Use of Electronic Health Records and Administrative Data for Public Health Surveillance of Eye Health and Vision-Related Conditions in the United States

AMANDA F. ELLIOTT, ARTHUR DAVIDSON, FLORA LUM, MICHAEL F. CHIANG, JINAN B. SAADDINE, XINZHI ZHANG, JOHN E. CREWS, AND CHIU-FANG CHOU

• PURPOSE: To discuss the current trend toward greater use of electronic health records and how these records could enhance public health surveillance of eye health and vision-related conditions.

• DESIGN: Perspective, comparing systems.

• METHODS: We describe 3 currently available sources of electronic health data (Kaiser Permanente, the Veterans Health Administration, and the Centers for Medicare & Medicaid Services) and how these sources can contribute to a comprehensive vision and eye health surveillance system.

• RESULTS: Each of the 3 sources of electronic health data can contribute meaningfully to a comprehensive vision and eye health surveillance system, but none currently provide all the information required. The use of electronic health records for vision and eye health surveillance has both advantages and disadvantages.

• CONCLUSIONS: Electronic health records may provide additional information needed to create a comprehensive vision and eye health surveillance system. Recommendations for incorporating electronic health records into such a system are presented. (Am J Ophthalmol 2012; 154:S63–S70. © 2012 by Elsevier Inc. All rights reserved.)

THE 2009 AMERICAN RECOVERY AND REINVESTMENT Act allocated $27 billion to promote the adoption and meaningful use of certified electronic health records (EHRs) by hospitals and eligible health care professionals.[1] EHRs contain a wide variety of data important to public health authorities, including data about selected patient demographics, medical diagnoses, medication prescriptions, and laboratory test results.[1] Availability of electronically stored and coded data could greatly enhance public health surveillance by complementing existing administrative data sources such as the Centers for Medicare and Medicaid Services (CMS) and the Veterans Health Administration (VHA).

Public health surveillance of eye health and vision-related conditions might benefit from increased access to and analysis of electronically available data (including EHRs). Approximately 14 million US residents aged 12 years or older have visual impairment (defined as presenting distance visual acuity of 20/50 or worse in the better-seeing eye). Of these, more than 80% could be corrected to 20/20 or better with refractive correction.[2] In addition to refractive disorders, the number of people in the United States affected by cataract, diabetic retinopathy, glaucoma, and age-related macular degeneration (ARMD) is estimated to be 20.5 million (17.2%), 4.1 million (3.4%), 2.2 million (1.9%), and 1.8 million persons (1.5%), respectively.[3–6] By 2020, these numbers are projected to increase to 30.1 million for cataract, 3.4 million for glaucoma, and 3 million for ARMD; and by 2050, the number affected by diabetic retinopathy is projected to increase to 16 million.[3,5–7] Vision impairment has been associated with decreased quality of life, increased dependence in activities of daily living, decreased participation in social activities, greater risk for depression and fall-related injuries, and other negative health outcomes.[8,9] Currently, the United States has no national registry for eye diseases and vision-related conditions that can be used to estimate the incidence or prevalence of these conditions, to identify factors associated with them, or to characterize adverse events. The need for surveillance of these conditions continues to grow because vision impairment and blindness are major public health problems that cause a substantial human and economic toll on individuals and society, including significant suffering, disability, and loss of productivity for millions of people in the United States.[10] A good surveillance system is essential in order to plan, implement, and evaluate effective public health programs.

Public health surveillance of eye health and vision-related conditions requires "ongoing, systematic collection, analysis, interpretation, and dissemination of outcome-specific data for use in public health action to reduce morbidity and mortality and to improve health."[11] A

TABLE 1. Elements of Vision and Eye Health Information Provided by 3 Sources of Electronic Health Information Data

Information Element	Electronic Health Information Data Sources		
	Kaiser Permanente	Veterans Health Administration	Centers for Medicare and Medicaid Services
Visual impairment	+	+	*
Eye disease	+	+	+
Vision-related functioning	*	*	*
Social participation restriction	−	−	−
Access to vision and eye care	+	+	+
Access to support services	‡	‡	+

+ Information adequate for surveillance is available.

* Information is limited to that provided by clinicians in the electronic health records or indicated by the ICD-9 code entered in claims data.

‡ Source is limited to if these prompts exist in the electronic health records for vision care.

− Information (from clinicians' notes) may be available for some patients but not for enough patients to be useful for surveillance purposes.

recent report on vision and eye health surveillance identified 6 necessary elements of a comprehensive vision and eye health surveillance system, defined by the ability to assess rates of and monitor disparities in 1) visual impairment, 2) eye disease, 3) vision-related functioning, 4) vision-related restrictions in social participation, 5) access to eye care, and 6) access to vision rehabilitation support and services by those who need them.[11] Improved surveillance of these factors through the coordinated use of EHR, administrative, and claims data could help in tracking progress toward meeting vision objectives in Healthy People 2020. For example, progress toward meeting the objective to "increase the proportion of adults who have a comprehensive eye examination, including dilation, within the last 2 years and/or by age 45"[12] could be assessed more readily if all ophthalmologists and optometrists reported data with EHRs that are interoperable with population registries and provide aggregate reports to public health officials. A substantial benefit to incorporating EHR data into public health surveillance efforts is that it could allow objective clinical data collected in real time to be available in an ongoing, systematic manner. Such a capacity could lead to much faster dissemination of information than major national health surveys such as the National Health and Nutrition Examination Survey (NHANES), the National Health Interview Survey (NHIS), and the Behavioral Risk Factor Surveillance System (BRFSS) are currently able to provide. While data for these surveys are regularly collected, a substantial lag time exists between data collection and availability for analysis. Most important, the use of EHR data for public health surveillance would provide a direct feedback mechanism that could support efforts to improve screening and intervention activities. Additional advantages of using EHR data to monitor vision-related conditions include the availability of data on objectively diagnosed eye conditions, precision of visual function, and the onset, duration, and outcome of diagnosed vision conditions.

CURRENTLY AVAILABLE NATIONAL ELECTRONIC HEALTH INFORMATION DATA SOURCES

IN RECENT DECADES, SEVERAL HEALTH CARE ORGANIZA-tions have begun using EHRs and administrative or claims-based data. The following section describes how 3 of these organizations, Kaiser Permanente, VHA, and CMS, have used such data to monitor the 6 elements of a comprehensive vision and eye health surveillance system outlined above[11] (Table 1).

• KAISER PERMANENTE: Kaiser Permanente, one of the nation's largest not-for-profit health plans, serving over 8.6 million members, began implementing an EHR in early 2000 as a way to improve care coordination. Today, Kaiser Permanente HealthConnect (an Epic [Verona, Wisconsin, USA] implementation) is the largest civilian EHR system. It enables the more than 14 000 Kaiser Permanente physicians to electronically access any member's medical record nationwide. Members also have access to their personal health records, allowing them to electronically schedule or change appointments, review test results, reorder prescription medications, and even e-mail their physicians. Kaiser Permanente specialty care physicians can e-consult with primary care physicians and coordinate treatment plans much more quickly and effectively than traditional referral-based models of care.[13] HealthConnect users can access clinical data from primary care and eye care providers, as well as access to care and referral rates between providers. In recent studies, Kaiser Permanente electronic data have been used in analyses of vision loss among people with diabetes, diabetic retinopathy management, and factors associated with people with diabetes obtaining follow-up eye examinations.[14,15] Since 2005, Kaiser Permanente HealthConnect has used the "Panel Support Tool," which identifies gaps in 32 evidence-based care recommendations for patients and provides point-of-

care reminders or alerts to physicians to take certain actions on the basis of a patient's profile. Kaiser Permanente's use of EHRs and the Panel Support Tool has led to better provider performance, including greater provider adherence to evidence-based clinical guidelines.[16]

• VETERANS HEALTH ADMINISTRATION: The VHA, which provides care for 5.3 million patients, has used an electronic information system to store patient records for decades.[17] According to the VHA, this system, the Veterans Health Information Systems and Technology Architecture (VistA), is "an integrated system of software applications that directly supports patient care at VHA healthcare facilities. . . . It connects VHA facilities' workstations and PCs with nationally mandated and locally adapted software applications that are accessed by end users through a graphical interface known as the Computerized Patient Record System."[18] The Computerized Patient Record System, introduced in 1997, allows clinicians to record patients' clinical details electronically and allows all clinicians in the same VHA facility access to patients' comprehensive clinical records. In theory, information in the clinical notes of primary care providers and eye care providers that are recorded in the Computerized Patient Record System could be obtained for analysis. Like the Kaiser Permanente EHR system, the VHA EHR system provides physicians with clinical reminders in the form of interactive dialogue boxes that are triggered by certain diagnoses, clinical conditions, patient characteristics, or passages of time.[17] These reminders suggest possibly needed actions such as laboratory tests, medication refills, patient education, or referral of patients to specialists.[17]

In 1 study, VHA data were used to assess the prevalence of vision impairment in the veteran population.[19] However, this study focused on only 1 VA medical center because VHA data from different centers have not yet been linked electronically. The VHA plans to move toward a more "patient-centric" information system in which national stores of clinical data will be available through a centralized Health Data Repository.[18] This capacity could greatly improve data-driven decision making and public health surveillance. Although the Health Data Repository will be an improvement over the existing system, it will store only limited sets of data from individual VHA facilities. The majority of clinical, administrative, and financial information will remain available only through local VistA data files, which can be cumbersome to use for research or public health purposes.

• CENTERS FOR MEDICARE AND MEDICAID SERVICES: CMS provides a third example of a national electronic data source, though not an EHR. Traditionally, CMS has provided only data concerning claims, program eligibility, and program enrollment. Participants' characteristics, utilization, and payment information are available at the person-level. The large number of people in the CMS claims database make this data source especially valuable for the study of low-incidence vision disorders such as endophthalmitis after intraocular surgery.[20] CMS claims data have been used alone and in conjunction with other data sets (eg, CMS claims data linked to the National Long-Term Care Survey) to examine vision-related concerns. For example, Lee and associates used 9 years of CMS claims data to estimate the percentage of Medicare beneficiaries with diabetes and chronic eye diseases who have annual eye examinations;[21] and Sloan and associates linked CMS claims data with the National Long-Term Care Survey and examined the relationship between obtaining regular eye examinations and changes in visual and functional status among people aged 65 years or older.[22] Limitations to the use of CMS data for surveillance include the data's genesis from and reliance on the specificity and sensitivity of the ICD-9 or CPT-4 diagnostic codes that may be too broad or too narrow (which potentially leads to under- or over-reporting of conditions), imperfect and variable coding practices among health care providers, and lack of direct laboratory data.[20,23] In addition, Medicare claims data only include people aged 65 years or older, some younger disabled people, and some people of all ages with end-stage renal disease, excluding the 15% of Medicare-enrolled persons who are enrolled in HMOs.

CMS's Integrated Data Repository, a part of the CMS data warehouse strategy, is charged with integrating CMS data. According to CMS, the purpose of the Integrated Data Repository is to "transition from a claim-centric orientation to a multi-view orientation that includes Beneficiaries, Providers, Health Plans, Claims, Drug Data, Clinical Data, and other data as needed."[24] Creation of an integrated data system would facilitate information sharing and provide potential users easier access to information with which to identify and monitor public health concerns. For example, such a system could be used to identify Medicare or Medicaid enrollees with a diagnosis of diabetic retinopathy and track their use of preventive services such as diabetes care or comprehensive eye examinations including retinal imaging photos. However, because Medicare reimbursement does not depend on accurate coding of a beneficiary's visual impairment, the data in such a system would likely have incomplete or inaccurate coding for level of visual impairment, which is important information for vision and eye health surveillance.[20]

Despite their limitations, each of the 3 electronic data systems described above has the potential to provide much of the information needed for a comprehensive vision and eye health surveillance program as outlined by the Centers for Disease Control and Prevention[11] (Table 1). However, while electronic data systems offer many advantages over traditional methods of vision and eye health surveillance, national and state health surveys, none of these 3 systems provides all of the information required for a truly national surveillance program because each collects data only on the specific subpopulation it serves, and none of them

TABLE 2. Advantages and Disadvantages of Using Electronic Health Information for Vision and Eye Health Surveillance

Advantages	Disadvantages
• Data available in real time	• EHR operating systems may not adequately document eye examinations and care
• Data abstraction can be automated	• Potential reluctance of eye care providers to adopt EHR technology
• Obtaining EHR data is less time-consuming than traditional chart reviews	• Incompatibility of different EHR systems
• Data are objective	• Possible limited public health value of data collected primarily for clinical purposes
• Sharing EHR information facilitates comparisons across geographic regions and diverse populations	• It is unclear if EHR data will contain all the types of information needed for public health surveillance of chronic conditions
• Allows for incidence, prevalence, and longitudinal analyses	• Cannot be linked with national survey data

EHR = electronic health record.

collects adequate information regarding vision-related restrictions in social participation or other data on vision-related functioning. Even with their limitations, however, the 3 systems we described are good examples of how electronic data systems could contribute to the establishment of a comprehensive vision and eye health surveillance system.

STEPS TOWARD THE ADOPTION AND USE OF ELECTRONIC HEALTH RECORDS IN THE HEALTH CARE COMMUNITY

THE AMERICAN RECOVERY AND REINVESTMENT ACT ESTABLISHED programs under CMS and the Office of the National Coordinator (ONC) to provide incentive payments to health care practitioners and hospitals who adopt and "meaningful use" certified EHR technology. To receive these payments, hospitals and health care providers must implement an EHR system that meets meaningful use guidelines established by CMS and ONC. On August 30, 2010, the Certification Commission for Health Information Technology and the Drummond Group Inc became the first entities authorized to test and certify EHR systems for compliance with standards and certification criteria.[25] ONC has also established regional extension centers that will post listings of certified EHR systems and help primary care providers meet meaningful use criteria.

Under sections 1848(o)(2)(A) and 1886(n)(3)(A) of the American Recovery and Reinvestment Act, providers qualify as meaningful EHR users if they 1) demonstrate use of certified EHR technology in a meaningful manner; 2) demonstrate to the satisfaction of the Secretary that certified EHR technology is connected in a manner that provides for the electronic exchange of health information to improve the quality of health care such as promoting care coordination, in accordance with all laws and standards applicable to the exchange of such information; and

3) use certified EHR technology to submit to the Secretary information on clinical quality measures and other measures in a form and manner specified by the Secretary. Stage 1 of demonstrating meaningful use, scheduled to begin in 2011, will focus on electronically capturing health information in a coded format, using that information to track key clinical conditions, communicating that information for care-coordination purposes, and reporting clinical quality measures and public health information.[26]

ADVANTAGES AND DISADVANTAGES OF USING ELECTRONIC HEALTH RECORDS PUBLIC HEALTH SURVEILLANCE

• **ADVANTAGES:** EHRs offer many advantages for providing medical care, including improved quality of care, enhanced patient experience of care, prevention of medical errors, increased efficiency of care provision, reduction of health care disparities, improved care coordination, reduction of unnecessary health care costs, increased administrative efficiencies, decreased paperwork, expanded access to affordable care, and improved population and public health.[27] EHRs also offer advantages for any public health surveillance activity. Data may be available in real time and abstraction can be automated and schedules set to reduce information processing burden.[28] This automated abstraction is much less time-consuming than traditional chart-based reviews of medical records. In addition, EHR data, which are entered by care providers during the medical care process, are objective, whereas survey data based on self-reports of patients are not.

The sharing of electronic health information supports public health goals by facilitating population-level monitoring.[29] Shared data would allow for comparisons across geographic regions and diverse and at-risk populations, and would also allow for incidence, prevalence, and longitudinal analyses. (Table 2 provides a summary of the advan-

tages and disadvantages of using EHR information for vision and eye health surveillance.) EHRs could eventually facilitate the sharing of information among health care facilities and the distribution of information to local, state, and national public health offices once this type of data exchange can be supported. It could also be used for large-scale incidence studies, the identification of rare diseases, and biosurveillance. Because incentive payments will drive EHR vendors to develop, and eligible providers to implement, certified EHRs, the health care community should anticipate soon having electronic access to large (central or federated) stores of data.

• DISADVANTAGES: Eye care providers face serious clinical drawbacks in implementing EHRs. Those working within academic settings or in large integrated health care organizations will have to accept the EHR system chosen by their organization, and the selected system might or might not adequately address proper documentation of eye examinations and care. Although eye care providers in private practice settings will be able to select an EHR system that meets their particular needs, even these systems may lack the charting functionality required to document eye examinations and care. Implementation of an EHR system is also likely to involve an initial loss of income because of the time that providers will need to spend implementing, learning, and personalizing the system and the money they will have to spend training staff and acquiring resources to use and maintain the system. Adoption of EHR technology could also be impeded by the need to change workflow and other office processes, as well as by a possible increase in the amount of time required to document patient visits.[13] In addition, specialized EHR uses could impose important costs on the health care system as a whole.

Currently, local regional extension center programs target EHR assistance to priority primary care providers to ensure the best functionality for the investment made to adopt, implement, and upgrade certified EHR technology. It would be beneficial to specialty care providers, such as ophthalmologists, if the same assistance were extended to them as well. Eye care professionals need to be engaged in the EHR design process to ensure effective workflow integration and the inclusion of EHR components specific to eye care.

Factors currently preventing EHRs from being used more often for vision and eye health surveillance include the incompatibility of different EHR systems and databases and the possible limited public health value of data collected primarily for clinical purposes. However, the Health Information Technology for Economic and Clinical Health (HITECH) Act and meaningful use criteria should help improve system compatibility, as should the requirement that certified EHRs be compliant with HL7 Continuity of Care Documents (CCD) or ASTM Continuity of Care Record (CCR), which will permit exchange of information.[26] Specific eye and vision-related data need to be captured in the CCD or CCR and can be shared using this standard exchange format.

As eye health and vision-related conditions are often chronic conditions, surveillance of these conditions involves tracking and forecasting several aspects of chronic disease including data on risk factors, social determinants of health, functional and disability-related outcomes, and patients' access to and use of care.[11] It remains to be seen whether clinical information provided to EHRs will include all of these data elements. None of the 3 available sources of electronic data that we examined contained all of the essential components for a comprehensive vision and eye health surveillance program. Another problem limiting the potential usefulness of EHR data in surveillance is that they cannot be linked to data collected in national surveys because national survey data contain no personal identifiers. Therefore, it is not possible to link EHR data with national survey data to combine objective clinical measures (eg, visual acuity and eye disease diagnoses) with the self-reported quality-of-life measures and health behaviors contained in national surveys.

FUTURE OF ELECTRONIC HEALTH RECORDS IN PROVISION OF EYE CARE AND PUBLIC HEALTH SURVEILLANCE

THE TOTAL ANNUAL FINANCIAL BURDEN OF MAJOR VISUAL disorders among US adults in 2004 on the US economy was estimated to be $35.4 billion ($16.2 billion in direct medical costs, $11.1 billion in other direct costs, and $8.0 billion in productivity losses), and the combined cost to the federal government and state governments was estimated to be $13.7 billion.[30] Although any increase in efforts to screen for and treat these disorders can be expected to increase direct medical care costs, the improved visual outcomes and decrease in vision-related disability that such an increase in screening and treatment would lead to can be expected to decrease associated costs (eg, reductions in costs of lost productivity and reductions in medical costs associated with vision-related disability).[30] In short, the implementation of EHRs, although costly in the short term, might contribute to lower health care costs over time.

Given the enormous federal incentives for adopting certified EHR systems, the number of health care providers and health care systems using such systems will likely increase substantially in the coming years. Currently, only 17% of US physicians and 12% of US ophthalmologists use either a minimally functional or a comprehensive EHR system, only 1.5% of US hospitals use a comprehensive EHR system, and only 7.6% of hospitals use a basic EHR system.[31–33] As primary care physicians increase their use of EHRs, their improved management of systemic diseases that affect eye health and their use of automated prompts to refer patients for periodic comprehensive eye evalua-

tions by eye care professionals should help prevent and improve the management of chronic eye conditions.

Because primary care providers typically see patients on a regular basis, they are uniquely poised to prevent vision loss and blindness by managing systemic diseases that contribute to these conditions and encouraging their patients to obtain periodic eye examinations from eye care providers. However, in a recent study Pham and associates surveyed primary care physicians on the delivery of preventive services, including eye examinations for diabetic patients, and linked to Medicare beneficiaries claims data and found that, although annual eye examinations are recommended for all diabetes patients, only 47.9% of US diabetes patients had received this service within the previous year.[34] In addition, only 51% of primary care physicians who participated in a National Eye Health and Education Program survey reported feeling they had adequate knowledge to advise patients on vision health, and only 27% reported that they had performed a basic eye screening on more than 50% of their patients.[35] The actual percentages of physicians who provided these services was likely even lower because of the effects of social desirability biases. Rowe and associates published a scientific review intended to help primary care providers develop informed strategies for providing eye care and included such recommendations as: controlling glucose, hypertension, and hyperlipidemia in persons with diabetes; advocating smoking cessation; assessing ocular effects of systemic medications; and considering the role of antioxidants and protection against ultraviolet light.[36] These care practices can contribute to improved eye health, and primary care providers can also monitor their patients' visual status over time and alert patients to visit an eye care provider when warranted. In fact, a survey conducted by the National Eye Institute found that 96% of adults reported that they would be somewhat or very likely to have their eyes examined if their primary care provider were to suggest they do so.[37] The number of people receiving preventive eye care services could be greatly bolstered through the use of physician prompts in the EHR to alert primary care providers to refer their patients for at least annual eye examinations.

Public health agencies should begin to prepare now for eventual use of EHR data. The potential exists for a disconnect between the creation of all the EHR data and public health's ability to receive and use it. No national regulations currently require results of eye-related procedures or vision screening to be reported, and even where clinicians or hospitals are required to share such data with local, state, and federal public health agencies, the public health capacity to use it is limited. ONC has set aside $600 million to support the development of health information exchange capabilities at regional and state levels. These state-designated entities have a responsibility of serving to inform and encourage health information exchange between clinicians and public health agencies. Additionally, once this data exchange is in place, care must also be taken to ensure the credibility of analyses using EHR data by using careful study design and conducting analyses in a transparent manner.

Finally, eye care providers and experts in vision-related and eye health surveillance need to work with EHR designers in creating effective eye care templates and clinical decision support tools for use by both eye care and primary care providers. Because specialty eye care may be difficult to access in some medical markets, EHR vendors will need to develop templates that can be used by both eye care specialists and primary care physicians.

INCREASING PUBLIC HEALTH SURVEILLANCE OF EYE HEALTH AND VISION-RELATED CONDITIONS

PUBLIC HEALTH SURVEILLANCE IN OTHER AREAS HAS ALready shown the benefit of using EHR data to achieve public health goals. In surveillance of notifiable and communicable diseases, researchers have used data from electronic laboratory reporting systems to avoid relying on clinician-initiated reporting of diseases and manual chart-based data collection. Automated methods save valuable time, and EHRs contain reportable disease information as well as data on selected patient demographics, the clinical status of patients, and prescribed treatments.[28,38] Studies of this nature have been limited to the EHRs available at the time of the study, so few national studies have been undertaken. The limited studies that have been done propose that, by using discrete data entry fields within an EHR, organizations could extract data into databases that could be joined with other such databases through unique identifiers to generate information for infection control surveillance programs.[28]

Public health agencies attempting to detect national trends in rates of visual impairment and eye disease and the risk factors for these conditions could similarly use data from multiple EHR sources to create a large, nationally representative database, the data in which could then be used to compare and contrast those results with data obtained from national health surveys (eg, NHANES, NHIS, and BRFSS) in an effort to detect national trends in visual impairment and eye disease and their risk factors. Timely and ongoing dissemination of such information can provide the basis for effective public health programs to promote vision health and prevent vision loss.

The use of EHR data may lead to improvements in chronic disease surveillance, including surveillance of eye health and vision-related conditions. The inclusion of clinically objective data in the public health surveillance of vision and eye health will ultimately provide clinicians with information to support action and to inform policies that support programs needed to evaluate the effectiveness of public health programs that aim to improve vision health in the United States.

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