Syndromic Surveillance for Measleslike Illnesses in a Managed Care Setting

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Surveillance for measles must be enhanced to support the objective of measles elimination in the United States. Many conditions produce febrile rash illnesses that are clinically similar to measles; investigations of measleslike illnesses (MLIs) should occur regardless of the incidence of measles. Few data exist regarding the incidence of MLI in the United States, and it is unknown how providers evaluate patients with such conditions. We searched databases at a large managed care organization to obtain complete ascertainment of MLI during 1994–1998. Among 6,000,000 patient encounters, 68 records were identified that met the study case definition. The incidence of MLI was 4.5 cases/100,000 persons/year. Measles diagnoses were considered by physicians for 9 patients (13.2%); 2 were laboratory-tested and reported to the state health department and the other 7 were given alternative diagnoses. It was not possible to determine for the remaining MLI patients whether measles was ruled out on clinical grounds or whether the possibility was not considered. Provider education regarding evaluation and reporting of measles is warranted. Databases at health care plans can be used to address public health issues and to establish syndromic surveillance for communicable diseases.

Measles is now being reported at record low levels in the United States; only ∼100 or fewer cases (<0.1 case/100,000 population) have been reported during each of the past 4 years [1]. The evidence that measles has been eliminated in the United States is compelling [2, 3]. However, the capacity of surveillance in the United States to detect measles—a function of both case-finding activity and of the completeness of reporting of detected cases to health departments—needs to be better understood [3–7].

Regarding case-finding activity, many conditions produce rash syndromes that could be measles—for example, rubella, scarlet fever, roseola, dengue fever, and drug reactions. Although the incidences of these illnesses vary over time and by location, some level of diagnostic activity or investigation of measleslike illness (MLIs) should be occurring regardless of the incidence of measles itself, and this activity can serve as a measure of case-finding effort. We have found that the annual incidence of MLI is at least 1.0 case/100,000 population in most settings and have suggested that this value could be used as a standard by which to evaluate the quality of surveillance in settings attempting measles elimination [5]. This approach is similar to the strategy used to monitor surveillance in the polio eradication program, which uses a value of 1 investigation of acute flaccid paralysis/100,000 children <15 years of age as an indicator of the quality of surveillance [8].

Most state health departments, including the Minnesota Department of Health, encourage physicians to immediately report illnesses suspected to be measles, before a diagnosis is laboratory-confirmed, so that they can be investigated and control measures introduced as appropriate. Reporting requirements for measles vary and are often open to interpretation. Minnesota, for instance, requires that all cases and suspected cases of measles be immediately reported; cases are those diagnosed by physicians to be measles, and suspected cases are “a condition or illness in which the signs and symptoms resemble” measles. [9]. Most states probably
Table 1. ICD-9 (International Classification of Diseases, 9th edition) codes used to search administrative data at HealthPartners staff-model clinics, 1994–1998.

<table>
<thead>
<tr>
<th>ICD-9 code</th>
<th>Condition</th>
</tr>
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<tbody>
<tr>
<td>055.9</td>
<td>Measles without mention of complication</td>
</tr>
<tr>
<td>056.8</td>
<td>Rubella with unspecified complication</td>
</tr>
<tr>
<td>056.9</td>
<td>Rubella without mention of complication</td>
</tr>
<tr>
<td>057.0</td>
<td>Erythema infectiosum (fifth disease)</td>
</tr>
<tr>
<td>057.8</td>
<td>Other specified viral exanthemata (Dukes’ [Filatow-Dukes] disease; exanthema subitum [sixth disease]; fourth disease; parascarlatina; pseudoscarlatina; roseola infantum)</td>
</tr>
<tr>
<td>057.9</td>
<td>Viral exanthem, unspecified</td>
</tr>
<tr>
<td>075</td>
<td>Infectious mononucleosis (glandular fever, monoytic angina, Pfeiffer’s disease)</td>
</tr>
<tr>
<td>446.1</td>
<td>Acute febrile mucocutaneous lymph node syndrome (Kawasaki disease)</td>
</tr>
<tr>
<td>483.0</td>
<td>Mycoplasma pneumoniae pneumonia</td>
</tr>
<tr>
<td>782.1</td>
<td>Rash and nonspecific skin eruption (exanthem)</td>
</tr>
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</table>

do not clarify whether cases should be reported on the basis of defined signs and symptoms, on physician consideration, or both.

The Centers for Disease Control and Prevention (CDC) collects data from states on the number of measles investigations that they conduct; this is one of the indicators used to monitor the quality of measles surveillance in the United States [7]. However, most persons with MLI present to private providers, who may not report patients for whom measles was ruled out; it is therefore likely that the data reported by states provide an incomplete picture of measles diagnostic activity.

Managed care organizations (MCOs) provide integrated, ambulatory, and hospital-based care to large, fairly well-defined populations of members. MCOs generally capture clinical events and services for these members in complex data systems. These data systems have recently been used to conduct syndromic surveillance to detect unusual patterns of symptoms, particularly in the context of bioterror and nosocomial infections [10–14]. We conducted syndromic surveillance using data systems from a large MCO to determine the incidence of MLI in an ambulatory population in Minnesota, to characterize provider diagnostic and reporting behavior when evaluating patients with MLI, and to explore the potential of MCO databases for conducting syndromic surveillance.

METHODS

Study site and population. HealthPartners is an MCO in the Minneapolis–St. Paul metropolitan area. The study was conducted at the HealthPartners staff-model clinics. Some 250 primary-care physicians provide clinical services in these clinics. The socioeconomic mix at the staff-model clinics is similar to that of the Twin Cities metropolitan region, although Medicaid participation was about one-third lower. The population in the Twin Cities metropolitan area was ∼90% white.

Data collection. The data system at the HealthPartners staff clinics includes ICD-9 (International Classification of Diseases, 9th edition) codes for each encounter, assigned by providers, electronically transcribed clinical notes, and laboratory claims and results. Retrospective case finding for MLI was conducted for the years 1994–1998 by means of a multistep process. Administrative data were searched by use of selected ICD-9 codes for a variety of maculopapular rashes and viral exanthems (table 1). Electronic clinical notes for this set of ICD-9–filtered records were then searched by use of a Boolean text-file search with application of relevant text-string terms. Various text strings were evaluated, and a strategy with high sensitivity for MLI was selected: ([cough OR conjunctivitis] AND [fever OR febrile] AND macul) OR measles OR morbilliform. Finally, the laboratory requisition system was queried for measles IgM testing. The medical records for the final, filtered set of encounters were then reviewed manually by 2 of the investigators (J.D.N., P.H., certified by the American Board of Pediatrics and the American Board of Family Practice, respectively) to extract more-precise information regarding the patient’s illness and the physician’s evaluation.

Case definition. To identify MLI during medical record review, we used a case definition derived from the clinical case definition for measles [15]: a generalized maculopapular rash with simultaneous fever (by history, or measured as ≥37.7°C on presentation) and cough, coryza, or conjunctivitis.

RESULTS

During 1994–1998, enrollment at the HealthPartners staff-model clinics was stable at ∼300,000 members; there were
5,966,269 patient encounters at the clinics during this time. After the administrative data set was filtered with the designated ICD-9 codes (table 1), the set was reduced to 20,559 records. This set was then further filtered by use of text-string search of electronic clinical notes (table 1), yielding 503 records. Eleven patients had measles IgM testing during 1994–1998. Of the 11, 3 were included among the 503 records, but the other 8 were missed by either the administrative screen or the text-string search: 2 involved records of the sole physician in the HealthPartners system who continued to use handwritten notes, 1 involved an ICD-9 coding error, 4 involved measles immunity screening for which an IgM test was inappropriately ordered, and 1 record could not be located.

The set of 503 records was reviewed by the physicians to identify 68 cases of MLI. Records for 7 other patients who had measles IgM testing but that were not identified by the automated search were also reviewed, and no other cases of MLI were identified. One of the 68 cases was confirmed by laboratory tests as measles. The positive predictive value of an ICD-9–based search for MLI was thus 0.3% (i.e., 68/20,559) in this population, whereas the positive predictive value of a combined ICD-9–based search in tandem with a text-string search was 13.5% (i.e., 68/503).

About 1.5 million patient-years were incorporated in our search; thus, the incidence of MLI was 4.5 cases/100,000 persons/year (i.e., 68/1.5 million). The distribution of MLI by time is shown in figure 1. Fifty (74%) of 68 cases of MLI occurred among children <5 years of age.

The diagnostic considerations of the providers were documented in the records of 9 (13.2%) of the 68 patients with MLI. Measles itself was explicitly considered for all 9 of these records: 2 were diagnosed by testing as streptococcal pharyngitis, 3 were ultimately diagnosed as reactions to recent measles vaccination, 1 was ultimately diagnosed as a drug reaction in a fully vaccinated patient taking antibiotics, and 1 was considered suspected measles but had no diagnostic plan documented. Two (2.9%) of the 68 patients underwent measles IgM testing. One of these patients was confirmed as having measles: a 14-month-old child who had just arrived from Vietnam. This was the only patient who had an ICD-9 code for measles.

Three patients were reported to the Minnesota Department of Health, including 2 (2.9%) of the 68 patients meeting the study definition for MLI. These included the patient who had been confirmed as having measles and the second patient who had undergone measles IgM testing.

**DISCUSSION**

Sixty-eight patients with MLI were detected in our MCO population during the period of observation, and the annual incidence of MLI was 4.5 cases/100,000 persons. This value is well above the level of 1.0 cases/100,000 population that one would expect to see in settings with adequate surveillance [5]. During this period, the Minnesota Department of Health reported 142 investigations for MLI to the CDC (including 36 cases confirmed as measles, 31 from Minneapolis–St. Paul). This corresponds to an annual rate of 0.61 cases of MLI/100,000 persons. Our data suggest that many patients with MLI are...
Physicians typically did not document their diagnostic considerations for patients with MLI, and measles diagnostic testing was conducted for just 2.9% of the patients. Although only 2 patients with MLI were reported to the Minnesota Department of Health, it is possible that physicians did not consider measles for the other patients with MLI because of more-plausible alternative diagnoses. On the other hand, the physicians may not have considered the diagnosis of measles because of a lack of familiarity with the disease. Although these cases were not investigated or tested for measles, it is unlikely that many of them represented measles: 74% of the cases occurred among preschool children, and measles vaccine coverage was ~92% for this cohort during the study period [16]. Nonetheless, our results reinforce the idea that provider education regarding recommended diagnostic and notification practices for MLI and other reportable conditions could be helpful for physicians.

In contrast to traditional surveillance, which relies on etiologic diagnosis, syndromic surveillance is based instead on a predetermined set of symptoms (e.g., rash and fever), generally captured from nontraditional sources of data. It can serve as a useful complement for traditional surveillance, particularly when early detection or more complete reporting is critical, for instance, for detecting disease outbreaks or biological terrorism. There is increasing interest in the use of large data sets from health care systems or laboratories to conduct syndromic surveillance for important conditions [10–14]. An ICD-9 code-based search of administrative records for MLI is within the capabilities of many managed care plans and hospitals, but this simple strategy proved extremely nonspecific for detecting MLI. The combination of an ICD-9 code-based search coupled with a text-string search of electronic clinic records had a positive predictive value of 13.5%, with physician chart review used as a reference standard. This level of performance might be acceptable for special studies to determine the incidence of select communicable diseases and syndromes; it might also be acceptable for prospective syndromic surveillance for select conditions. Of course, the predictive value of any syndromic surveillance system would depend on the search strategy and search terms for the disease being monitored. Of note, some 95% of ICD-9 codes and 95% of electronic notes are in the HealthPartners data system within 1 and 4 days, respectively, so this system could actually be used to prompt confirmatory laboratory testing, disease notification, or other provider behavior.

Our study has a number of limitations. First, because no managed care plan is “typical,” the experience at HealthPartners may not be generalizable to other patient and provider populations with different demographics, disease epidemiology, practice patterns, and information systems. Furthermore, cases of MLI may have been missed by our search strategy: Our searches, based on ICD-9 codes and text strings, could have missed coding errors and misspelled terms. Such coding errors could have been due to simple errors or to more systematic factors, such as the organization of billing forms. Finally, we may have excluded important ICD-9 codes, text strings, and laboratory diagnoses in our search strategy and thereby missed an unknown number of MLIs. We were unable to determine the sensitivity of our search strategies, because this would have involved record review of the entire set of ~6 million records.

We were able to use data from a large managed care plan to answer important public health questions relating to surveillance and to provider performance. Data systems from health care systems, from insurers, and from laboratories are designed to address other functions, but as long as researchers and public health practitioners are aware of their weaknesses, these systems can be used to conduct special studies or for enhanced, timely, and efficient surveillance. Such activities need to be conducted within the framework of the Health, Insurance Portability and Accountability Act of 1996, and HealthPartners has indeed been able to conduct similar new projects since enactment of these new regulations. Additional research is needed to assess the utility of these methodologies at other health care systems and for other communicable and vaccine-preventable diseases.

Acknowledgments

We thank Kristen Ehresmann, for providing data regarding measles investigations conducted by the Minnesota Department of Health, and Mary McCauley, National Immunization Program, Centers for Disease Control and Prevention, for editorial comments and assistance.

References

8. de Quadros CA, Hersh BS, Olivé JM, Andrus JK, da Silveira CM, Carrasco PA. Eradication of wild poliovirus from the Americas: acute