ORIGINAL INVESTIGATION

Failure to Vaccinate Medicare Inpatients

A Missed Opportunity

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Background: Hospitalized elderly patients are at risk for subsequent influenza and pneumococcal disease. Despite this risk, they are often not vaccinated in this setting.

Methods: We reviewed the medical records of a national sample of 107 311 fee-for-service Medicare patients, 65 years or older, discharged from April 1, 1998, through March 31, 1999, with a principal diagnosis of acute myocardial infarction, heart failure, pneumonia, or stroke. We linked patient identifiers to Medicare Part B claims to identify influenza and pneumococcal vaccines paid for before, during, or after hospitalization. The main outcome measures were documentation by chart review or paid claim of influenza or pneumococcal vaccination.

Results: Of the 104 976 patients with a single hospitalization, 35 169 (33.5%; 95% confidence interval [CI], 33.2%-33.8%) received pneumococcal vaccination prior to admission, 444 (0.4%; 95% CI, 0.4%-0.5%) were vaccinated in the hospital, and 1076 (1.0%; 95% CI, 1.0%-1.1%) were vaccinated within 30 days of discharge. In the subgroup of 40 488 patients discharged from October through December, 12 782 (31.6%; 95% CI, 31.1%-32.0%) received influenza vaccination prior to admission, 755 (1.9%; 95% CI, 1.7%-2.0%) were vaccinated in the hospital, and 4302 (10.6%; 95% CI, 10.3%-10.9%) were vaccinated after discharge. Of patients who were unvaccinated prior to admission, 97.3% (95% CI, 97.1%-97.5%) did not receive influenza vaccine and 99.4% (95% CI, 99.3%-99.4%) did not receive pneumococcal vaccine before hospital discharge.

Conclusion: National recommendations for inpatient vaccination against influenza and pneumococcal disease are not being followed for the vast majority of eligible Medicare patients admitted to the hospital.

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INFLUENZA AND PNEUMOCOCCAL vaccines are underutilized for Americans 65 years and older. Based on the 1999 Behavioral Risk Factor Surveillance System (BRFSS) survey, 66.9% received the influenza vaccine during the previous 12 months and 54.1% had ever received the pneumococcal vaccine.[1] This underutilization is not without consequences. Influenza causes more than 100 000 excess hospitalizations and 20 000 deaths each year.[2] Infection due to *Streptococcus pneumoniae* accounts for at least 500 000 cases of pneumonia and 50 000 cases of bacteremia in the United States each year.[3-6] The combined reporting category of influenza and pneumonia represents the fifth leading cause of death for this age group.[7]

Hospitalized patients are at particular risk for subsequent influenza and pneumococcal disease.[8] Up to 46% of subsequent influenza-related hospitalizations and approximately two thirds of influenza-related deaths occur in elderly persons who have been previously discharged during that flu season.[9] Similarly, up to two thirds of patients hospitalized with serious pneumococcal infections have been hospitalized at least once during the previous 3 to 5 years.[10-14] Despite the risk of subsequent disease, immunization status is often not documented and vaccination is rarely offered to hospitalized patients.[8,15-18]

The Advisory Committee on Immunization Practices (ACIP) recommends administration of influenza and pneumococcal vaccines to inpatients as a strategy for increasing vaccination coverage among adults.[2,3] As a part of the Centers for Medicare & Medicaid Service (CMS) national efforts to improve the quality of care given to Medicare beneficiaries, we evaluated the utilization of influenza and pneumococcal vaccines in a large cohort of patients admitted to the hospital during 1998 and 1999.

METHODS

SUBJECTS

Details of implementation of the CMS national quality improvement projects have been

previously published.[19] Medicare fee-for-service hospital claims data were used to identify discharges with a principal diagnosis of acute myocardial infarction, heart failure, pneumonia, or stroke. These 4 clinical topics have been selected as national quality improvement priorities for the Medicare Program.[20] Managed care hospitalizations were not included because claims were not consistently submitted for them. Up to 850 discharges (900 for heart failure) were randomly selected for each of the 4 clinical conditions from each state and the District of Columbia.[19] We selected all eligible cases if there were fewer than the targeted number of discharges available. Based on Medicare quality improvement organization contract cycles, the sample period varied by state and clinical topic. Discharges for a 6-month period within each state were sampled. For a third of the states, this period was from April to September 1998; for another third of the states, July to December 1998; and for the remaining states, October 1998 to March 1999. All states had pneumonia cases sampled from October to December 1998 to assess inpatient influenza vaccine screening and administration. Informed consent and institutional review board approval were not required because the data were collected for administration of the Medicare program, not for research, and access to these data is given to the Program by law.

DATA COLLECTION

Hospitals sent photocopies of the selected medical records to 1 of 2 CMS-contracted clinical data abstraction centers that used topic-specific computerized data collection tools with explicit predefined criteria for manual chart review and data entry. Continuous monitoring of the quality of data collection through interrater reliability testing occurred throughout the process for each clinical topic. Questions related to influenza vaccine were limited to the charts of patients admitted during October 1998 through December 1998. There was no date restriction on questions related to pneumococcal immunization. Each chart was reviewed to determine if the patient's influenza and pneumococcal vaccination status was documented in the medical record and if indicated vaccines were administered prior to discharge.

Subsequent to medical record review, we linked the unique patient identifiers for all selected cases to Medicare Part B claims for influenza vaccination provided between July 1, 1998, and January 31, 1999, and for pneumococcal vaccination provided during 1991 through 1999.

DATA ANALYSIS

Patients were included in the analysis if they were 65 years or older, were discharged alive, were not transferred to another acute care facility, and did not leave the hospital against medical advice. Diagnosis-specific exclusion criteria included acute myocardial infarction–admission for observation only or ongoing treatment of a recent myocardial infarction (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] code 410.x2); heart failure–procedure code that indicated dialysis (*ICD-9-CM* codes 39.95 or 54.98); and pneumonia–transfer from another acute care hospital, absence of a working diagnosis of pneumonia, or patient receiving comfort measures only. For this analysis, patients who had only 1 hospitalization during the study period were analyzed separately from those who had multiple hospitalizations for the same or different clinical reasons.

Influenza vaccination was examined for patients with a single hospitalization who were discharged from October 1, 1998, through December 31, 1998. Vaccination prior to admission was based on finding a paid claim from July 1, 1998, to the date of admission, or medical record documentation of patient self-reported vaccination. Inpatient vaccination was determined by documentation in the medical record or by a paid claim during the dates of the hospital stay. Vaccination after discharge was determined by finding a claim for the influenza vaccine from the date of hospital discharge to January 31, 1999.

Pneumococcal vaccination was examined for all patients with a single hospitalization at any point during the year of study. Vaccination prior to admission was based on finding a claim for the pneumococcal vaccine before the date of hospitalization (Medicare Part B claims are available for pneumococcal vaccines paid for since 1991) or by medical record documentation of patient self-reported vaccination. Inpatient vaccination was determined by documentation in the medical record or by a paid claim during the hospital stay. Vaccination after discharge was determined by examining claims during the 30 days after discharge.

Inpatient vaccination of patients with multiple hospitalizations was determined by medical record documentation during any of their hospital stays or by finding a claim during any of the patient's admissions. Analysis of influenza vaccination was limited to those with discharges between October 1, 1998, and December 31, 1998. Outpatient vaccination was determined by identification of a claim for the influenza vaccine (July 1, 1998, through January 31, 1999) or for the pneumococcal vaccine (1991 through 30 days after last discharge) during any of the dates the patient was not hospitalized, or by medical record documentation of patient self-reported vaccination.

For all analyses, where there was conflicting evidence with only 1 source demonstrating vaccination (eg, a paid Part B claim was found but the patient stated that he or she had not been immunized), we assumed that the patients were immunized. This circumstance was rare, occurring in only 0.6% of the cases for influenza vaccine and 0.8% of the cases for pneumococcal vaccine.

STATISTICAL ANALYSES

Descriptive statistics were calculated for the limited demographics available in this data set and all analyses were summarized across clinical topics and patient variables including age, race, and sex. Differences in immunization rates across various population subgroups were compared using χ^2 tests. Exact binomial 95% confidence intervals (CIs) were calculated for all results. All reported *P* values are 2-sided.

Because the sample of cases represented a fixed maximum number of patients per diagnosis per state, we applied normalized weights to adjust all reported vaccination rates. Two factors composed a normalized weight: crude weight and probability of sampling. Crude weight was calculated for each state by dividing the number of sampled cases by the state universe (the total number of records in a state for a given topic). The probability of sampling was calculated using the total number of eligible cases in the samples for the study divided by the corresponding portion of the universe of cases in the Medicare population. Similar procedures were applied when stratifying vaccination rates by age, race, and sex.

All analyses were completed using SAS statistical software (SAS version 8.1, SAS Institute Inc, Cary, NC).

RESULTS

Of the 144482 total hospitalizations, we excluded 8508 because of diagnosis-specific exclusions, 10756 because of patient age younger than 65 years, and 15451 because of patient death during the hospital stay or because the patient left the hospital against medical advice. This resulted in 109767 hospital discharges in the

final data set. Of these, 41 426 occurred from October 1, 1998, to December 31, 1998.

We identified 107 311 unique patients cared for during these hospitalizations. Of these patients, 104 976 (97.8%) had a single hospitalization and 2335 (2.2%) had more than 1 admission. Demographic characteristics of the patients are summarized in **Table 1**. The mean age of the patients was 78.6 years (median, 78 years), with pneumonia patients being slightly older than those with other conditions (mean, 79.4 years; median, 79 years). The mean age of the patients with more than 1 hospitalization was 78.8 years (median, 79 years). Patients 85 years or older made up almost a quarter of the study population. The majority of patients were white (88%), and females predominated in the sample (55.2%).

Influenza vaccination of patients with a single hospitalization is summarized in **Table 2**. Of the 40 488 unique patients discharged from October through December 1998, 12 782 (31.6%; 95% CI, 31.1%-32.0%) had evidence of vaccination prior to admission, 755 (1.9%; 95% CI, 1.7%-2.0%) were vaccinated in the hospital, and 4302 (10.6%; 95% CI, 10.3%-10.9%) had a claim for vaccination after discharge through January 31, 1999. Expressed in another way, 26 951 (97.3%; 95% CI, 97.1%-97.5%) of the 27 706 patients who were unvaccinated prior to admission did not receive the influenza vaccine before hospital discharge, representing a missed opportunity. There were no significant differences in the utilization of influenza vaccine across clinical topics ($P=.12$). When the results were adjusted for the sampling strategy, 31.1% (95% CI, 30.7%-31.6%) had evidence of vaccination prior to admission, 1.5% (95% CI, 1.4%-1.7%) were vaccinated in the hospital, and 10.1% (95% CI, 9.8%-10.4%) had a claim for vaccination after discharge.

Pneumococcal vaccination of patients with a single hospitalization is summarized in **Table 3**. Of the 104 976 total patients, 35 169 (33.5%; 95% CI, 33.2%-33.8%) had evidence of vaccination prior to admission, 444 (0.4%; 95% CI, 0.4%-0.5%) were vaccinated in the hospital, and 1076 (1.0%; 95% CI, 1.0%-1.1%) had a claim for vaccination within 30 days of discharge. Expressed in another way, 69 363 (99.4%; 95% CI, 99.3%-99.4%) of the 69 807 patients who were unvaccinated prior to admission did not receive the pneumococcal vaccine before hospital discharge, representing a missed opportunity. There were statistically significant differences across clinical topics in the proportion of patients vaccinated with the pneumococcal vaccine ($P<.001$), with pneumonia patients being more likely to have received it before, during, or after hospitalization. When the results were adjusted for the sampling strategy, 32.9% (95% CI, 32.6%-33.2%) had evidence of vaccination prior to admission, 0.3% (95% CI, 0.3%-0.4%) were vaccinated in the hospital, and 0.9% (95% CI, 0.9%-1.0%) had a claim for vaccination after discharge.

Utilization of influenza vaccine stratified by demographic group is summarized in **Table 4**. There were significant differences in rates across age groups ($P<.001$), racial/ethnic categories ($P<.001$), and between men and women ($P<.001$). Vaccination rates adjusted for sampling strategy ranged from 23.4% (95% CI, 13.2%-36.5%) for Hawaiian natives to 45.2% (95% CI, 44.7%-45.7%) for white patients. The age group of 65 to 69 years (38.9%; 95% CI, 37.6%-40.2%) and the group 85 years and older (39.6%; 95% CI, 38.6%-40.5%) were least likely to be immunized.

Table 1. Demographic Characteristics of 107 311 Medicare Patients Admitted to US Hospitals Between April 1, 1998, and March 31, 1999, With Acute Myocardial Infarction, Heart Failure, Pneumonia, or Stroke*

Characteristic	No. (%)
Age group, y	
65-69	14 767 (13.8)
70-74	20 812 (19.4)
75-79	23 561 (22.0)
80-84	22 205 (20.7)
≥85	25 966 (24.2)
Race	
White	94 461 (88.0)
African American	8120 (7.6)
Hispanic	2461 (2.3)
Asian	1183 (1.1)
Native American	526 (0.5)
Hawaiian native	151 (0.1)
Other	409 (0.4)
Sex	
Female	59 204 (55.2)
Male	48 107 (44.8)

*Based on the review of a systematic random sample of up to 850 fee-for-service Medicare hospitalizations per state for each clinical topic. After exclusions, there were 107 311 unique patients identified from a total of 109 767 eligible hospitalizations.

Similarly, there were significant differences across age groups ($P<.001$) and racial groups ($P<.001$) in the proportions of patients who received the pneumococcal vaccine (**Table 5**). There was no significant difference in pneumococcal vaccination rates based on sex ($P=.10$). Vaccination rates adjusted for sampling strategy ranged from 19.9% (95% CI, 19.0%-20.8%) for African Americans to 36.2% (95% CI, 35.9%-36.6%) for white patients. As expected, the proportion of patients who had received pneumococcal vaccine at least once increased with age up to 85 years. Patients who were 85 years or older had lower rates of vaccination but this may reflect the lack of Part B claims data for pneumococcal vaccine given prior to 1991.

Influenza and pneumococcal vaccination rates among patients who had more than 1 hospital admission are summarized in **Table 6**. Although vaccination in the hospital with the influenza vaccine was more common in patients with more than 1 hospitalization than in patients with a single admission (5.9% vs 1.9%, $P<.001$), the total vaccination rate for this population was not significantly different (46.9% vs 44.1%, $P=.25$). Patients with more than 1 hospitalization were 3 times more likely ($P<.001$) to receive pneumococcal vaccine as an inpatient (1.3%; 95% CI, 0.9%-1.8%) than those with a single hospitalization (0.4%; 95% CI, 0.4%-0.5%). Overall pneumococcal vaccination rates were higher in patients with more than 1 admission (40.3%; 95% CI, 38.3%-42.3%) than among those with a single admission (34.9%; 95% CI, 34.7%-35.2%) ($P<.001$).

Table 2. Proportion of Medicare Inpatients Who Received Influenza Vaccination Before, During, or After Hospitalization*

	Prior to Admission†		During Admission‡		After Discharge§		Total	
Diagnosis (n)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted‖ % (95% CI)	Weighted % (95% CI)
AMI (6549)	31.2 (30.1-32.3)	30.3 (29.2-31.4)	1.4 (1.2-1.8)	1.3 (1.1-1.7)	11.4 (10.7-12.2)	10.8 (10.0-11.6)	44.1 (42.8-45.3)	42.4 (41.2-43.6)
Heart failure (10 529)	31.4 (30.5-32.3)	31.2 (30.3-32.1)	1.9 (1.6-2.2)	1.7 (1.5-2.0)	10.5 (9.9-11.1)	9.8 (9.2-10.3)	43.8 (42.8-44.7)	42.7 (41.7-43.6)
Pneumonia (13 772)	31.7 (30.9-32.5)	31.4 (30.6-32.2)	2.4 (2.2-2.7)	1.9 (1.6-2.1)	10.7 (10.2-11.3)	10.1 (9.6-10.6)	44.9 (44.0-45.7)	43.4 (42.6-44.2)
Stroke (9638)	31.9 (31.0-32.8)	31.1 (30.2-32.0)	1.3 (1.1-1.5)	1.0 (0.8-1.2)	10.1 (9.5-10.7)	9.8 (9.3-10.5)	43.3 (42.3-44.3)	42.0 (41.0-43.0)
All patients (40 488)	31.6 (31.1-32.0)	31.1 (30.7-31.6)	1.9 (1.7-2.0)	1.5 (1.4-1.7)	10.6 (10.3-10.9)	10.1 (9.8-10.4)	44.1 (43.6-44.5)	42.7 (42.2-43.2)

*Analysis is limited to Medicare patients with a single hospitalization who were discharged between October 1 and December 31, 1998. Weighted results reflect adjustment based on the state-specific sampling scheme. CI indicates confidence interval; n, number of patients; and AMI, acute myocardial infarction.
†Based on an analysis of Medicare Part B paid claims or documentation in the hospital medical record of prior vaccination during the current influenza season.
‡Based on hospital medical record abstraction and analysis of paid Medicare Part B claims.
§Based on an analysis of Medicare Part B paid claims through January 31, 1999.
‖There were no significant differences across clinical topics in the utilization of influenza vaccine ($P = .12$).

Table 3. Proportion of Medicare Inpatients Who Received Pneumococcal Vaccination Before, During, or After Hospitalization*

	Prior to Admission†		During Admission‡		After Discharge§		Total	
Diagnosis (n)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted‖ % (95% CI)	Weighted % (95% CI)
AMI (18 701)	31.1 (30.4-31.7)	31.1 (30.4-31.8)	0.2 (0.2-0.3)	0.2 (0.2-0.3)	0.8 (0.7-0.9)	0.8 (0.6-0.9)	32.1 (31.4-32.8)	32.1 (31.4-32.7)
Heart failure (31 180)	33.8 (33.3-34.3)	33.0 (32.5-33.5)	0.3 (0.2-0.3)	0.2 (0.2-0.3)	0.8 (0.7-0.9)	0.6 (0.6-0.7)	34.8 (34.3-35.4)	33.9 (33.3-34.4)
Pneumonia (24 846)	37.0 (36.4-37.6)	36.2 (35.6-36.8)	1.0 (0.9-1.2)	0.8 (0.7-0.9)	2.0 (1.8-2.2)	1.8 (1.6-2.0)	40.0 (39.4-40.6)	38.8 (38.2-39.4)
Stroke (30 249)	31.9 (31.3-32.4)	31.2 (30.7-31.7)	0.2 (0.2-0.3)	0.2 (0.2-0.3)	0.6 (0.5-0.7)	0.6 (0.5-0.6)	32.7 (32.2-33.2)	32.0 (31.4-32.5)
All patients (104 976)	33.5 (33.2-33.8)	32.9 (32.6-33.2)	0.4 (0.4-0.5)	0.3 (0.3-0.4)	1.0 (1.0-1.1)	0.9 (0.9-1.0)	34.9 (34.7-35.2)	34.2 (33.9-34.4)

*Analysis is limited to Medicare patients with a single hospitalization who were discharged between April 1, 1998, and March 31, 1999. Weighted results reflect adjustment based on the state-specific sampling scheme. CI indicates confidence interval; n, number of patients; and AMI, acute myocardial infarction.
†Based on an analysis of Medicare Part B paid claims or documentation in the hospital medical record of prior immunization with the pneumococcal vaccine.
‡Based on hospital medical record abstraction and analysis of paid Medicare Part B claims.
§Based on an analysis of Medicare Part B paid claims for services provided within 30 days after patient discharge.
‖There were statistically significant differences across clinical topics in the proportion of patients immunized with the pneumococcal vaccine ($P<.001$).

COMMENT

Hospital-based vaccination of adults against influenza and pneumococcal disease has been recommended since the 1980s.[15,21-31] The ACIP continues to promote hospital-based vaccination of adults in its most recent recommendations for the prevention of influenza and pneumococcal disease.[2,3] The Infectious Diseases Society of America[4] and the American Thoracic Society[32] have endorsed this practice in recently published guidelines for the management of patients admitted with community-acquired pneumonia.

We demonstrated that a large proportion of Medicare inpatients admitted with common clinical conditions had not received influenza and pneumococcal vaccines prior to their stay and rarely received them in the hospital. Our linkage with Medicare claims data also suggests that patients not vaccinated prior to or during hospitalization are often not immunized in the short-term after discharge. Only 10.6% of the patients received influenza vaccine after discharge and 1.0% received pneumococcal vaccine in the month after discharge. A previous report indicated that screening of vaccination status was documented for only 13.3% of inpatients for influenza and only 8.5% of inpatients for pneumococcal vaccine.[8] This suggests that hospitalizations represent a missed opportunity for vaccination. Rates of hospital-based influenza and pneumococcal vaccination have changed very little since 1995.[16]

Consistent with the findings of other investigators,[1,2,6,16,33-35] we found substantial racial disparities in vaccination rates. African American, Native American, and Hawaiian native patients had the lowest rates of influenza vaccination in our study population and African American patients had the lowest rates of pneumococcal vaccination. These disparities largely reflect differences in ambulatory vaccination rates. Lack of access to primary care, limited awareness of need for vaccination, and misconceptions about vaccination have been implicated as possible reasons for racial disparity in immunization rates.[35-40] This suggests that hospitalization may be a particularly opportune time to vaccinate minority patients.

Several factors might explain the lack of effective hospital-based vaccination programs.[8,16] Skepticism about vac-

Table 4. Proportion of Medicare Inpatients Who Received Influenza Vaccination Before, During, or After Hospitalization by Age, Race, and Sex*

Characteristic (n)	Prior to Admission†		During Admission‡		After Discharge§		Total	
	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted‖ % (95% CI)	Weighted % (95% CI)
Age group, y								
65-69 (5399)	27.0 (25.9-28.2)	26.3 (25.1-27.5)	1.9 (1.6-2.3)	1.5 (1.2-1.9)	11.2 (10.4-12.1)	11.1 (10.3-12.0)	40.2 (38.9-41.5)	38.9 (37.6-40.2)
70-74 (7720)	31.8 (30.7-32.8)	32.0 (30.9-33.0)	1.8 (1.5-2.1)	1.5 (1.2-1.8)	12.0 (11.3-12.8)	11.3 (10.6-12.1)	45.6 (44.5-46.7)	44.8 (43.7-45.9)
75-79 (8854)	32.9 (31.9-33.9)	32.6 (31.7-33.6)	1.8 (1.5-2.1)	1.5 (1.3-1.8)	11.4 (10.7-12.0)	10.7 (10.1-11.4)	46.0 (44.9-47.0)	44.9 (43.8-45.9)
80-84 (8408)	34.6 (33.6-35.7)	33.5 (32.5-34.6)	2.0 (1.7-2.3)	1.8 (1.5-2.1)	10.3 (9.6-11.0)	9.5 (8.9-10.2)	46.9 (45.8-48.0)	44.8 (43.8-45.9)
≥85 (10 107)	30.1 (29.2-31.0)	29.7 (28.8-30.6)	1.9 (1.6-2.2)	1.5 (1.2-1.7)	8.9 (8.3-9.4)	8.4 (7.9-8.9)	40.9 (39.9-41.9)	39.6 (38.6-40.5)
Race								
White (35 108)	33.5 (33.0-34.0)	33.1 (32.6-33.6)	1.9 (1.7-2.0)	1.6 (1.4-1.7)	11.2 (10.8-11.5)	10.6 (10.2-10.9)	46.5 (46.0-47.1)	45.2 (44.7-45.7)
African American (3360)	16.2 (15.0-17.5)	17.3 (16.0-18.6)	1.6 (1.2-2.1)	1.7 (1.3-2.2)	7.0 (6.2-7.9)	7.0 (6.1-7.9)	24.9 (23.4-26.3)	25.9 (24.5-27.5)
Hispanic (1033)	22.1 (19.6-24.7)	21.4 (19.0-24.1)	1.1 (0.5-1.9)	0.5 (0.2-1.2)	9.1 (7.4-11.0)	8.2 (6.6-10.1)	32.2 (29.4-35.2)	30.2 (27.4-33.1)
Asian (537)	31.7 (27.7-35.8)	29.8 (25.9-33.8)	2.0 (1.0-3.6)	2.3 (1.2-4.0)	6.3 (4.4-8.7)	4.9 (3.2-7.0)	40.0 (35.9-44.3)	37.0 (32.9-41.2)
Native American (236)	12.3 (8.4-17.2)	15.9 (11.5-21.2)	8.9 (5.6-13.3)	5.2 (2.7-8.9)	2.5 (0.9-5.5)	3.9 (1.8-7.2)	23.7 (18.5-29.7)	25.0 (19.6-31.1)
Hawaiian native (57)	21.1 (11.4-33.9)	19.0 (9.9-31.6)	1.8 (0.0-9.4)	1.7 (0.0-9.2)	3.5 (0.4-12.1)	2.7 (0.2-10.9)	26.3 (15.5-39.7)	23.4 (13.2-36.5)
Other (157)	20.4 (14.4-27.5)	24.6 (18.1-32.1)	2.5 (0.7-6.4)	1.3 (0.2-4.6)	5.7 (2.7-10.6)	4.4 (1.8-8.9)	28.7 (21.7-36.4)	30.3 (23.2-38.1)
Sex								
Female (22 303)	30.7 (30.1-31.3)	30.0 (29.4-30.6)	1.8 (1.6-2.0)	1.6 (1.5-1.8)	10.3 (9.9-10.7)	9.9 (9.5-10.3)	42.8 (42.2-43.5)	41.5 (40.9-42.2)
Male (18 185)	32.7 (32.0-33.4)	32.5 (31.9-33.2)	1.9 (1.7-2.1)	1.4 (1.3-1.6)	11.0 (10.5-11.5)	10.3 (9.8-10.7)	45.6 (44.9-46.3)	44.2 (43.5-45.0)

*Analysis is limited to Medicare patients with a single hospitalization who were discharged between October 1 and December 31, 1998, with a principal diagnosis of acute myocardial infarction, heart failure, pneumonia, or stroke. Weighted results reflect adjustment based on the state-specific sampling scheme. CI indicates confidence interval.

†Based on an analysis of Medicare Part B paid claims or documentation in the hospital medical record of prior vaccination during the current influenza season.

‡Based on hospital medical record abstraction and analysis of paid Medicare Part B claims.

§Based on an analysis of Medicare Part B paid claims through January 31, 1999.

‖There were significant differences across age groups ($P<.001$), race ($P<.001$), and sex ($P<.001$) in the utilization of the influenza vaccine.

cine effectiveness may impact programs in any patient care setting. However, the effectiveness of the influenza vaccine is now largely unquestioned as having been shown to reduce hospitalizations for pneumonia and influenza, other respiratory conditions, and congestive heart failure, and to reduce mortality from all causes.[2,41-49] Influenza vaccine is immunogenic when administered to hospitalized patients and those with chronic renal disease.[50,51]

The efficacy of the pneumococcal vaccine in the elderly has been more controversial.[52] Numerous epidemiologic studies have demonstrated that pneumococcal vaccine is approximately 60% effective in preventing invasive disease (bacteremia and meningitis) due to *S pneumoniae*.[48,53-58] The effectiveness of vaccination in elderly patients or those who are chronically ill has been more difficult to demonstrate.[52,59-61] However, a recent retrospective cohort study of elderly patients with chronic lung disease showed pneumococcal vaccine to be associated with a 43% reduction in the number of hospitalizations for pneumonia and a 29% reduction in the risk of death from all causes.[62] Preliminary data from a large, prospective, population-based study of influenza and pneumococcal vaccines (the majority received both) in patients 65 years and older suggests marked reductions in the incidence of hospitalization for influenza, pneumonia, pneumococcal pneumonia, and death.[63] This is consistent with the findings of a managed care cohort study in the United States that demonstrated the additive benefit of receiving both vaccines.[64] Reports from multiple outbreak investigations,[65-67] and the emergence of antibiotic-resistant strains of *S pneumoniae* continue to support the need for pneumococcal vaccination in the elderly population.[68]

Both influenza and pneumococcal vaccinations have been shown to be cost-effective.[41,43,46,47,62,69] Medicare Part B pays for influenza and pneumococcal vaccines over and above the basic diagnosis related group payment for inpatient care.[58] A hospital can submit a roster bill to reduce the administrative burden of submitting individual claims for administered vaccinations.[70]

Although concern about adverse reactions is another reason cited for not vaccinating inpatients, serious adverse events are exceedingly rare.[2,3] The administration of the influenza vaccine is not associated with higher rates of systemic symptoms compared with placebo injections.[71,72] Redness and tenderness at the injection site may occur in 10% to 15% of patients being reimmunized with the pneumococcal vaccine.[73] These reactions are almost always mild and self-limited. Among large populations of Medicare patients, rates of hospitalization within 30 days of revaccination with pneumococcal vaccine are no higher than rates of admission for patients being vaccinated the first time.[74] In a meta-analysis of 9 randomized controlled trials of pneumococcal vaccine efficacy (including more than 7500 patients), there were no reports of severe febrile, anaphylactic, or neurologic complications.[60] Many hospital- and emergency department–based vaccination programs have been safely and effectively implemented with

Table 5. Proportion of Medicare Inpatients Who Received Pneumococcal Vaccination Before, During, or After Hospitalization by Age, Race, and Sex*

Characteristic (n)	Prior to Admission†		During Admission‡		After Discharge§		Total	
	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted % (95% CI)	Weighted % (95% CI)	Unweighted‖ % (95% CI)	Weighted % (95% CI)
Age group, y								
65-69 (14 485)	22.4 (21.7-23.1)	22.2 (21.5-22.9)	0.6 (0.5-0.7)	0.5 (0.4-0.7)	1.4 (1.2-1.6)	1.3 (1.1-1.5)	24.4 (23.7-25.1)	24.1 (23.4-24.8)
70-74 (20 365)	34.5 (33.8-35.1)	33.8 (33.2-34.5)	0.4 (0.3-0.5)	0.4 (0.3-0.5)	1.1 (1.0-1.3)	1.0 (0.9-1.2)	36.0 (35.4-36.7)	35.2 (34.6-35.9)
75-79 (23 015)	36.6 (35.9-37.2)	35.8 (35.2-36.4)	0.4 (0.3-0.4)	0.3 (0.3-0.4)	1.0 (0.9-1.1)	0.9 (0.7-1.0)	37.9 (37.3-38.5)	37.0 (36.4-37.6)
80-84 (21 693)	36.7 (36.1-37.4)	35.9 (35.3-36.5)	0.4 (0.3-0.5)	0.3 (0.2-0.3)	0.9 (0.8-1.0)	0.7 (0.6-0.8)	38.0 (37.3-38.6)	36.9 (36.2-37.5)
≥85 (25 418)	33.5 (33.0-34.1)	33.0 (32.4-33.5)	0.4 (0.4-0.5)	0.3 (0.2-0.4)	0.9 (0.8-1.0)	0.8 (0.7-0.9)	34.8 (34.3-35.4)	34.1 (33.5-34.7)
Race								
White (92 409)	35.3 (35.0-35.6)	35.0 (34.7-35.3)	0.4 (0.4-0.4)	0.3 (0.3-0.4)	1.1 (1.0-1.1)	0.9 (0.9-1.0)	36.8 (36.5-37.1)	36.2 (35.9-36.6)
African American (7995)	18.4 (17.6-19.3)	18.8 (17.9-19.6)	0.5 (0.4-0.7)	0.6 (0.4-0.7)	0.7 (0.5-0.9)	0.6 (0.4-0.8)	19.6 (18.7-20.5)	19.9 (19.0-20.8)
Hispanic (2409)	22.0 (20.4-23.8)	19.6 (18.1-21.3)	0.6 (0.3-1.0)	0.5 (0.3-0.9)	1.2 (0.8-1.7)	1.2 (0.8-1.7)	23.8 (22.1-25.5)	21.4 (19.7-23.1)
Asian (1132)	28.3 (25.7-31.0)	23.4 (20.9-25.9)	0.9 (0.4-1.6)	0.5 (0.2-1.2)	0.5 (0.2-1.2)	0.1 (0.0-0.6)	29.7 (27.0-32.4)	24.0 (21.6-26.6)
Native American (497)	20.7 (17.2-24.6)	23.7 (20.0-27.7)	2.2 (1.1-3.9)	1.2 (0.4-2.6)	0.4 (0.0-1.4)	0.2 (0.0-1.0)	23.3 (19.7-27.3)	25.0 (21.3-29.1)
Hawaiian native (146)	21.2 (14.9-28.8)	26.6 (19.7-34.6)	0.7 (0.0-3.8)	0.5 (0.0-3.4)	1.4 (0.2-4.9)	1.4 (0.2-4.9)	23.3 (16.7-31.0)	28.5 (21.3-36.5)
Other (388)	21.6 (17.7-26.1)	21.3 (17.3-25.7)	0.3 (0.0-1.4)	0.1 (0.0-1.1)	0.3 (0.0-1.4)	0.1 (0.0-1.1)	22.2 (18.1-26.6)	21.4 (17.4-25.8)
Sex								
Female (57 978)	33.4 (33.0-33.8)	32.7 (32.3-33.0)	0.4 (0.4-0.5)	0.4 (0.3-0.4)	0.9 (0.9-1.0)	0.8 (0.8-0.9)	34.7 (34.3-35.1)	33.8 (33.5-34.2)
Male (46 998)	33.7 (33.2-34.1)	33.2 (32.8-33.6)	0.4 (0.4-0.5)	0.3 (0.3-0.4)	1.1 (1.0-1.2)	1.0 (0.9-1.1)	35.2 (34.8-35.7)	34.5 (34.1-35.0)

*Analysis is limited to Medicare patients with a single hospitalization who were discharged between April 1, 1998, and March 31, 1999, with a principal diagnosis of acute myocardial infarction, heart failure, pneumonia, or stroke. Weighted results reflect adjustment based on the state-specific sampling scheme. CI indicates confidence interval.

†Based on an analysis of Medicare Part B paid claims or documentation in the hospital medical record of prior immunization with the pneumococcal vaccine.

‡Based on hospital medical record abstraction and analysis of paid Medicare Part B claims.

§Based on an analysis of Medicare Part B paid claims for services provided within 30 days after patient discharge.

‖There were significant differences across age groups ($P<.001$) and racial groups ($P<.001$) in the proportions of Medicare beneficiaries immunized with the pneumococcal vaccine. There was no significant difference in pneumococcal immunization rates based on sex ($P=.10$).

Table 6. Proportion of Medicare Inpatients With More Than 1 Admission Who Received Influenza or Pneumococcal Vaccination in the Hospital or in the Ambulatory Setting

Vaccine	No. of Patients	No. (%; 95% Confidence Interval)		
		Vaccinated in Hospital‡	Vaccinated as Outpatient§	Total
Influenza*	461	27 (5.9; 3.9-8.4)	189 (41.0; 36.5-45.6)	**216** (46.9; 42.2-51.5)
Pneumococcal†	2335	30 (1.3; 0.9-1.8)	910 (39.0; 37.0-41.0)	**940** (40.3; 38.3-42.3)

*Analysis is limited to Medicare patients who were discharged between October 1 and December 31, 1998.

†Analysis is limited to Medicare patients who were discharged between April 1, 1998, and March 31, 1999.

‡Based on hospital medical record abstraction and analysis of paid Medicare Part B claims.

§Based on an analysis of Medicare Part B paid claims or documentation in the hospital medical records of prior vaccination in the ambulatory setting. Analysis of the Medicare Part B claims included all services provided up to 30 days following the last discharge for the pneumococcal vaccine and through January 31, 1999, for the influenza vaccine.

no evidence of significant risk demonstrated in any of these studies.[75-85]

The lack of a systems-based approach might be the most important barrier to inpatient vaccination. A variety of approaches including systems based on nurse-, pharmacist-, or computer-driven reminders have shown varying success.[18,75-83] However, standing orders programs that authorize nurses or pharmacists to administer vaccinations according to an institution- or physician-approved protocol have achieved higher rates of immunization,[15] approaching 90% for influenza and 70% for pneumococcal vaccines.[82] The ACIP has recommended the use of standing orders programs to increase immunization rates in outpatient and inpatient settings.[2,3,15]

Our study has several limitations. Most important is that Medicare claims underestimate vaccination rates. In 1998, the estimated coverage of Medicare beneficiaries that was estimated from claims differed from that estimated by the BRFSS telephone survey by about 23% for both influenza and pneumococcal vaccines (CMS, unpublished data, February 2002). This underestimation may occur because of underascertainment of vaccination through paid Medicare claims (eg, mass vaccination clinics that do not submit Medicare claims) or due to overreporting of vaccination in the BRFSS telephone survey. In addition, data for pneumococcal vaccine claims are not available prior to 1991. This would affect our total pneumococcal vaccine coverage estimates for the oldest age group. Patients who may

have received the influenza or pneumococcal vaccines prior to their Medicare eligibility would not have been captured through analysis of paid claims. However, these limitations do not affect our evaluation of inpatient vaccination rates that were based predominantly on chart review. If we assume that our study population had rates of immunization equal to those reported by BRFSS,[1] then 13 402 patients discharged from the hospital from October 1, 1998, to December 31, 1998, never received the influenza vaccine during that flu season. Similarly, 48 184 patients were discharged from the hospital during the time frame studied and had never received the pneumococcal vaccine. These results, if extrapolated to the 12 683 000 discharges of patients 65 years and older from nonfederal acute care hospitals during 1999,[86] would suggest that millions of patients who have not received the influenza or pneumococcal vaccines are discharged from the hospital each year.

We were not able to account for contraindications to the administration of these vaccines or for patient refusal to be vaccinated. However, specific contraindications to these vaccines are uncommon,[2,3] and motivated providers can influence patients' attitudes about influenza and pneumococcal vaccination.[37,87] Our study did not include patients younger than 65 years. However, results of the 1997 National Health Interview Survey demonstrated that rates of vaccination for high-risk patients in this age group were lower than rates for patients 65 years and older.[15]

In summary, published recommendations for inpatient vaccination of adults against influenza and pneumococcal disease are not being followed for the majority of eligible patients admitted to hospitals. Failure to vaccinate these inpatients is a missed opportunity that places them at risk for preventable adverse events including morbidity, hospital readmission, and death associated with influenza and pneumococcal disease. Ensuring that hospital inpatients are screened for immunization status and vaccinated when appropriate will require the implementation of strategies such as those being used to prevent other forms of medical errors—systems-based approaches that provide for the routine delivery of these vaccines to patients at high risk for subsequent disease.

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