Tracking Varicella Deaths: Accuracy and Completeness of Death Certificates and Hospital Discharge Records, New York State, 1989–1995

Karin Galil, MD, MPH, Mark J. Pletcher, MD, MPH, Barbara J. Wallace, MSPH, MD, Jane Seward, MBBS, MPH, Pamela A. Meyer, PhD, Andrew L. Baughman, PhD, MPH, and Melinda Wharton, MD, MPH

Before widespread vaccination, varicella infection resulted in more than 11 000 hospitalizations[1] and 100 deaths annually in the United States.[2] Since vaccine licensure in 1995, varicella incidence has decreased markedly.[3] Mathematical models have predicted that vaccination will shift the peak incidence of disease to older ages as the incidence declines.[4] Because older persons are at increased risk of morbidity and mortality from varicella,[5,6] it is essential to monitor these outcomes as vaccination coverage increases.[7,8] The Centers for Disease Control and Prevention (CDC) encourages state health departments to search death certificates and hospital discharge databases to estimate the number of varicella deaths. In this study, we assessed the validity and utility of these data sources.

METHODS

New York State death certificates and a statewide hospital discharge database (Statewide Planning and Research Cooperative System, or SPARCS) were searched for varicella codes (*International Classification of Diseases, 9th Revision* [*ICD-9*] 052.X and *International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] 052.X, respectively) for 1989 through 1995. Copies of hospital records (physician attestation sheet, history and physical examination, discharge summary) and death certificates were requested for all deaths identified. Deaths were excluded if the person was not a New York State resident or died outside the state. New York City residents were excluded for logistical reasons. We matched records in the 2 databases on decedents' dates of birth and death, sex, and names. Two authors (M.J.P., J.S.) reviewed death certificates to confirm the presence of varicella and hospital records to classify the cause of death, on the basis of all available data, as varicella, herpes zoster, varicella-zoster virus (VZV) infection (unclassifiable), or unrelated to VZV infection.

The positive predictive value (PPV) of a varicella code in a data source was defined as the proportion of deaths identified by the data source that were classified as varicella after medical record review. The PPV in each database search was calculated 3 ways: (1) by excluding unclassifiable VZV deaths; (2) by assuming that unclassifiable VZV deaths were from herpes zoster; and (3) by assuming that unclassifiable VZV deaths were from varicella. The PPV was calculated separately for persons aged younger than 50 years and those aged 50 years and older, because varicella is rare in older adults. Exact binomial confidence limits were calculated for each PPV.[9] Capture–recapture analysis[10] was used to estimate the total number of varicella deaths during the study period. Confidence intervals were calculated by the goodness-of-fit method.[11] The completeness of each data source was calculated as the number of verified deaths identified by each database as a proportion of the estimated total number of varicella deaths by capture–recapture analysis. We used the Fisher exact test[12] to compare PPV estimates and the McNemar test[12] to compare the completeness estimates.

RESULTS

The search of the death certificates and the SPARCS database yielded 64 potential varicella deaths (Table 1). Hospital records were available for 54 deaths (84%); 5 deaths occurred outside of nonfederal hospitals and 5 records were not found. We identified 45 deaths by searching death certificates (36 hospital records found) and 42 deaths by searching SPARCS (41 hospital records found). Classifications of cause of death by database are shown in Table 2.

From the 54 records reviewed, we identified 30 varicella deaths. Excluding a stillborn death at 25 weeks' gestation (from severe maternal varicella), the median age at death of the 29 persons was 23 years (range=4–91 years); 14 (48%) were male. Twenty-two (76%) were White, 2 (7%) Black, 2 (7%)

TABLE 1—Number of Potential Varicella Deaths Identified by Search of Automated Vital Records Databases and Availability of Hospital Records: New York State (Excluding New York City), 1989–1995

Database	No. of Potential Varicella Deaths Identified	No. (%) of Hospital Charts Available for Review
Death certificates exclusively	22	13 (59)[a]
Hospital discharge database (SPARCS) exclusively	19	18 (95)
Both databases	23	23 (100)
Total	64	54 (84)

[a]Five deaths occurred outside of nonfederal hospitals.

TABLE 2—Comparison of Varicella Diagnoses on Death Certificates and Hospital Discharge Records With Review of Hospitalization Records: New York State (Excluding New York City), 1989–1995

	Classification After Review of Medical Record[a]					
Database	Varicella	Herpes Zoster	Unclassifiable VZV Infection	VZV Was Not Cause of Death	N	Positive Predictive Value (%) of a Varicella Code[a] (95% CI)[b]
Death certificates, age group						
<50	23	1	0	3	27	85 (66, 96)
≥50	3	3	2	1	9	43 (10, 82)
Total	26	4	2	4	36	76 (59, 89)
Hospital discharge records, age group						
<50	19	0	1	5	25	79 (58, 93)
≥50	2	3	4	7	16	17 (2, 48)
Total	21	3	5	12	41	58 (41, 74)

Note. CI = confidence interval; VZV = varicella-zoster virus.
[a]The proportion of deaths identified by the data source that were classified as varicella, excluding unclassifiable VZV deaths.
[b]Exact binomial confidence interval

Asian/Pacific Islander, and 3 (10%) of unknown race. Eight persons (28%) were previously healthy, 5 (17%) were severely immunocompromised (4 with cancer, 1 with severe combined immunodeficiency), and 16 (55%) had other underlying conditions. The median age at death varied with underlying health status: 32 years (range=8–38) in previously healthy persons, 24 years (range=6–91) in persons with coexisting conditions, and 6 years (range=4–16) in immunocompromised persons.

PPV of a Varicella Code

The PPV of a varicella code was greater on a death certificate than in SPARCS and was higher in persons aged younger than 50 years than in those aged 50 years and older (Table 2). The PPVs were not substantially altered under our three assumptions, namely that they could not be classified and were excluded, that they were all assumed to be due to varicella, and that they were all assumed to be due to herpes zoster.

Capture–Recapture Analysis

Of the 30 varicella deaths, 9 (30%) were identified exclusively from a search of death certificates, 4 (13%) exclusively from SPARCS, and 17 (57%) from both sources. Excluding deaths without medical records, the capture–recapture analysis yielded an estimate of 32 (95% confidence interval [CI]= 30, 38) varicella deaths. The search was 81% complete (26 of 32) for the death certificates and 66% complete (21 of 32) for the SPARCS hospital discharge data (P=.27).

DISCUSSION

Monitoring varicella mortality is important for evaluating the impact of a national vaccination program. The results of our capture–recapture analysis suggest that the search of death certificates in New York State identified more varicella deaths (81% vs 66%) and that the data source had a higher PPV than did the search of SPARCS hospital discharges and the SPARCS data. The greater completeness of data in death certificates reflects the fact that only deaths among inpatients in nonfederal hospitals are recorded in SPARCS. The PPV was a function of age; whereas the validity of a reported varicella death in a person aged younger than 50 years was approximately 80%, the validity of such a report in a person aged 50 years or older was less than 43% (i.e., what was coded as a varicella death had an equal or greater likelihood of being due to herpes zoster).

Study limitations include the difficulty in distinguishing varicella and disseminated herpes zoster, the small number of persons in the study (particularly persons aged 50 years and older), and a possible underestimation of total varicella deaths through capture–recapture analysis. Because the same physician may have coded the discharge diagnoses and completed the death certificate, the assumption of 2 independent data sources for capture–recapture analysis may have been violated.[10] Medical records were unavailable for 10 deaths (16%). Assuming that these deaths were similar to those we reviewed, the total number of varicella deaths estimated by capture–recapture analysis might have been as high as 42, with correspondingly lower estimates of completeness.

This study suggests that death certificates are useful for monitoring varicella deaths for persons aged younger than 50 years. Hospital discharge records were neither more accurate nor more complete than death certificates and may be more difficult to search. In states with automated hospital discharge databases, it may be preferable to search both sources of information to derive a better estimate of the number of varicella deaths. ■

About the Authors

Karin Galil, Jane Seward, Pamela A. Meyer, Andrew L. Baughman, and Melinda Wharton are with the Centers for Disease Control and Prevention, Atlanta, Ga. At the time of this study, Mark J. Pletcher was with the Association of Schools of Public Health, Atlanta, Ga. Barbara J. Wallace is with the New York State Department of Health, Albany.

Requests for reprints should be sent to Karin Galil, MD, MPH, CDC Mail Stop E-61, 1600 Clifton Rd, Atlanta, GA 30333 (e-mail: kgalil@cdc.gov).

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Contributors

K. Galil contributed to the collection, analysis, and interpretation of data and to the writing and revision of the manuscript. M.J. Pletcher, B.J. Wallace, J. Seward, and P.A. Meyer contributed to the study design and data collection; M.J. Pletcher and P.A. Meyer also contributed to data analysis, and B.J. Wallace and J. Seward also were involved in revising the manuscript. A.L. Baughman contributed to data analysis and interpretation and to revising the manuscript. M. Wharton contributed to the study design and revising the manuscript.

Human Participant Protection

No human subjects participated in this study.

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