

Identifying Diabetes Mellitus or Heart Disease Among Health Maintenance Organization Members: Sensitivity, Specificity, Predictive Value, and Cost of Survey and Database Methods

Patrick J. O'Connor, MD, MPH; William A. Rush, PhD; Nicolaas P. Pronk, PhD; and Linda M. Cherney, MPH

Abstract

We conducted a study of the sensitivity, specificity, positive predictive value, and cost of two methods of identifying diagnosed diabetes mellitus or heart disease among members of a health maintenance organization (HMO). Among 3186 adult HMO members who were attending one primary care clinic, 2326 were reached for a telephone survey (efficiency = 0.73). Among these members, 1991 answered standardized questions to ascertain whether they had diabetes or heart disease (corrected response rate = 0.85). Linkage was then made to computerized diagnostic databases. By means of both a database method and a survey method, the 1976 members with complete data for analysis were classified as having or not having diabetes or heart disease. When results with the two methods disagreed, charts were reviewed to confirm the presence or absence of diabetes or heart disease. Diabetes was identified among 4.7% of adult members, and heart disease was identified among 3.7%. Identification of diabetes differed between the database method and the survey method (sensitivity 0.91 vs 0.98, specificity 0.99 vs 0.99, positive predictive value 0.94 vs 0.83). Identification of heart attack history was similar for the database method and the survey method (sensitivity 0.89 vs 0.95, specificity 0.99 vs 0.99, positive predictive value 0.79 vs 0.81). The cost of obtaining data was \$13.50 per member for the survey method and \$0.30 per member for the database method. Database methods or survey methods of identifying selected chronic diseases among HMO members may be acceptable for various purposes, but database identification methods appear to be less expensive and provide information on a higher proportion of HMO members than do survey methods. Accurate identification of chronic diseases among patients supports clinic-level measures for clinical improvement, research, and accountability.

(*Am J Man Care* 1998;4:335-342)

From the HealthPartners Research Foundation, Minneapolis, MN.
Address correspondence to: Patrick O'Connor, MD, HealthPartners Research Foundation, PO Box 1309, 8100 34th Avenue South, Minneapolis, MN 55440-1309.

To evaluate and improve the care of members with conditions such as heart disease or diabetes, a health maintenance organization (HMO) must first be able to determine accurately which members have such conditions. An increasing number of HMOs are developing sophisticated databases that often include outpatient and inpatient diagnostic data, utilization and claims data, charge and cost data, pharmacy data, and laboratory data. The potential to use these databases in an integrated way to improve care has long been recognized^{1,2} and is an important factor driving the development of integrated data systems.^{3,4} Early reports of the performance of such databases were discouraging,⁵ but more recent reports have shown some hospital-based systems perform reasonably well for at least some conditions.^{6,8}

As the healthcare market has evolved, it has become clear that payers will demand clinic-level assessments of quality of care.^{9,10} However, few studies have been conducted to assess the performance of outpatient databases necessary for improving and assessing medical care.^{6,7,11} Herein we report on the cost and effectiveness of two simple methods of identifying diagnosed diabetes or heart disease among HMO members. These are important clinical conditions that are of interest to both providers and evaluators of healthcare.

... METHODS ...

All 3186 adult members of a staff model HMO primary care clinic in the Upper Midwest were enumerated from insurance databases. From this group, all members who had telephone numbers listed either with the HMO or with directory assistance were included in a telephone survey to identify the prevalence of selected chronic diseases and other factors. Of the 3186 subjects, 2326 were reached by telephone after a maximum of four calls (efficiency 0.73). Of those reached, 1991 members completed the inter-

view (corrected response rate 0.85). Of those who completed the interview, 1976 members had all data needed for analysis from both database and survey sources. Further details of the survey are reported elsewhere.¹²

The study clinic was owned by the HMO and staffed by 3.5 primary care physicians (three full time physicians and one part time) who provided outpatient and inpatient care of the clinic patients with subspecialty consultation as required. All physicians were salaried, and all patients had capitated payment arrangements, some having \$5 or \$10 copayments for outpatient visits. Of adult patients, 14% were 65 years and older; about 800 children also received care at this clinic. At each outpatient visit, the physician filled out an encounter form with printed lists of about 200 International Classification of Diseases (ICD-9) codes in checklist format. Physicians were routinely encouraged to mark as many ICD-9 codes as were appropriate for the content of a particular office visit. Often more than one code was checked, and all codes were then entered by trained personnel into computerized diagnostic databases. Presence or absence of known diabetes mellitus or heart disease was ascertained for each of the 1976 study subjects by each of two methods.

Survey Method

Each member completed a 15 to 20 minute telephone interview designed by us to ascertain the presence or absence of chronic diseases such as diabetes mellitus and heart disease. The specific questions used to classify study subjects were adopted from the Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System (BRFSS)¹³ and were as follows:

1. Heart disease was assigned if the study subject answered *yes* to the question, "Have you ever been told by a doctor that you had a heart attack?"
2. Diabetes was assigned if the study subject answered *yes* to the question, "Have you ever been told by a doctor that you have diabetes?" and (if a woman) answered *no* to the question, "Was this only when you were pregnant?"

Database Method

Computerized diagnostic databases were reviewed for selected diagnostic codes to ascertain the presence or absence of diabetes mellitus or heart disease. Diagnostic databases were reviewed from July 1, 1992, to July 1, 1994, for specific ICD-9 codes. On the basis

of diagnostic data, study subjects were assigned conditions of interest according to the following system:

1. Existing heart disease was assigned if the study subject had at least one visit with any of the following ICD-9 diagnoses: 428.0 (congestive heart failure), 412 (history of myocardial infarction), 429.2 (arteriosclerotic cardiovascular disease), or 413.9 (angina) in a defined 1-year period.
2. Diabetes was assigned if the study subject had two primary care clinic visits in the defined 2-year period with any ICD-9 diagnosis starting with 250 (diabetes mellitus and various diabetes-related complications). Two diabetes codes were required because previous work had indicated that using only one diabetes diagnosis identified many patients who did not have diabetes.

When the survey method and the database method gave conflicting data on presence or absence of the conditions of interest, charts were reviewed.

A standard criterion assignment of diabetes or heart disease required at least two of three possible sources of data (survey report, ICD-9 code, or chart audit) to agree that the patient had or did not have the particular condition. Costs of obtaining information with the survey method and the database method were tracked and compared.¹⁴

... RESULTS ...

Among the 2326 study subjects reached by telephone, 2006 (86%) had at least one visit to the primary care clinic during the 12-month period from July 1, 1993, to June 30, 1994. The 14% of study subjects who had no clinic visits had a mean age of 39.9 years, and 60.7% were men. Among the 2326 members reached by telephone, 1991 (85%) completed the telephone survey, which was conducted in July and August of 1994. Of the 1991 who completed the survey, 1976 members had complete data for all variables needed for the analysis, including data from both telephone survey and database sources. Chart audits to seek further documentation of the conditions of interest were performed for 94 of the 1976 members. No exclusions of study subjects were made on the basis of continuous enrollment in the HMO. During the 2 years that data were collected, no extraordinary programs to screen for diabetes or heart disease, beyond routine clinical activities, were underway.

What Is the Best Method to Identify Diagnosed Diabetes?

Table 1 shows the proportion of patients among whom diabetes was identified with the survey method and the database method. For 1860 members (94%) the survey method and database method showed agreement that diabetes was absent. For 83 members (4%) the two methods showed agreement that diabetes was present. For 33 members (<2%) the two methods showed disagreement on the presence of diabetes.

For members with disagreement between the survey method and the database method on identification of diagnosed diabetes, charts were audited to ascertain the correct classification. Of the seven members with database indication of diabetes but with surveys not indicating diabetes, two did have diabetes according to National Diabetes Data Group (NDDG) criteria,¹⁵ and five did not (although three of these five had impaired glucose tolerance according to NDDG criteria). Among the 26 members with survey identification of diabetes but with database classification as not having diabetes, 15 had no evidence of diabetes mellitus, eight met NDDG criteria for diabetes, and three had no chart data available to allow confirmation or refutation of a decision about the diagnosis of diabetes.

Including the classification information from the chart audits, a standard criterion classification was constructed. This classified as having diabetes 83 members with diabetes identified with both the survey method and the database method, two members who denied having diabetes during the survey but had both database and chart review findings that confirmed the diagnosis of diabetes, and eight members who lacked a database diagnosis of diabetes but self-reported having diabetes in the survey and had chart review evidence of diabetes. Thus a total of 93 adult members (4.7%) met the standard criterion for having diagnosed diabetes.

The standard criterion for members without diabetes included the 1860 members with neither survey nor database evidence of diabetes plus five members who denied having diabetes during the survey and whose charts showed no evidence of diabetes but had been given the ICD-9 diagnosis of diabetes in the database and 18 members who had neither chart evidence of diabetes nor database evidence but who stated they had diabetes during the survey. This produced a standard criterion of 1883 members without diabetes.

Tables 2 and 3 were constructed to compare the performance of the survey method and the database method of classifying diagnosed diabetes against the standard criterion classification of diabetes. The survey method allowed correct identification of diabetes

among 91 of 93 members (98% sensitivity) and correct identification of no diabetes among 1865 of 1883 members without diabetes (99% specificity). Among 109 members who reported having diabetes during the survey, 91 actually had diabetes (positive predictive

Table 1. Agreement in Identification of Diagnosed Diabetes Between Survey Method and Database Method for 1976 Adults Enrolled at an HMO-Owned Primary Care Clinic

| Survey Method | Database Method | | Total |
|---------------|-----------------|-------------|-------|
| | Diabetes | No Diabetes | |
| Diabetes | 83 | 26 | 109 |
| No Diabetes | 7 | 1860 | 1867 |
| Total | 90 | 1886 | 1976 |

Table 2. Classification of Diagnosed Diabetes with Survey Method Compared with Standard Criterion Classification

| Survey Method | Standard Criterion | | Total |
|---------------|--------------------|-------------|-------|
| | Diabetes | No Diabetes | |
| Diabetes | 91 | 18* | 109 |
| No Diabetes | 2 | 1865 | 1867 |
| Total | 93 | 1883 | 1976 |

*Includes three with no visits in chart

Table 3. Classification of Diagnosed Diabetes with Database Method Compared with Standard Criterion Classification

| Database Method | Standard Criterion | | Total |
|-----------------|--------------------|-------------|-------|
| | Diabetes | No Diabetes | |
| Diabetes | 85 | 5* | 90 |
| No Diabetes | 8 | 1878 | 1886 |
| Total | 93 | 1883 | 1976 |

value 83%). If the three members who reported diabetes but had no ICD-9 code or sufficient chart data to resolve the disagreement were all classified as having diabetes, the positive predictive value of the survey method would rise from 83% to 86%.

The database method (based on two or more primary care clinic ICD-9 codes of diabetes in the previous 24 months) allowed correct identification of diabetes among 85 of 93 members with diabetes (91% sensitivity) and correct identification of no diabetes among 1878 of 1883 members without diabetes (99.7% specificity). Among 90 members for whom diabetes was identified with the database method, 85 actually had diabetes (positive predictive value 94%).

What Is the Best Method to Identify Diagnosed Heart Disease?

Table 4 shows the agreement between the survey method and the database method of identifying diagnosed heart disease. For 1880 members (95%), neither the survey method nor the database method indicated heart disease. For 35 members (1.8%), both the survey method and the database method indicated heart disease. For 61 members (3%), the two

methods showed disagreement on the presence of heart disease. Among 18 members with survey-method indication of heart disease but no database method indication of heart disease, chart review showed no known heart disease for 10 members. The other eight members had chart evidence of heart disease, including chart or electrocardiographic evidence of myocardial infarction in seven instances. Among 43 members with no survey report of previous heart attack but with database evidence of heart disease, only two had documentation of previous myocardial infarction according to clinical or electrocardiographic criteria. However, 31 of these 43 members had chart documentation of known nonvalvular heart disease.

With chart review data, a final assignment of identified heart disease was given to 35 members who had both survey method and database method evidence of heart disease, another eight members who had survey reports of a previous heart attack plus chart evidence of heart disease, and another 31 members who had chart and database evidence of heart disease although they reported no previous heart attack. This produced a standard criterion total of 74 members (3.7%) with identified heart disease. A final assignment of no heart disease was given to 1880 members who had neither survey method nor database method evidence of heart disease. In addition, 10 members who reported a previous heart attack during the survey but had neither chart nor database evidence of heart disease and 12 members who had neither survey nor chart review evidence of heart disease were classified as having no heart disease. This produced a standard criterion total of 1902 members with no heart disease.

After reclassification of discordant cases by means of chart review, Tables 5 and 6 were constructed to show how the survey method and database method compared with the standard criterion heart disease classification. The survey method allowed correct identification of heart disease among 43 of 74 members (sensitivity 58%) and correctly identification of no known heart disease among 1892 of 1902 members (specificity 99.5%). Among 53 members classified as having heart disease with the survey method, 43 actually had heart disease (positive predictive value 81%).

Because the survey question specifically concerned heart attack history, additional analysis was done. This analysis showed that among 53 members classified as having heart disease with the survey method, 42 actually had chart evidence of a heart attack (positive predictive value of survey for heart attack 79%). Among the 44 members with standard criterion classification of

Table 4. Agreement in Identification of Diagnosed Heart Disease Between Survey Method and Database Method for 1976 HMO Members Attending a Primary Care Clinic

| Survey Method | Database Method | | Total |
|------------------|-----------------|------------------|-------|
| | Heart Disease | No Heart Disease | |
| Heart Disease | 35 | 18 | 53 |
| No Heart Disease | 43 | 1880 | 1923 |
| Total | 78 | 1898 | 1976 |

Table 5. Classification of Diagnosed Heart Disease with Survey Method Compared with Standard Criterion Classification

| Survey Method | Standard Criterion | | Total |
|------------------|--------------------|------------------|-------|
| | Heart Disease | No Heart Disease | |
| Heart Disease | 43 | 10 | 53 |
| No Heart Disease | 31 | 1892 | 1923 |
| Total | 74 | 1902 | 1976 |

having a heart attack, 42 reported a heart attack history during the survey (sensitivity of survey for heart attack 95%; corresponding specificity of survey for heart attack 99%).

The database method identified heart disease among 66 of 74 members (sensitivity 89%) and no heart disease among 1890 of 1902 members without heart disease (specificity 99.4%). Among 78 members classified as having heart disease with the database method, 66 actually had heart disease (positive predictive value 85%). Table 7 compares the performance of the survey method with that of the database method in identifying diagnosed diabetes or heart disease.

Cost Comparison of the Two Methods

Only the direct costs of data collection were compared. The survey method provided information on about 63% of all adults (1991 of 3186 adults) enrolled at the HMO clinic of interest at a cost of \$13.50 per completed survey. This amounted to about \$27,000, excluding the costs of instrument development and analysis of data.

The database method provided recent (within 1 year) data on 86% of all the adults enrolled at the clinic and on a higher proportion of those with diabetes or heart disease. The database method drew classification information from computerized databases that were created and maintained by the HMO for a variety of clinical, financial, and regulatory purposes. The marginal cost of extracting these data was the salary of one highly skilled programmer for 2 days, or approximately \$600. The programming language needed to acquire the necessary data was added to an existing program in 2 hours. The time from initiation of data gathering to availability of a data file for analysis was 8 weeks for the survey method and 1 week for the database method.

Whereas the cost of the survey method was about \$13.50 per member included in this analysis, the cost of the database method was about \$0.30 per member for each of the approximately 2000 members included in this analysis. Although novel ways of conducting the survey with computerized technology might lower the survey costs somewhat, the costs would still be substantially higher than acquiring necessary information from clinical databases. Surveys performed at clinic visits would be no less expensive than mailed surveys and would likely capture a smaller proportion of the overall clinic members and overrepresent high utilizers of care.

... DISCUSSION ...

The ability to accurately identify diabetes, heart disease, or other chronic diseases supports accurate quality of care measures used for various purposes. Accurate identification of chronic conditions also enables more appropriate fiscal and administrative decisions and more accurate evaluation of clinical improvement activities ranging from guideline implementation to disease management initiatives.^{1 16-18}

In assessing the performance of methods to identify a particular condition among patients, the measures

Table 6. Classification of Diagnosed Heart Disease with Database Method Compared with Standard Criterion Classification

| Database Method | Standard Criterion | | Total |
|------------------|--------------------|------------------|-------|
| | Heart Disease | No Heart Disease | |
| Heart Disease | 66 | 12 | 78 |
| No Heart Disease | 8 | 1890 | 1898 |
| Total | 74 | 1902 | 1976 |

Table 7. Sensitivity, Specificity, and Positive Predictive Value, Cost, and Penetration of the Survey Method and the Database Method of Identifying Diagnosed Diabetes or Diagnosed Heart Disease

| | Survey Method | Database Method |
|---------------------------------------------------------------|---------------|-----------------|
| Diabetes Identification | | |
| Sensitivity | 0.98 | 0.91 |
| Specificity | 0.99 | 0.99 |
| Positive predictive value | 0.83 | 0.94 |
| Heart Disease Identification | | |
| Sensitivity | 0.58 | 0.89 |
| Specificity | 0.99 | 0.99 |
| Positive predictive value | 0.81 | 0.85 |
| Heart Attack Identification | | |
| Sensitivity | 0.95 | 0.89 |
| Specificity | 0.99 | 0.99 |
| Positive predictive value | 0.81 | 0.79 |
| Proportion of members who contributed information to estimate | 63% | 86% |
| Cost of identification method per member | \$13.50 | \$0.30 |

of greatest practical importance are sensitivity, an estimate of the proportion of a population with a particular condition captured with the identification method, and positive predictive value, an estimate of the proportion of those reported as having a particular condition who actually have the condition. For diabetes, the sensitivity of the survey method (0.98) and the sensitivity of the database method (0.91) were both acceptable. The positive predictive value of the database method (0.94) was superior to that of the survey method (0.83) because of overreporting of diabetes during the survey. The reasons for this observed overreporting of diabetes were not clear and merit further investigation. Although both methods have acceptable sensitivity, the superior positive predictive value and lower cost of the database method would be an advantage in many scenarios. Previous reports have suggested good agreement between hospital claims data and clinical identification of diabetes,^{19,21} although few studies have been performed to assess the accuracy of diabetes outpatient data.¹¹

Both the database and the survey methods performed acceptably as a measure of previous heart attack (sensitivity 0.89 vs 0.95, specificity 0.99 vs 0.99, positive predictive value 0.85 vs 0.81). However, the survey method was less sensitive as an accurate indicator of overall heart disease, as would be expected (sensitivity 0.58, specificity 0.99, positive predictive value 0.79). When the survey method is intended to measure overall heart disease, it may be strengthened by including additional questions. With respect to database identification of heart disease, the mix of ICD-9 codes used for identification could be varied to match the population of interest. Although more validation of the use of combinations of ICD-9 codes would be useful, especially for the codes used to identify congestive heart failure, it appears that diagnostic database information can be used for accurate identification of diagnosed heart disease.

As HMOs assign more importance to quality improvement efforts and as the public demands increased public disclosure of quality of care measures, accurate identification of chronic conditions among groups of members will become increasingly important. There are some published data to suggest that database methods of identifying heart disease and diabetes may perform better than survey or medical record review methods in obtaining relevant and accurate diagnostic data.^{6,22,23} The performance of the database method used in this study could be further augmented by means of linking additional pharmacy, laboratory, or procedural database codes to diagnostic data.^{7,24-26} Recent rapid advances in database design

and development and wider use of electronic medical records may ultimately lead to further improvement in database methods to identify chronic conditions.

Survey methods do have some advantages. For accountability purposes, member surveys may provide a more credible measure of health plan performance than measures calculated internally by the health plan itself. Novel strategies to integrate patient self-reported data on factors such as smoking, exercise, diet, and other behavioral risk factors could provide important information that is often not available in even the most sophisticated clinical databases. Because surveys require the voluntary cooperation of members, survey information is perhaps more straightforward than database information in terms of privacy concerns, if it is assumed that the confidentiality and anonymity of data are appropriately assured. Finally, as can be seen in this analysis, survey methods for identifying chronic conditions have acceptable sensitivity and positive predictive value, at least for selected conditions at the clinic level.²⁷

Whether data are collected with surveys or from databases, the development of accurate methods to identify chronic conditions raises important ethical and confidentiality issues that must be carefully considered. Access to such clinical data must necessarily be limited and carefully controlled to respect patient privacy and confidentiality. Further, health insurers must not use these confidential data to create barriers to health plan enrollment or barriers to required medical services.^{28,29}

In comparisons of methods to identify chronic diseases among HMO members, efficiency of a method is defined as the proportion of members who can be "reached" with each method. In this study the efficiency of the survey method was 73% and the corrected survey response rate was 85%, so that information needed to classify HMO members by means of survey was available for only 63% of adults from whom information was sought. In theory, database information is available for all enrolled members. However, 14% of adult members had no clinic visits with a physician in a 1-year period. Thus about 86% of adults had information available to classify chronic disease status with the database method, but key pieces of information may not be uniformly available for all who received clinical care. Nevertheless, in this study the database method included information from a higher proportion of targeted members (86%) than did the survey method (63%). It is interesting that members who did not respond to the survey were more likely to be younger and be more likely not to have clinic visits

than those who did respond. Thus members contributing no information overlapped to some extent for the two methods of identification.

There are a number of limitations to the interpretation of the data. First, generalizability is limited because the study was conducted at only one HMO-owned clinic. Second, not all adults attending the primary care clinic were included in the analysis. Third, the standard criteria were, as is often the case in primary care research, imperfect. The two conditions studied are difficult to identify or exclude for some patients. For both conditions, the proportion of subclinical or undiagnosed cases may fluctuate somewhat on the basis of quality of clinical care, physician or patient characteristics, or special efforts to screen for particular conditions.

Despite the limitations, the data establish in a credible way the sensitivity, specificity, predictive value, and cost of two methods of identifying among HMO members clinical conditions of tremendous clinical and cost importance. The availability of credible, inexpensive methods to define these groups of patients at the clinic level opens exciting possibilities for assessing and improving clinical care. HMOs that can find ways to involve their members directly in a wide range of consensual, confidential, and effective clinical, preventive, and educational strategies stand to improve both health outcomes and member satisfaction.³⁰⁻³³

... REFERENCES ...

1. Pryor DB, Califf RM, Harrell FE Jr, et al. Clinical databases: Accomplishments and unrealized potential. *Med Care* 1985;23:623-647.
2. Miller RH, Luft HS. Managed care plan performance since 1980. *JAMA* 1994;271:1512-1520.
3. Roos NP, Shapiro E. Using the information system to assess change: The impact of downsizing the acute sector. *Med Care* 1995;33(suppl 12):DS109-DS126.
4. Black CD, Burchill CA, Roos LL. The Population Health Information System: Data analysis and software. *Med Care* 1995;33(suppl 12):DS127-DS131.
5. Haynes RB, Sackett DL, Tugwell P. Problems in the handling of clinical and research evidence by medical practitioners. *Arch Intern Med* 1983;143:1971.
6. Moritz TE, Ellis NK, VillaNueva CB, et al. Development of an interactive database management system for capturing large volumes of data. *Med Care* 1995;33:OS102-OS106.
7. Tamblyn R, Lavoie G, Petrella L, Monette R. The use of prescription claims databases in pharmacoepidemiological research: The accuracy and comprehensiveness of the prescription claims database in Quebec. *J Clin Epidemiol* 1995;48:999-1099.
8. Nielson GL, Sorenson HT, Pederson AB, Sabroe S. Analyses of data quality in registries concerning diabetes mellitus: A comparison between a population based hospital discharge and an insulin prescription registry. *J Med Syst* 1996;20:1-10.
9. National Committee for Quality Assurance. *Report Card Pilot Project Technical Report*. Washington, DC: National Committee for Quality Assurance; 1995.
10. Foundation for Accountability. *Guidebook for Performance Measurement: Prototype*. Portland, OR: Foundation for Accountability; 1995.
11. Young TK, Roos NP, Hammerstrand KM. Estimated burden of diabetes mellitus in Manitoba according to health insurance claims: A pilot study. *Can Med Assoc J* 1991;144:318-324.
12. O'Connor PJ, Rush WA, Rardin KA, Isham GJ. Are managed care members willing to engage in two-way communication to improve health? *HMO Pract* 1996;10:17-19.
13. Stein AD, Lederman RI, Shea S. The Behavioral Risk Factor Surveillance System questionnaire: Its reliability in a statewide sample. *Am J Public Health* 1993;83:1768-1772.
14. Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. *Cost-effectiveness in Health and Medicine*. New York: Oxford University Press; 1996:178.
15. National Diabetes Data Group. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. *Diabetes* 1979;28:1039-1057.
16. Dans PE. Looking for answers in all the wrong places. *Ann Intern Med* 1993;119:855-857.
17. Etinger S, McCormick KA. Databases: Their use in developing clinical practice guidelines and estimating the cost impact of guideline implementation. *J Am Health Inform Manage Assoc* 1996;67:52-60.
18. Psaty BM, Koepsell TD, Suscovick D, et al. An approach to several problems in using large databases for population-based case-control studies of the therapeutic efficacy and safety of anti-hypertensive medicines. *Stat Med* 1991;10:653-662.
19. Romano PS, Roos LL, Luft HS, et al. A comparison of administrative versus clinical data: Coronary artery bypass surgery as an example. *J Clin Epidemiol* 1994;47:249-260.
20. Jollis JG, Ancukiewicz M, DeLong ER, et al. Discordance of databases designed for claims payment versus clinical information systems: Implications for outcomes research. *Ann Intern Med* 1993;119:844-850.
21. Roos LL, Sharp SM, Cohen MM. Comparing clinical information with claims data: Some similarities and some differences. *J Clin Epidemiol* 1991;44:881-888.
22. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol* 1992;45:613-619.
23. Mortenson PB. The untapped potential of case registers and record-linkage studies in psychiatric epidemiology. *Epidemiol Rev* 1995;17:205-209.
24. Sartor F, Waickiers D. Estimate of disease prevalence using drug consumption data. *Am J Epidemiol* 1995;141:782-787.
25. Roos LL, Walld R, Wajda A, et al. Record linkage strategies, outpatient procedures, and administrative data. *Med Care* 1996;34:570-582.
26. West SL, Strom BL, Freundlich B, et al. Completeness of prescription recording in outpatient medical records from a health maintenance organization. *J Clin Epidemiol* 1994;47:165-171.

27. Pronk NP, O'Connor PJ, Isham G, Hawkins CM. Building a patient registry for implementation of health promotion initiatives in a managed care setting: Description of the approach and initial findings. *HMO Pract* 1997; 11:43-46.
28. Kassirer JP. Managed care and the morality of the marketplace. *N Engl J Med* 1995;333:50-52.
29. Markson LE, Nash DB, eds. *Accountability and Quality in Health Care: The New Responsibility*. Oakbrook Terrace, Ill: Joint Commission on Accreditation of Healthcare Organizations; 1995
30. Greenlick MR. Educating physicians for population-based clinical practice. *JAMA* 1992;267:1645-1648.
31. Starfield B. The promise of HMOs: Primary care, prevention, research, and education. *HMO Pract* 1993;7:103-110.
32. Yudkin JS. How can we best prolong life? Benefits of coronary risk factor reduction in non-diabetic and diabetic subjects. *Br Med J* 1993;306:1313-1318.
33. Schauffler HH, Rodriguez T. Availability and utilization of health promotion programs and satisfaction with health plan. *Med Care* 1994;32:1182-1196