontal diseases also tend to have lower rates of dental care use than the general population,^{19,41,42} so self-reports based on whether patients were told by their dentists that they have periodontal disease likely would underestimate disease prevalence. Nevertheless, a number of self-reported questionnaire items have been tested for their validity as markers for periodontal disease.

Blicher et al.⁴³ summarized 16 studies identified in a systematic MEDLINE search for articles, published between 1966 and June 12, 2004, that evaluated the

validity of self-reported periodontal disease using clinical measures as the standard. A measure was considered to have good validity when the sum of sensitivity plus specificity or predictive value positive plus predictive value negative was $\geq 120\%$. Because the measures potentially could be used for etiologic studies, surveys, or surveillance, the relative importance of sensitivity and specificity was uncertain; therefore, the criterion was based on both parameters. Only seven of the 16 studies were conducted among probability samples of participants. In general, the specificity of the measures was high and sensitivity was low.

Sixteen self-reported measures for periodontal disease provided sensitivity, specificity, or predictive values. Thirteen of those 16 self-reported measures were considered valid. However, just five of the 16 measures were considered valid compared to more than one clinical periodontal parameter. In that review, the best individual measures were "Have you had periodontal disease with bone loss?", "Do you have periodontal disease with bone loss?", and "Has any dentist/hygienist told you that you have deep pockets?". The results did not consistently suggest any individual measure to be of sufficient validity to be used by itself in a general population. Therefore, the investigators concluded that a combination of those individual self-reported measures, demographic characteristics, and data on major risk factors, such as smoking, may prove to be a more valid alternative to the use of individual self-reported items.

A subsequent MEDLINE search identified one additional study published since June 12, 2004 that validated self-reported measures of periodontal disease.⁴⁴ Consistent with prior studies, the investigators concluded that individual items of self-reported periodontal disease or self-reported symptoms of periodontal disease have poor sensitivity and low predictive power. They suggested that future studies evaluate the predictive ability of multiple regression models using several self-reported variables to estimate periodontal status in epidemiological studies.

In summary, individual questionnaire items have not been identified that could serve as valid markers for clinically determined periodontitis. However, a combination of items might improve the sensitivity and specificity of that approach. Those items could include questions specific to periodontal disease signs or symptoms; established risk factors, such as smoking and diabetes; and sociodemographic characteristics that are associated strongly with periodontal disease.

A MODEL-BASED APPROACH TO PUBLIC HEALTH SURVEILLANCE: AN EXAMPLE

In the late 1980s, the Centers for Disease Control and Prevention (CDC) sought to estimate how many

Americans died each year as a result of cigarette smoking.⁴⁵ Or, put differently, they sought to estimate how many premature deaths could be avoided if smoking were eliminated. In principle, the answer to that question would require an experiment in which mortality rates were measured before and after the complete elimination of smoking. That approach, of course, is impractical. Instead, CDC developed a model-based approach to estimating smoking-attributable mortality by using relative risk estimates for various smoking-related diseases derived from a large prospective cohort study, death certificate data from the National Center for Health Statistics, and self-reported survey data on smoking prevalence, daily smoking intensity, duration of cessation among former smokers, gender, and age. Applying that model-based approach, CDC initiated surveillance for smoking-attributable mortality for states.⁴⁶ Although there are methodological limitations to this approach for surveillance, it has provided reasonably reliable estimates of smoking-attributable impact⁴⁷ that have been useful for public health policy. These state-based estimates have been used to rank the states for annual death rates due to smoking, to monitor progress in reducing the impact of smoking within states, and to support advocacy and adoption of effective tobacco control measures by state and local governments.⁴⁸ Perhaps similar approaches could increase awareness of the prevalence and impact of periodontal diseases in cities, counties, states, and the nation.

NEXT STEPS

Other articles in this supplement to the *Journal of Periodontology* present results from cross-sectional and cohort studies to identify the “best” set of variables in a multivariable approach to estimating the prevalence of periodontitis in populations based on self-reported information. At present, the plan is to identify the most promising set of candidate variables from those individual studies and test their predictive ability in a prospective cohort study. If that approach is successful, a statistical model would be developed that would permit valid prevalence estimates of periodontitis for the United States, individual states, and cities or counties. It is hoped that the result will be a relatively inexpensive and timely surveillance mechanism whose estimates would be acceptable to clinicians, researchers, and the public. Those surveillance data would provide a rational basis for preventing, treating, and monitoring periodontitis in populations.

CONCLUSIONS

The current approach to monitoring periodontal diseases is invasive, resource-intensive, not feasible for

most states or counties, and probably not sustainable at the national level. A model-based approach to periodontal disease surveillance that does not rely on clinical examinations potentially could provide timely, valid, and useful information to guide and evaluate public health policy and programs.

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