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Passive case-finding for Alzheimer's disease and related dementias in two United States communities*

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Abstract

Passive surveillance for disease is a public health approach that relies on documentation available within existing health records for the region or communities being studied. Its 2 primary advantages over active case-finding are the lower cost of research and the lower burden on the population studied. The effectiveness of passive case-finding depends on the comprehensiveness of the healthcare coverage in a given community and the adequacy of the available medical records. The Rochester Epidemiology Project has permitted dementia case detection for Olmsted County, Minnesota, using a medical records-linkage system. These data were compared with case ascertainment using direct assessment of individuals in an epidemiologic study of the same community. At Group Health Research Institute, investigators compared dementia and Alzheimer's disease cases detected using an electronic medical record database search with those identified by a parallel active case-finding study. The advantages and disadvantages of passive case-finding are discussed, concluding that the purpose of the study should determine the case-finding approach that is employed.

1. Introduction

Case-finding is essential for studies of disease prevalence and incidence. Case-finding of persons with Alzheimer's disease and related dementias (ADRD) has proved particularly challenging. Symptom onset is typically gradual, often occurring years before traditional diagnostic criteria are met. The distinction between normal aging and mild dementia is often

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unclear, and clinicians and researchers have used a variety of terms to distinguish prodromal states of dementia from normal aging including today's many versions of mild cognitive impairment (MCI). Social attitudes resulting in acceptance of cognitive impairment as normal for old age or, in some cultures, obscuring or denying the illness to avoid embarrassment and shame also complicates case-finding.

In passive case-finding for Alzheimer's disease (AD), investigators rely solely on medical record systems to identify individuals with dementia in a given community. This approach is potentially more cost-effective than active case-finding, where all individuals in the target population, or a representative sample thereof, must be personally and directly evaluated in 1 or more stages to determine whether they have the condition. However, to be the most useful for epidemiologic purposes, a record system must cover all or the majority of individuals in a geographically defined area. Further, the records need to be quite detailed, with documentation consistently completed according to a set of common guidelines. The attractiveness of passive case-finding increases as more and more record systems convert from paper records to electronic records. The 2 main issues for this approach relate to validity of diagnosis and to comprehensiveness of coverage (who is included in the system and who is not). Given the multiplicity and diversity of healthcare and medical record systems in the United States, there are few US databases available to address these issues.

Some relevant data are presented in this article, from 2 research projects funded since the 1980s by the National Institute on Aging as *Alzheimer's disease patient registries* (ADPRs) [1]. Knopman, Petersen, and Rocca report on some recent research that involves the Rochester Epidemiology Project (REP) located in Olmsted County, Minnesota, and Larson reports on experience with a health maintenance organization (HMO) called Group Health and located in the Seattle, Washington, area. In the Discussion, Ganguli provides a synthesis of this material and gives some final thoughts.

2. Experience using the Rochester Epidemiology Project in Olmsted County, Minnesota

Passive surveillance using medical record information is generally regarded as insensitive to enumerate cases of dementia in a given population because of the low recognition of dementia in routine medical practice [2–8]. In prior experience with passive surveillance for the detection of prevalent [9,10] or incident dementia [11–13] using the REP, a 2-phase approach of screening for specific diagnostic codes and manual abstraction of records screened positive was used. To improve the sensitivity of the manual review of records of all of the subjects who received a diagnostic code for dementia, the review included the time period of interest plus the subsequent 6 years. Moderate or severe dementia would invariably come to medical attention at some point before death, allowing retrodating the onset of dementia historically.

With the initiation of the Mayo Clinic Study of Aging (MCSA) in 2004, it became possible to compare a passive surveillance system to detect cases of dementia with an active case-finding study. The MCSA was designed to establish a prospective, population-based cohort of subjects in Olmsted County, Minnesota, and to study the prevalence, incidence, and risk factors associated with mild cognitive impairment (MCI) and dementia. The study methodology was described in detail in prior publications [14,15].

Virtually all persons in Olmsted County receive medical care from either the Mayo Clinic or Olmsted Medical Center. These 2 healthcare providers participate in the medical records-linkage system of the REP [16]. Other smaller healthcare facilities in Olmsted County have also been included in the REP over the years. The REP medical records-linkage system was

used in the MCSA to generate a list of all Olmsted County residents age 70 to 89 years who had been in contact with the system at least once within the 3 years prior to the index date, October 1, 2004. After eliminating nonresidents and duplicate records, a sampling frame of 9,953 unique individuals who were alive on the index date was created.

Between November 2004 and January 2007, study staff attempted to contact an age- and sex-stratified random sample of 5,233 subjects from the total list of 9,953 subjects. Because the MCSA was designed to characterize cognitive impairment of lesser severity than dementia, persons who had already been diagnosed with dementia were not examined. To that end, a procedure to exclude subjects with documented dementia using a visual review of electronic medical record (EMR) information was developed. The medical records of all subjects who were randomly selected to participate in the study were reviewed by research assistants whenever research authorization was given. Persons obtaining medical care within the REP are asked to authorize access to their medical records for research purposes [17].

The research assistants reviewed all notes in the Mayo Clinic EMR from the time of access through several years before. If any mention of cognitive impairment was recorded, those cases were reviewed by a behavioral neurologist (D.S.K.) experienced in the ascertainment of dementia from medical record information. For logistical reasons, the medical records of Olmsted Medical Center could not be reviewed as part of this passive screening. A subject was considered to have dementia of mild or greater severity (approximately equivalent to Clinical Dementia Rating [CDR] ≥ 1 [18]) using the following criteria: (1) the diagnosis of “dementia” was used by physicians or nurse practitioners consistently over time, once the diagnostic label was first mentioned, *and* (2) if mention was made of specific symptoms of dementia that interfered with daily life (including memory loss sufficient to require someone other than the subject to manage the subject’s medications; loss of ability to prepare meals, travel independently, care for home or apartment, or shop for oneself; or dependency due to cognitive impairment); *or* (3) if there was a change in the subject’s living situation to a more structured environment that appeared to be the result of the cognitive loss (e.g., admission to a nursing home).

All subjects who lacked a diagnosis of dementia in their EMR and who were not terminally ill were invited to participate in the in-person examination of the MCSA. For those participating in person, informed consent was obtained in writing, after the study was explained. The in-person assessments included 3 elements: (1) an interview by a study nurse of both the subject and an informant using a structured questionnaire based on the CDR scale [18]; (2) a mental status examination and neurological examination performed by a study physician; and (3) an extensive neuropsychological assessment [14]. The data for each subject were reviewed in a consensus conference, and subjects were given a final diagnosis of normal cognition, MCI, or dementia. Dementia was defined using the *Diagnostic and Statistical Manual of Mental Disorders-IV* criteria [19].

Fig. 1 shows a flow chart of the study. From the 5,233 eligible Olmsted County residents selected for the study, 170 persons were excluded for administrative reasons (114 could not be contacted, 56 were terminally ill), 263 died prior to contact, and 402 subjects had dementia diagnosed through medical record review (passive surveillance). Of the remaining 4,398 subjects who were invited to the in-person exam, 2,050 were seen in person (active surveillance) and 669 agreed to a telephone interview including the Telephone Interview for Cognitive Status-modified (TICS-m). However, because the TICS-m proved to be inadequate for distinguishing MCI from dementia, persons evaluated with TICS-m only were excluded from these analyses [20].

Of the 2,050 subjects who were evaluated in-person, 14 subjects could not be evaluated completely for cognitive status, 67 received a final consensus diagnosis of dementia, 329 had MCI, and 1,640 had normal cognitive function. To compute the age- and sex-specific prevalence figures for dementia, the subjects found to have dementia by passive surveillance were repositioned to the total intended study sample. In particular, a hypothetical total population of 2,206 subjects was reconstructed to include all of the subjects who were evaluated in-person and those who would have been evaluated in-person if the passive screening for dementia had not been performed (Fig. 1). The 14 subjects with unclear cognitive status were considered non-demented in these analyses. Finally, the cognitive status of subjects as measured at the time of the in-person examination was assumed to be the same as on October 1, 2004. This retrodating of cognitive status allowed us to compute point prevalence figures for dementia using October 1, 2004, at the prevalence day [14].

For the reconstructed population of 2,206 subjects, the analysis projected a total number of 223 subjects with dementia, of whom 67 were detected only at in-person contact and 156 were detected by passive surveillance. The age- and sex-specific prevalence figures for dementia adjusted using propensity scores are shown in Table 1. The overall prevalence of dementia directly standardized to the total Olmsted County population was 10.0% (Table 1).

Because the research team examined in-person only subjects who were screened negative by the passive surveillance mechanism, the only measure of validity that can be derived directly from this study is the negative predictive value of 96.7% (1,983/2,050; Table 2). The specificity and the positive predictive value of the passive detection of dementia could not be calculated directly. However, with the assumption that 100.0% of persons who were determined to be demented through passive surveillance would have been diagnosed as demented at the in-person exam, the sensitivity of passive surveillance would be 70.0% (156/223). Of the 67 subjects who were not detected by passive surveillance, the majority 59 (88.1%) were mildly demented ($\text{CDR} \leq 1$). Only 8 (11.9%) subjects not detected by passive surveillance had a $\text{CDR} \geq 2$. In addition, there was some mention of cognitive impairment in the medical record of 21 of the 67 subjects (31.3%), but the severity of the symptoms was very mild or not specified.

Even though the passive surveillance mechanisms used in this validation study were not as rigorous as those used in previous formal incidence or prevalence studies in Olmsted County [9–13], the ability to detect dementia by passive surveillance was higher than in other populations [2–7]. There are several reasons why this experience was more favorable than the experience of others. First, there has been improved recognition of dementia in primary care practice in this decade compared with the past. Second, because the in-person assessments were more extensive than in most prior studies and because the current study distinguished MCI from dementia, patients who were classified as having MCI might have been counted as undetected dementia cases in prior studies. Third, access to medical care in Olmsted County, Minnesota, may be better than in some other populations in the United States [16]. Fourth, the use of EMRs has facilitated the ascertainment of dementia in the last decade compared with the use of paper records before.

The passive surveillance used in the MCSA could have been improved. In prior passive studies of dementia incidence [11–13], the time lag between the target years for incident dementia and when the medical records were surveyed was 6 years or longer. By contrast, in the current study, prevalent dementia was identified in real time. Had there been a longer lag between medical record review and the prevalence day, the detection rate for dementia would have been higher. In addition, medical records from Olmsted Medical Center were not reviewed as part of the passive screening because of time constraints. Thus, some additional persons who had been diagnosed with dementia but were never evaluated by

Mayo Clinic physicians might have been uncovered. Finally, the research assistants who conducted the initial screening of the medical record did not perform a formal retrieval of diagnostic codes for dementia from the REP indexes but rather conducted a more informal visual scanning of the EMR in real time.

Another weakness of the current study was the inability to determine the prevalence of dementia among subjects who refused in-person assessments or who died prior to contact. It is likely that dementia prevalence in non-participants was higher than in participants; therefore, the true dementia prevalence for the entire population may be higher than reported here. In addition, there may be features in the unrecognized cases of dementia that differ from those of persons recognized by routine medical care. Patients with dementia who fail to be diagnosed or who die prior to diagnosis might have different demographics or risk factor profiles compared with patients who have more favorable survival.

The MCSA experience suggests that high rates of dementia detection can be obtained by passive surveillance using a medical records-linkage system. In the future, there may be a role for passive surveillance of dementia, given the increasing cost and decreasing rate of participation in studies involving active contacts.

3. Experience using the Group Health medical records system in Seattle, Washington

In 1978, Burton Reiffler led development of the University of Washington (UW) Geriatrics and Family Services Clinic, the first outpatient comprehensive dementia service in the United States [21]. As part of the clinic's program, each patient had a comprehensive diagnostic evaluation. The evaluation was codified into a standardized evaluation, and a primitive (by today's standards) database was established. This database supported a series of largely descriptive studies on such topics as the coexistence of dementia and depression, outcomes of the diagnostic work-up, and adverse drug reactions causing dementia. In 1982, patients from that first "registry" became the clinical core of the original UW Alzheimer's Disease Research Center, a volunteer, so-called, convenience sample. At the time, that sample was considered uniquely valuable since subjects represented relatively early stage community-residing AD patients [22]. Although the population represented persons coming to a specialty clinic and thus was a referral population, these persons were older compared to individuals from populations in earlier studies.

In 1986, NIA announced its intention to support ADPRs. The vision was that incident case registries for ADRD would be valuable for dementia research the way cancer registries had been for cancer research, especially for prevention, screening, understanding disease course, and as a source of patients for dementia research programs including clinical trials. The goal of the UW ADPR was to develop an incident case registry based in a well-established HMO, Group Health, from an enumerated population of about 23,000 persons over age 60 years residing in central King County. The original UW Group Health ADPR enrolled persons within 1 year from the onset of dementia [23].

From 1994 through 1996, a parallel cohort study, the Adult Changes in Thought (ACT) Study, began enrolling 2,581 persons without dementia to determine incidence and to collect data prospectively on risk factors before disease onset. Inspired by epidemiologic studies like the Framingham Heart Study and the Honolulu Heart Watch, landmark studies of heart disease and stroke, the ACT Study was also designed to be consistent with, and allow cross-cultural comparisons with, the Kame project (a population-based study of Japanese-Americans residing in King County), the Honolulu-Asia Aging Study (successor to the

Honolulu Heart Watch), and the long-running Adult Health Study of the Hiroshima Radiation Effects Registry in Japan [24].

Today the ACT Study has become a “living laboratory” with continuous enrollment based on random samples of persons over age 65 years participating in Group Health and drawn from the same region as the original ACT and ADPR studies. Sampling and enrollment are standardized and designed so that approximately 2,000 persons without dementia are evaluated every 2 years to determine changes in cognitive and overall function and to document onset and causes of dementia. The “living laboratory” provides subjects and data for other research projects, including studies of insulin resistance and MCI, and a demonstration project using the ADPR/ACT biobank for Genome Wide Association Studies (GWAS) based on EMR phenotype data. The eMERGE projects (funded by NHGRI) seek to establish “proof of concept” and feasible methods to demonstrate how genomic and other biobank data can be linked to clinical data drawn from EMRs to allow high throughput, more rapid and efficient research and discovery [25].

LESSONS LEARNED 1

Studies that include only patients from clinical research centers are not representative of ADRD in the general population.

Parallel experiences in diverse settings for case-finding allow comparisons of characteristics of cases found. In particular, subjects recruited through an academic medical center and various specialty clinics are younger, more highly educated, have more severe disease, and have higher frequency of the ApoE ϵ 4 allele, while those identified in the ADPR population-based sample (through Group Health) are older, have had shorter duration of symptoms, have milder disease when identified, and have a lower frequency of known genetic markers of AD. These differences are important enough to make results from clinical series of cases found in more highly selected populations less generalizable to the general population, which is the population of interest for prevalence and prevention research as well as research aiming to improve patient care [26,27]. Use of highly selected study populations likely explains why many “discoveries” in AD research have not been enduring because they were not reproducible in more representative populations (e.g., platelet membrane fluidity [28,29]).

LESSONS LEARNED 2

Population-based samples allow for assessment of selection bias. Tsuang and colleagues investigated the effects of selection bias in a community-based autopsy series. Although autopsied persons were more likely to be educated beyond high school, married, White, and to have a clinical diagnosis of AD, adjustment for these selection factors had little effect on the relative frequency estimates in this series [30].

Haneuse and colleagues have since described a statistical method to identify and adjust for selection bias and have applied the method in a population-based neuropathological study which is part of the ACT Study [31]. When information is available on factors that govern selection, inverse-probability weighting provides an analytic approach to adjust for selection bias, thereby better ensuring the generalizability of results from population-based neuropathologic studies. It is now standard practice to employ this statistical method in neuropathologic research using ACT data.

Research based on case-finding from an enumerated population (like Group Health) or a discrete geographic entity (like Olmsted County, Minnesota, with the REP medical records-linkage system) or in a country with universal national health service (like the Netherlands), can assess the effect of selection factors and adjust for them. The combination of an

enumerated population base plus these methods should markedly enhance the generalizability of autopsy-based research, an area previously thought to be unreliable [25].

Electronically stored clinical data could prove valuable as the basis for an efficient, less costly case-finding method. In early efforts with the ADPR, data from existing Group Health databases containing admission, discharge and transfer diagnoses, clinic visit logs, mental health and neuroimaging schedules, and clinician referrals were utilized to find incident cases. Strategies using these sources were neither very sensitive nor very specific. Incident cases were missed and many false positive signals made case-finding efforts inefficient.

Group Health instituted an EMR system beginning in 2002, and it was fully implemented by 2004. Now that the EMR is populated with abundant clinical event data, how “good” might dementia cases derived from EMR be? This question is of interest because EMR-derived phenotype data could be an efficient way to build the NHGRI public data base available to qualified investigators, called dbGaP. Ultimately scientists from the eMERGE project and NHGRI would like to know just how feasible large biobanks linked with EMRs are for high throughput genomic research.

The accuracy of dementia phenotype data derived from EMRs was studied using ACT cases and controls as “gold standards”. Preliminary data compared EMR case-finding to ACT results based on a random sample of 3,174 persons over age 65 years who were not demented when enrolled in ACT, who had at least 1 biennial follow-up, and whose ACT status was known since development of Group Health’s EMR. The population included 2,637 persons known not to be demented – 537 with any dementia (412 with probable or possible AD, by NINCDS criteria); 58.0% were women, and 91.0% were White.

Several EMR data elements, which might distinguish persons with dementia from those without, were examined: ICD-9 codes; laboratory studies often used in the dementia work-up (e.g., B-12, thyroid function testing); neuroimaging; drugs used in treatment of AD/AD and combinations of these elements. In this sample, the best case-finding criteria were 5 or more mentions of an ICD-9 code used for dementia and/or use of a dementia drug (e.g., donepezil, memantine). Overall this strategy identified 55.1% of ACT dementia cases with 4.1% false positives (n = 108 false positives); 58.5% of ACT probable/possible AD cases (5.9%; n = 162 false positives); 62.6% ACT probable AD cases (7.7%; n = 223 false positives). Men were less likely to be identified by EMR criteria but there were no other important differences related to demographic features. Sensitivity of case-finding could be increased by using a single EMR mention of an ICD-9 code indicating dementia or dementia drug prescription. That strategy detected 72.6% of persons having any type of dementia, 79.3% of probable or possible AD cases, and 84.0% of NINCDS probable AD cases. However, the trade-off for such high sensitivity was larger numbers of false positives than true positives: to detect 289 (84.0%) of NINCDS probable AD cases, it falsely identified 517 individuals (18.0%), some of whom had other dementias. This high rate of false positives would necessitate adjudication, presumably by chart review to be useful for research purposes.

The availability of an EMR in an enumerated population has made passive case-finding an attractive strategy given the high cost of surveillance in cohort studies and in incident case-finding studies like ACT and ADPR. As expected, there were tradeoffs between completeness of case-finding (sensitivity) and generation of false positives (specificity). As case-finding became more sensitive, the number of false positives eventually outnumbered true positives.

When documentation of dementia increases and treatments are more widespread, EMR-based passive case-finding may become good enough for prevalence, prevention, and

biobank linked clinical research. Work is now underway to determine whether natural language processing using more sophisticated search strategies will succeed and eventually replace the rather simplistic search strategies relying on diagnostic codes or prescription of drugs.

There is great potential for EMR-based, passive, case-finding techniques developed in the context of enumerated populations receiving care through an integrated delivery system. Ideally large registries of dementia cases and controls could be created that contain environmental and other risk factor data (including health risk appraisal data) from EMRs and that are also linked to biobank and neuropathology data. Currently the greatest challenges to achieving this vision are the sensitivity and specificity of case-finding methods and the uncertainty about the selection of controls caused by the gradual onset of dementia, the lack of a biologic marker for AD, and the under-recognition of dementia in everyday medical care.

4. Discussion

Thoughtfully implemented passive surveillance systems can detect the majority of cases of dementia in a population, if the population is comprehensively served by an integrated healthcare delivery system with adequate documentation within an EMR. There are notable *caveats*, and it is important to understand both the strengths and limitations of passive surveillance so that reasonable expectations are put into place along with appropriate checks and balances.

The major strength, of course, is cost savings. The major limitation is the fact that some proportion of cases will be missed. As in any case-detection approach, sensitivity and specificity are usually enhanced at each other's expense. What is the tipping point at which the insensitivity or non-specificity might make the approach untenable and the cost moot? It most likely depends on the purpose of case detection in that context. Is it to identify cases for a drug trial? For a public health intervention? For prevalence estimation? For a risk factor study?

To be more specific, as regards prevalence, the first issue is the degree of under-ascertainment associated with passive surveillance. The second is whether ascertainment is biased in a particular direction, e.g., towards specific demographic or clinical characteristics, and whether individuals with those characteristics are more or less likely than others to have their dementia detected. Following from the second point, it can be asked whether a sample accrued through passive surveillance can serve as a platform for unbiased association and risk factor studies.

The Mayo Clinic group was able to compare, within the same population, a new active case-finding study of dementia with a pre-existing passive surveillance system. The passive system was based on research assistant screen followed by expert clinician's review of EMRs. Since the active study was focused on mild impairment, the only patients examined in person were those whose records did not already contain a diagnosis, or documentation suggestive, of dementia. Positive predictive value was therefore not estimable; negative predictive value was high, as would be expected for a rare event. The active case-finding study found the majority of dementia cases had also been detected by passive surveillance. However, there were also a number of cases that had not been recognized in the medical record. These amounted to 30.0% of all individuals with dementia; as expected, the majority of cases missed were mild. It is unclear at this time whether they were significantly different in other ways from those who were detected passively, such as age or gender.

The Seattle group was similarly able to compare active case-finding with passive surveillance within the EMRs of patients enrolled in the Group Health HMO. Here, passive case detection was achieved by computerized searching on several elements including diagnoses, tests, and drugs. Investigators were able to examine the accuracy of various combinations of passive case-finding criteria. The best of the strategies was able to detect 72.6% of any dementia cases, a figure remarkably similar to that noted in the Rochester study, and even higher proportions of those with AD. This strategy was more likely to identify women with AD than men with AD.

Neither study has yet revealed whether detection by passive surveillance was enhanced or diminished by other clinical characteristics. Since passive ascertainment depends entirely on detection and documentation by regular healthcare providers, there is a concern that it can be biased towards the more severe cases. Possibly, it can be biased toward cases with behavioral manifestations in addition to cognitive ones, and against those with significant comorbid conditions. It is likely biased towards those who actively seek services for dementia. The latter might in turn reflect the level of concern about dementia and cognitive impairment within a given community, which might itself vary by socioeconomic, educational, and ethnic group.

The amount of information available to the public through mass media regarding dementia and changes in cognition may be altering people's attitudes and behavior towards seeking services. There are interesting questions to be answered about what specific complaints bring patients to the provider who diagnoses the dementia. For example, does being labeled initially as having depression or a stroke influence the subsequent probability of dementia being detected and documented? As regards service utilization, clues have been reported that are related to frequency and duration of visits, or missed appointments, that might increase the probability of dementia and could be flagged for passive surveillance.

Detection in the course of regular healthcare may also be a function of the familiarity and sophistication of the healthcare providers in that community. There are known differences between the time and resources available to assess dementia in primary care versus specialist settings. Individual providers' own characteristics may predict the likelihood of detection, documentation, or referral to specialists. Integrated delivery systems may allow for better, more comprehensive, care as well as better documentation which would enhance passive surveillance.

Under-ascertainment due to differential healthcare seeking can also affect risk factor studies, as the putatively healthy comparison group could be contaminated with undetected cases of dementia. However, in at least 1 other passive surveillance study, associations between dementia and various exposures seem very similar to those found in studies that used active case-finding [32]. Another potential source of bias, which this time favors passive surveillance, is refusal bias; individuals appear less likely to refuse to let their medical records be used for research than to refuse to participate in active case-finding studies. The burden on the population of an active contact survey is much higher than the burden of a passive surveillance system.

Under-ascertainment is inevitable and should be taken into account when making prevalence estimations. Some degree of bias may also be inevitable; the key may be to ascertain the nature and degree of the selection bias if any, so that it can be accounted for appropriately in the analyses. It will be worthwhile to mine existing databases to identify characteristics associated with dementia that could further enhance case ascertainment. In summary, it does appear that passive surveillance may play a valid and useful role in dementia case

ascertainment, given certain standards with regard to integration of care and electronic documentation, and adequate recognition of inherent limitations.

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Fig. 1. Flow chart of the steps involved in defining the sample for the prevalence study of dementia in the Mayo Clinic Study of Aging (Olmsted County, Minnesota). The dotted lines indicate steps involving re-proportioning of subjects with dementia.

Prevalence of dementia in Olmsted County, Minnesota, expressed as number of cases per 100 persons, as of October 1, 2004 (directly standardized to the total county population and adjusted using propensity scores)

Table 1

Sex	Age class (years)*					All ages
	70 to 74	75 to 79	80 to 84	85 to 89		
Men	15/334 5.3 (2.9–7.7)	20/286 7.6 (4.7–10.4)	50/359 14.6 (11.7–17.6)	29/145 20.4 (14.8–26.0)		114/1,124 10.0 (8.5–11.5)
Women	7/280 2.7 (0.9–4.6)	19/230 8.4 (5.0–11.8)	43/381 12.1 (9.2–15.0)	40/191 22.4 (16.9–27.9)		109/1,082 10.0 (8.4–11.6)
Both sexes	22/614 3.8 (2.4–5.3)	39/516 8.1 (5.7–10.4)	93/740 13.0 (10.8–15.1)	69/336 21.8 (17.6–26.1)		223/2,206 10.0 (8.9–11.2)

* For each age and sex group, the following data are presented: number of cases, population at risk, prevalence figure, and 95% confidence interval.

Table 2

Diagnostic validity of passive surveillance (medical record review) versus active case-finding (in-person exam) in Olmsted County, Minnesota

		<u>In-person exam</u>		
		Yes dementia	No dementia	Total
Passive surveillance	Yes dementia	156	0*	156
	No dementia	67	1,983	2,050
	Total	223	1,983	2,206

* Assuming that all patients with dementia detected by passive surveillance would have been confirmed by the in-person exam.

The negative predictive value of the passive surveillance was $1,983/2,050 = 96.7\%$.

The sensitivity of the passive surveillance was $156/223 = 70.0\%$.