Hospital Readmissions Among Children With H1N1 Influenza Infection

abstract

OBJECTIVES: To describe readmissions among children hospitalized with H1N1 (influenza subtype, hemagglutinin1, neuraminidase 1) pandemic influenza and secondarily to determine the association of oseltamivir during index hospitalization with readmission.

METHODS: We reviewed data from 42 freestanding children's hospitals contributing to the Pediatric Health Information System from May through December 2009 when H1N1 was the predominant influenza strain. Children were divided into 2 groups by whether they experienced complications of influenza during index hospitalization. Primary outcome was readmission at 3, 7, and 30 days among both patient groups. Secondary outcome was the association of oseltamivir treatment with readmission.

RESULTS: The study included 8899 children; 6162 patients had uncomplicated index hospitalization, of whom 3808 (61.8%) received oseltamivir during hospitalization, and 2737 children had complicated influenza, of whom 1055 (38.5%) received oseltamivir. Median 3-, 7-, and 30-day readmission rates were 1.6%, 2.5%, and 4.7% for patients with uncomplicated index hospitalizations and 4.3%, 5.8%, and 10.3% among patients with complicated influenza. The 30-day readmission rates did not differ by treatment group among patients with uncomplicated influenza; however, patients with complicated index hospitalizations who received oseltamivir had lower all-cause 30-day readmissions than untreated patients. The most common causes of readmission were pneumonia and asthma exacerbations.

CONCLUSIONS: Oseltamivir use for hospitalized children did not decrease 30-day readmission rates in children after uncomplicated index hospitalization but was associated with a lower 30-day readmission rate among children with complicated infections during the 2009 H1N1 pandemic. Readmission rates for children who had complicated influenza infection during index hospitalizations are high.

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KEY WORDS

H1N1 influenza virus, antivirals, readmission, Pediatric Health Information System

ABBREVIATIONS

CCC: chronic comorbid condition
ESSENCE: Early Notification of Community-Based Epidemics
ICD-9CM: International Classification of Diseases, Ninth Revision, Clinical Modification
influenza H1N1: influenza subtype, hemagglutinin1, neuraminidase 1
IQR: interquartile range
LOS: length of stay

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The novel pandemic influenza A H1N1 virus (influenza subtype, hemagglutinin1, neuraminidase 1; hereafter referred to as H1N1), first appeared in the spring of 2009.[1–3] The resultant burden on emergency departments and inpatient wards stretched institutions caring for children.[4] Few data exist examining hospital readmission for children with H1N1 or influenza in general. Data regarding the use of oseltamivir, an inhibitor of the influenza enzyme neuraminidase,[5] have been conflicting with some studies showing shortened duration and severity of seasonal influenza infection in adults and children including patients with high-risk conditions.[6–16] However, 2 recent meta-analyses have suggested that although oseltamivir decreases the duration of symptoms or the time to first alleviation

of symptoms, it did not decrease the rate of provider-diagnosed pneumonia or hospitalization.[17,18] These new findings arise in part from the fact that 9 randomized controlled trials sponsored by manufacturers had not previously been published in full even though patients agreed to be subjects in a study of what was an experimental medication.[17] It is unknown whether oseltamivir may affect long-term complications such as superinfections and exacerbations of underlying conditions including asthma.[19–21]

Data on readmissions for children hospitalized with influenza are limited. Such data may be helpful in planning for future epidemics and pandemics. The primary objective of this study was to determine the rate of hospital readmission at 3-, 7-, and 30-day intervals after discharge among patients with complications of influenza during their index hospitalization and for children with uncomplicated index hospitalization. A secondary objective of this study was to determine the association between oseltamivir administration during the index hospitalization and readmission among children with complicated and uncomplicated influenza during the H1N1 pandemic. We hypothesized that hospitalized children treated with oseltamivir would experience fewer subsequent readmissions. Finally, we compared readmission rates between children with uncomplicated and complicated index influenza hospitalizations.

METHODS

Study Design and Data Source

Data for this multicenter retrospective cohort study were obtained from the Pediatric Health Information System, which contained demographic and resource-utilization data from 42 freestanding children's hospitals. Participating hospitals are located in noncompeting markets of 27 states plus the District of Columbia and account for 20% of all pediatric hospitalizations in the United States. Billing data include medications, radiologic imaging studies, laboratory tests, ICU charges, and diagnoses. Data are deidentified before inclusion in the database, but encrypted medical record numbers allow for tracking individual patients across admissions. The Children's Hospital Association (Overland Park, KS) and participating hospitals jointly ensure data quality as described previously.[22,23] In accordance with the Common Rule (45 CFR 46.102(f)) and the policies of Cincinnati Children's Hospital Medical Center Institutional Review Board, this research, using a deidentified data set, was not considered human subjects research.

Study Participants

Patients ≤18 years of age hospitalized with influenza between May 2 and December 11, 2009 (Morbidity and Mortality Weekly Report weeks 17–48) at participating hospitals were eligible for inclusion. Because oseltamivir was the predominant antiviral agent used during the H1N1 pandemic period (only 52 patients received antiviral agents other than oseltamivir), patients receiving other antiviral agents either alone or in combination with oseltamivir were excluded (Fig 1).

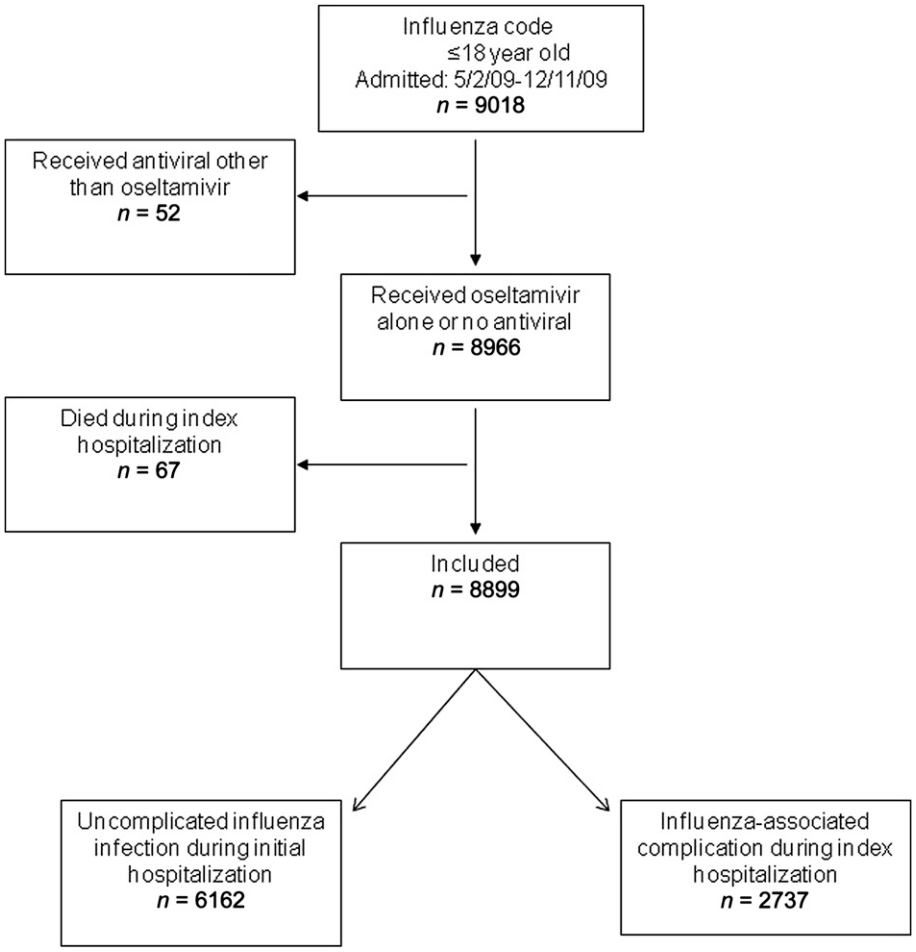

FIGURE 1 Flowchart of study cohort.

Study Definitions

Children with influenza were identified by the presence of an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM), discharge diagnosis code 487 (influenza) or 488 (influenza due to certain identified influenza viruses) in any discharge diagnosis field. To maximize the likelihood that only children with novel H1N1 were included, we defined our study period to coincide with the periods when novel H1N1 was the predominant circulating virus. Therefore, the start and end dates were chosen to include the first and last 2-week periods when at least 10% of surveillance samples tested positive for influenza viruses in the United States. World Health Organization–collaborating laboratories and the National Respiratory and Enteric Virus Surveillance System. The start date also coincided with the first week that 2009 Influenza A H1N1 was the predominant strain isolated in World Health Organization/National Respiratory and Enteric Virus Surveillance System laboratories.[24] During this period, ~1.0% of samples tested positive for seasonal influenza viruses, H3N2 seasonal influenza virus or influenza B.

A priori, through consensus of the study team of pediatric hospital medicine, critical care, infectious diseases, and emergency medicine physicians, we constructed 2 lists of diagnoses: complications of influenza and conditions precipitated by influenza (Appendix). Complications of influenza included conditions caused directly by the influenza virus (eg, encephalopathy) as well as illnesses that occurred as a result of preceding influenza infection (eg, bacterial pneumonia). Conditions precipitated by influenza included underlying diagnoses that were exacerbated by influenza infection (eg, asthma). To compile these 2 lists, the study team drew on several sources: the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE) II list of ICD-9-CM discharge diagnosis for influenza syndromic surveillance in the military, validated in the 2009 H1N1 influenza pandemic,[25–28] and pediatric-specific lists of influenza-related diagnoses, which remain unvalidated.[29–32] Chronic comorbid conditions (CCCs; eg, malignancy) were identified using a previously reported classification method.[33] For patients with multiple readmissions, only data from the index rehospitalization were included. However, patients with >1 ICD-9 code for the index readmission may have been coded as having both a condition precipitated by influenza and an influenza-related complication.

Main Outcome Measures

Patients were divided into 2 groups: those who had an uncomplicated index hospitalization and those who experienced an influenza-related complication or condition precipitated by influenza during their initial hospitalization. The primary outcomes were all-cause readmissions within 3, 7, and 30 days of the discharge from the index hospitalization as well as readmission within 3, 7, and 30 days with a complication of influenza or a condition precipitated by influenza. This time frame was chosen to identify short-term rehospitalizations as well as an extended period to identify complications that developed subsequent to the index visit. Secondary outcome was the association of oseltamivir treatment with readmission at 3, 7, and 30 days.

Statistical Analysis

Analyses were performed on each group separately, and then readmission rates were compared between the 2 groups. Variables were summarized using frequencies and percentages for categorical variables and median, interquartile range (IQR), and range values for continuous variables. Demographic characteristics and outcomes were compared by using χ^2 tests for categorical variables.

Bivariate analyses examined the association between treatment group and 30-day readmissions in the both study populations (patients with uncomplicated and complicated index hospitalizations), as well as in the following subgroups: those in the ICU during the index hospitalization, those with CCCs, those readmitted for a complication of influenza, and those readmitted for a condition precipitated by influenza. Multivariable logistic regression was performed to measure the association between treatment group and 3-, 7-, and 30-day readmission using primary readmission diagnosis, adjusting for gender, race, payor status, and age. To account for severity of illness, we adjusted for the presence of a CCC and for the LOS and requirement for ICU admission during the index hospitalization. Generalized estimating equations accounted for clustering of outcomes within hospitals. Odds ratios and 95% confidence intervals were reported to convey the magnitude and the precision of the estimate of effect. Analyses were performed by using SAS version 9.2 (SAS Institute, Cary, NC). A 2-tailed $P < .05$ was considered statistically significant.

RESULTS

During the study period, 8899 children were included in the analysis, of whom 6162 patients (69.2%) had no condition precipitated by influenza or influenza-related complications during index hospitalization.

Of the 6162 patients with uncomplicated influenza, 3808 (61.8%) received oseltamivir (Fig 1). The median age was 4.9 years (IQR 1.3–10.0 years). Statistically significant differences occurred by treatment group in race, payor status, presence of a (CCC), and age (Table 1). CCCs were more prevalent among children receiving oseltamivir; however, among individuals with CCCs only the presence of a hematologic/immunologic CCC was significantly greater in the oseltamivir group. The median index hospital LOS for all patients was 2 days (IQR 1–3 days) with no difference found by treatment group. For all patients, 9.4% were admitted to the ICU during the index hospitalization.

There were 2737 children with an influenza-related complications or conditions precipitated by influenza during the index hospitalization of whom 1055 patients (38.5%) received oseltamivir. Differences occurred by treatment groups in gender, race, payor status, presence of a CCC, age, and LOS (Table 1).

Table 2 shows readmission rates at 3-, 7-, and 30-day intervals for all children with influenza during index

TABLE 1 Characteristics of Patients Admitted to the Hospital Admitted With Uncomplicated or Complicated Influenza During Initial Hospitalization by Treatment Groups

	Uncomplicated Influenza				Complicated Influenza			
	Overall	Oseltamivir	No Oseltamivir	*P*	Overall	Oseltamivir	No Oseltamivir	*P*
	6162	3808 (61.80)	2354 (38.20)		2737	1055 (38.55)	1682 (61.45)	
Male gender, *n* (%)	3527 (57.24)	2172 (57.04)	1355 (57.56)	.686	1544 (56.41)	562 (53.27)	982 (58.38)	.009
Race, *n* (%)								
Non-Hispanic white	2041 (35.53)	1209 (34.06)	832 (37.92)	.001	980 (38.78)	419 (42.54)	561 (36.38)	<.001
Non-Hispanic black	1759 (30.62)	1079 (30.39)	680 (30.99)		595 (23.55)	239 (24.26)	356 (23.09)	
Hispanic	1561 (27.18)	1029 (28.99)	532 (24.25)		766 (30.31)	253 (25.69)	513 (33.27)	
Asian	149 (2.59)	94 (2.65)	55 (2.51)		72 (2.85)	22 (2.23)	50 (3.24)	
Other	234 (4.07)	139 (3.92)	95 (4.33)		114 (4.51)	52 (5.28)	62 (4.02)	
Payor, *n* (%)								
Government	3444 (73.65)	2177 (75.46)	1267 (70.74)	<.001	1495 (73.57)	545 (67.53)	950 (77.55)	<.001
Private	769 (16.45)	400 (13.86)	369 (20.60)		335 (16.49)	159 (19.7)	176 (14.37)	
Other	463 (9.90)	308 (10.68)	155 (8.65)		202 (9.94)	103 (12.76)	99 (8.08)	
Disposition, *n* (%)								
Home	5933 (96.28)	3676 (96.53)	2257 (95.88)	.507	74 (2.7)	26 (2.46)	48 (2.85)	.076
Other	145 (2.35)	82 (2.15)	63 (2.68)		2531 (92.47)	965 (91.47)	1566 (93.1)	
Home health services	67 (1.09)	41 (1.08)	26 (1.10)		90 (3.29)	46 (4.36)	44 (2.62)	
Skilled nursing facility	17 (0.28)	9 (0.24)	8 (0.34)		42 (1.53)	18 (1.71)	24 (1.43)	
Complex chronic condition, *n* (%)								
Any CCC	1888 (30.64)	1237 (32.48)	651 (27.66)	<.001	1035 (37.82)	371 (35.17)	664 (39.48)	.024
Neuromuscular	493 (8.00)	321 (8.43)	172 (7.31)	.114	230 (8.40)	90 (8.53)	140 (8.32)	.849
Hematologic/immunologic	446 (7.24)	306 (8.04)	140 (5.95)	.002	382 (13.96)	123 (11.66)	259 (15.4)	.006
Cardiovascular	318 (5.16)	211 (5.54)	107 (4.55)	.086	209 (7.64)	80 (7.58)	129 (7.67)	.934
Malignancy	302 (4.9)	182 (4.78)	120 (5.10)	.574	36 (1.32)	11 (1.04)	25 (1.49)	.321
Congenital or genetic	253 (4.11)	155 (4.07)	98 (4.16)	.859	21 (0.77)	10 (0.95)	11 (0.65)	.391
Respiratory	245 (3.98)	154 (4.04)	91 (3.87)	.728	114 (4.17)	29 (2.75)	85 (5.05)	.003
Metabolic	93 (1.51)	65 (1.71)	28 (1.19)	.105	70 (2.56)	24 (2.27)	46 (2.73)	.458
Gastrointestinal	61 (0.99)	41 (1.08)	20 (0.85)	.382	196 (7.16)	74 (7.01)	122 (7.25)	.813
Renal	37 (0.6)	28 (0.74)	9 (0.38)	.081	126 (4.6)	53 (5.02)	73 (4.34)	.406
Age, y, *n* (%)								
1–5	3499 (56.78)	2125 (55.8)	1374 (58.37)	.001	1506 (55.02)	620 (58.77)	886 (52.68)	.006
6–12	1743 (28.29)	1063 (27.91)	680 (28.89)		810 (29.59)	292 (27.68)	518 (30.8)	
13–18	920 (14.93)	620 (16.28)	300 (12.74)		421 (15.38)	143 (13.55)	278 (16.53)	
LOS, d, *n* (%)								
0–1	2019 (32.77)	1211 (31.8)	808 (34.32)	.189	390 (14.25)	174 (16.49)	216 (12.84)	.032
2–3	2732 (44.34)	1702 (44.7)	1030 (43.76)		877 (32.04)	331 (31.37)	546 (32.46)	
4–6	925 (15.01)	589 (15.47)	336 (14.27)		531 (19.4)	187 (17.73)	344 (20.45)	
≥7	486 (7.89)	306 (8.04)	180 (7.65)		939 (34.31)	363 (34.41)	576 (34.24)	

hospitalization. No differences in readmission rates at any of the measured time periods occurred between treatment groups of children with uncomplicated index hospitalizations. The all-cause readmission rates at 3, 7, and 30 days were 1.9%, 2.5%, and 4.7%, respectively. The 30-day readmission rate for patients admitted to the ICU during their index hospitalization was 3.1% and 7.5% for patients with underlying CCC (Table 2).

Readmission rates among patients with influenza-related complications or conditions precipitated by influenza at index hospitalization were high with all-cause readmission rates at 3, 7, and 30 days of 4.3%, 5.8%, and 10.2%, respectively (Table 2). The only difference between treatment groups for children with complications of influenza at index hospitalization was that there was a lower readmission rate at 30 days in children treated with oseltamivir for readmissions due to influenza-related complications and for patients who were admitted to the ICU during index hospitalization. The most common influenza-related complications resulting in readmission were primarily respiratory in nature, and the most common condition precipitated by influenza was asthma exacerbation (Table 3).

In the multivariable analysis, oseltamivir receipt was not associated with changes in 3-, 7-, or 30-day readmission in all children with initially uncomplicated influenza or in subgroups readmitted for influenza-related complications and condition precipitated by influenza (Table 4). However, among children who experienced complicated index hospitalizations, patients who received oseltamivir had a decreased rate of all-cause 3-, 7- and 30-day readmissions (Table 4). Readmissions due to influenza-related complications were lower at all 3 time points in children who received oseltamivir. The only difference by treatment group in children readmitted with conditions precipitated by influenza occurred at 3 days.

When adjusted for ICU admission during index hospitalization, gender, race, payor, age, LOS during index hospitalization, and the presence of a CCC patients with influenza-related complications or conditions precipitated by influenza had significantly lower all-cause readmission at 7 and 30 days compared with those with

TABLE 2 Readmission Rates of Patients With Uncomplicated or Complicated Influenza During Initial Hospitalization at 3, 7, and 30 Days by Treatment Groups

Readmissions	Uncomplicated Influenza, % Median (95% CI)				Complicated Influenza, % Median (95% CI)			
	Overall	Oseltamivir	No Oseltamivir	*P*	Overall	Oseltamivir	No Oseltamivir	*P*
3 d								
Any readmission	1.9 (1.6–2.3)	1.8 (1.4–2.2)	2.1 (1.6–2.8)	.308	4.3 (3.8–5)	4 (3.3–4.7)	5 (4–6.1)	.106
Influenza-related complications	0.4 (0.3–0.6)	0.4 (0.2–0.6)	0.5 (0.2–0.8)	.550	1.7 (1.4–2.2)	1.5 (1.1–2)	2.1 (1.5–2.9)	.145
Conditions precipitated by influenza	1.6 (1.3–2.0)	1.5 (1.2–2.0)	1.8 (1.3–2.4)	.430	2.4 (2–2.9)	2.2 (1.7–2.8)	2.9 (2.1–3.7)	.140
7 d								
Any readmission	2.5 (2.2–3.0)	2.4 (1.9–2.9)	2.8 (2.2–3.6)	.316	5.8 (5.1–6.5)	5.3 (4.6–6.2)	6.5 (5.4–7.8)	.098
Influenza-related complications	0.8 (0.6–1.1)	0.8 (0.6–1.2)	0.8 (0.5–1.3)	.977	2.4 (2–2.9)	2.2 (1.7–2.8)	2.8 (2.1–3.7)	.175
Conditions precipitated by influenza	2.0 (1.6–2.3)	1.9 (1.5–2.3)	2.1 (1.6–2.8)	.476	2.8 (2.4–3.3)	2.7 (2.1–3.3)	3.1 (2.3–4)	.412
30 d								
Any readmission								
Overall	4.7 (4.1–5.2)	4.5 (3.8–5.2)	4.9 (4.0–5.9)	.429	10.2 (9.4–11.1)	9.6 (8.6–10.7)	11.3 (9.9–12.9)	.066
ICU admission during index hospitalization	3.1 (1.8–4.9)	2.5 (1.1–4.7)	4.1 (1.8–7.6)	.284	15.7 (13.6–18)	14.8 (12.2–17.6)	17.4 (13.9–21.4)	.242
CCC	7.5 (6.3–8.7)	7.6 (6.2–9.2)	7.2 (5.4–9.5)	.766	19.8 (17.9–21.9)	20.3 (17.9–23)	18.9 (15.6–22.6)	.511
Influenza-related complication[a]								
Overall	2.4 (2.0–2.8)	2.3 (1.8–2.8)	2.6 (1.9–3.3)	.553	4.5 (3.9–5.1)	3.9 (3.2–4.6)	5.5 (4.5–6.7)	.008
ICU admission during index hospitalization	2.2 (1.2–3.8)	1.9 (0.8–4)	2.7 (1–5.8)	.537	4.9 (3.7–6.3)	3.4 (2.2–5)	7.5 (5.1–10.5)	.004
CCC	3.9 (3–4.8)	3.6 (2.6–4.7)	4.5 (3–6.3)	.555	6.6 (5.4–8)	6.1 (4.7–7.8)	7.6 (5.4–10.2)	.321
Conditions precipitated by influenza[a]								
Overall	3 (2.5–3.4)	2.9 (2.4–3.5)	3 (2.3–3.7)	.983	4.4 (3.9–5.1)	4.4 (3.7–5.2)	4.5 (3.5–5.5)	.946
ICU admission during index hospitalization	1.4 (0.6–2.7)	0.8 (0.2–2.4)	2.3 (0.7–5.2)	.262	2.4 (1.6–3.5)	2 (1.1–3.3)	3.1 (1.7–5.3)	.224
Chronic comorbid condition	3.8 (3–4.8)	4.2 (3.2–5.5)	3.1 (1.9–4.7)	.278	5.5 (4.4–6.7)	5.9 (4.5–7.6)	4.6 (2.9–6.8)	.283

CI, confidence interval.
[a] Data include patients who were readmitted with multiple diagnoses.

TABLE 3 30-Day Readmission Rates by Influenza-Related Complications and Conditions Precipitated by Influenza

Code	Diagnosis	*n*	%
Influenza-related			
486	Pneumonia, organism unspecified	41	19.2488
46619	Acute bronchiolitis due to other infectious organisms	13	6.1033
4829	Bacterial pneumonia, unspecified	13	6.1033
4878	Influenza with other manifestations	13	6.1033
78031	Febrile convulsions (simple), unspecified	13	6.1033
5119	Unspecified pleural effusion	12	5.6338
414	*Escherichia coli* infection in conditions classified elsewhere and of unspecified site	11	5.1643
51881	Acute respiratory failure	9	4.2254
46410	Acute tracheitis without mention of obstruction	8	3.7559
4644	Croup	7	3.2864
4111	Methicillin-susceptible *Staphylococcus aureus* in conditions classified elsewhere and of unspecified site	6	2.8169
4119	Bacterial infection due to other *Staphylococcus*	5	2.3474
4112	Methicillin-resistant *Staphylococcus aureus* in conditions classified elsewhere and of unspecified site	4	1.8779
413	*Klebsiella pneumoniae* infection in conditions classified elsewhere and of unspecified site	4	1.8779
417	*Pseudomonas* infection in conditions classified elsewhere and of unspecified site	4	1.8779
4830	Pneumonia due to *Mycoplasma* pneumoniae	4	1.8779
99591	Sepsis	4	1.8779
99592	Severe sepsis	4	1.8779
412	Pneumococcus infection in conditions classified elsewhere and of unspecified site	3	1.4085
46611	Acute bronchiolitis due to respiratory syncytial virus	3	1.4085
4940	Bronchiectasis without acute exacerbation	3	1.4085
4104	Bacterial infection due to *Streptococcus*, group D (*Enterococcus*)	2	0.939
481	Pneumococcal pneumonia (*Streptococcus pneumoniae* pneumonia)	2	0.939
48283	Pneumonia due to other Gram-negative bacteria	2	0.939
380	Streptococcal septicemia	1	0.4695
3819	Other staphylococcal septicemia	1	0.4695
389	Unspecified septicemia	1	0.4695
4100	Bacterial infection due to unspecified *Streptococcus*	1	0.4695
4109	Bacterial infection due to other *Streptococcus*	1	0.4695
4110	Bacterial infection due to unspecified *Staphylococcus*	1	0.4695
415	*Hemophilus influenzae* infection in conditions classified elsewhere and of unspecified site	1	0.4695
4181	Bacterial infection due to mycoplasma	1	0.4695
4185	Bacterial infection due to other Gram-negative organisms	1	0.4695
32082	Meningitis due to Gram-negative bacteria, not elsewhere classified	1	0.4695
32381	Other causes of encephalitis and encephalomyelitis	1	0.4695
34550	Localization-related (focal) (partial) epilepsy and epileptic syndromes with simple partial seizures, without mention of intractable epilepsy	1	0.4695
46411	Acute tracheitis with obstruction	1	0.4695
4660	Acute bronchitis	1	0.4695
4821	Pneumonia due to *Pseudomonas*	1	0.4695
48231	Pneumonia due to *Streptococcus*, group A	1	0.4695
48241	Methicillin susceptible pneumonia due to *Staphylococcus aureus*	1	0.4695
4848	Pneumonia in other infectious diseases classified elsewhere	1	0.4695
5109	Empyema without mention of fistula	1	0.4695
5121	Iatrogenic pneumothorax	1	0.4695
5130	Abscess of lung	1	0.4695
5184	Acute edema of lung, unspecified	1	0.4695
7291	Myalgia and myositis, unspecified	1	0.4695
Precipitated by influenza			
49390	Asthma, unspecified, unspecified	90	43.2692
49392	Asthma, unspecified, with (acute) exacerbation	40	19.2308
49300	Extrinsic asthma, unspecified	23	11.0577
49391	Asthma, unspecified, with status asthmaticus	23	11.0577
49302	Extrinsic asthma, with (acute) exacerbation	15	7.2115
78603	Apnea	9	4.3269
49301	Extrinsic asthma, with status asthmaticus	5	2.4038
78607	Wheezing	2	0.9615
49381	Exercise induced bronchospasm	1	0.4808

TABLE 4 Multivariable Analysis of the Association of Oseltamivir Receipt and Readmission

	Uncomplicated Influenza				Complicated Influenza			
	Unadjusted OR (95% CI)	*P*	Adjusted OR[a] (95% CI)	*P*	Unadjusted OR (95% CI)	*P*	Adjusted OR[a] (95% CI)	*P*
3 d								
Any readmission	1.41 (0.92–2.15)	.114	1.25 (0.82–1.88)	.289	0.60 (0.41–0.87)	.007	0.63 (0.45–0.87)	.006
Influenza-related complication	1.06 (0.33–3.33)	.921	1.04 (0.33–3.23)	.952	0.45 (0.27–0.74)	.002	0.48 (0.30–0.75)	.001
Conditions precipitated by influenza	1.42 (0.89–2.24)	.133	NE		0.65 (0.38–0.95)	.031	0.64 (0.41–0.97)	.037
7 d								
Any readmission	1.32 (0.90–1.94)	.153	1.23 (0.84–1.80)	.277	0.71 (0.50–1.01)	.062	0.72 (0.52–1.00)	.048
Influenza-related complication	0.87 (0.37–2.00)	.748	0.87 (0.35–2.10)	.753	0.61 (0.38–0.94)	.026	0.61 (0.41–0.92)	.018
Conditions precipitated by influenza	1.34 (0.90–2.01)	.142	1.23 (0.83–1.79)	.295	0.71 (0.46–1.11)	.134	0.74 (0.50–1.09)	.127
30 d								
Any readmission	1.14 (0.79–1.64)	.472	1.15 (0.80–1.64)	.444	0.75 (0.55–1.01)	.062	0.70 (0.53–0.91)	.007
Influenza-related complication	0.86 (0.51–1.45)	.583	0.92 (0.54–1.55)	.742	0.58 (0.38–0.88)	.011	0.54 (0.37–0.78)	<.001
Conditions precipitated by influenza	1.71 (0.79–3.68)	.172	NE		0.84 (0.61–1.14)	.265	0.80 (0.61–1.03)	.093

CI, confidence interval; NE, not estimable; OR, odds ratio.
[a] Adjusted for ICU admission during index hospitalization, gender, race, payor, age, LOS during index hospitalization, and the presence of any CCC.

uncomplicated index hospitalizations (Table 5). However, patients with complicated index hospitalizations had greater readmissions due to influenza-related complications and conditions precipitated by influenza at 3, 7, and 30 days.

DISCUSSION

In this study, children admitted with influenza were divided into 2 groups by whether they had complications of influenza during their index hospitalization. Children in the group with uncomplicated influenza had low rates of readmission, whereas those in the group with complications of influenza had a much higher rate or readmissions within 30 days. Among patients with uncomplicated influenza, 54.6% received oseltamivir during their index hospitalization, and only 38.5% of

TABLE 5 Comparison of Readmission Rates of Children With Influenza-Related Complications or Conditions Precipitated by Influenza During Index Hospitalization With Uncomplicated Influenza Infection at Index Hospitalization

Readmissions	Overall	Oseltamivir	No Oseltamivir
	OR (95% CI)	OR (95% CI)	OR (95% CI)
3 d			
Any readmission	0.8 (0.6–1.1)	0.7 (0.5–1.1)	0.9 (0.6–1.4)
Influenza-related complications	6.2 (3.1–12.1)***	5.2 (2–13.7)***	8.8 (3.2–24.6)***
Conditions precipitated by influenza	54.2 (13.1–225)***	23.1 (5.3–100.2)***	NE
7 d			
Any readmission	0.8 (0.6–1)*	0.8 (0.6–1.1)	0.8 (0.6–1.1)
Influenza-related complications	3.6 (2.2–5.8)***	2.9 (1.5–5.5)**	4.6 (2.2–9.7)***
Conditions precipitated by influenza	16.4 (7.5–36.2)***	13.7 (4.8–39.4)***	20.3 (6–68.8)***
30 d			
Any readmission	0.7 (0.6–0.9)***	0.8 (0.6–1)**	0.7 (0.6–1)*
Influenza-related complications	1.7 (1.2–2.2)***	1.3 (0.9–2)	2 (1.3–3.2)**
Conditions precipitated by influenza	6.6 (4.2–10.4)***	5.8 (3.2–10.4)***	7.6 (3.6–16)***

Adjusted for ICU admission during index hospitalization, gender, race, payor, age, LOS during index hospitalization, and the presence of any chronic comorbid condition. Overall models additionally adjusted for Oseltamivir receipt. CI, confidence interval; NE, not estimable; OR, odds ratio.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

children with complicated infections received oseltamivir. In this cohort of children hospitalized with influenza virus during the H1N1 pandemic and discharged without a complication of influenza during the index admission, there were no differences in the 3-, 7-, or 30-day adjusted readmission rates according to whether patients had received oseltamivir during index hospitalization. However, in the unadjusted analysis among patients who experienced a complication due to influenza during the index hospitalization, oseltamivir was associated with lower odds of patients with readmissions due to influenza-related complications and for those who experienced ICU admission at index hospitalization. In the adjusted analysis among children with complicated index influenza admissions 3-, 7-, and 30-day all-cause readmissions were lower than in patients who received oseltamivir compared with those not treated. When adjusted for demographic differences and severity of illness, all-cause readmissions were lower in the children who had complex index hospitalization compared with those with uncomplicated index infections but readmissions for influenza-related complications, and conditions precipitated by influenza were significantly higher in the group with complicated index admissions.

Hospital readmission is a complex process that depends on patient health status, hospital care, and factors external to the patient and quality of hospital care.[34] Readmissions after influenza infections have not been well described, although other complications of pandemic H1N1 influenza, such as asthma exacerbations, have been noted previously.[19,20,35] One study that evaluated readmission in children with complicated pneumonia found that children with influenza coinfection had longer LOS and a trend toward higher mortality, but a lower 14-day hospital readmission rate.[36] In this cohort, the most common influenza-related complications and conditions precipitated by influenza were respiratory in nature (infections and asthma, respectively). The 30-day readmission rate of 4.7% in children with uncomplicated index hospitalization accorded with the 30-day readmission rate in a large all-diagnosis cohort of patients discharged from children's hospitals in 24 American states (4.8%), suggesting no increase in disease burden in children after influenza infection during the H1N1 pandemic period compared with children hospitalized with other illnesses.[37] The 30-day readmission rate among patients with uncomplicated influenza was highest for children with underlying complex chronic condition, consistent with previous findings.[37,38] Patients who suffered a complication of influenza during the index hospitalization had a significantly higher unadjusted 30-day readmission rate (10.3%) for all-cause readmissions, as well as for influenza-related complications or conditions precipitated by influenza, than patients who had uncomplicated infections during index admission.

Surprisingly, in the adjusted analysis, all-cause 30-day readmission was lower in the group with complicated index influenza course than those with uncomplicated index hospitalization, even though readmissions were higher for influenza-related complications or conditions precipitated by influenza in the group with complicated influenza. These data may reflect the importance of underlying conditions in children who have complicated index influenza admissions. Furthermore, it appears that complications of influenza remain an ongoing concern in this population even after discharge.

The primary goal of therapy once infection is established should be minimizing the extent of disease and preventing disease complications. The efficacy of oseltamivir has been called into question in recent studies because of reporting bias.[17,18,35] The 2 recent meta-analyses of oseltamivir use in adults also noted bias due to suppression of data and showed oseltamivir decreased the duration of symptoms by <1 day but did not decrease hospitalizations or clinician-diagnosed pneumonias.[17,18] In children, oseltamivir appeared to decrease symptom duration but had no effect on hospitalizations.[18] In this study, oseltamivir use during the index hospitalization was not associated with subsequent change in 30-day readmissions in children with uncomplicated initial hospitalization, but in children with complicated initial hospitalization, odds of readmission were higher in untreated patients. However, a minority of children in the complicated group (38.5%) received oseltamivir in contrast to children with uncomplicated index course (54.6%). The Centers for Disease Control and Prevention did alter its guidelines in September 2009 (midway through our study period), although the recommendation to treat hospitalized children remained unchanged.[39] Still, it is unclear why the rate of administration in this group was low. It is possible that patients had longer duration of symptoms before admission and clinicians thought oseltamivir would be relatively ineffective, so they did not treat; however, we do not have data on duration of symptoms before admission. Because a minority of patients in the complicated

group received oseltamivir, treatment may have been a proxy for other differences in hospital care. Alternatively, the lower rates of readmissions among the children with complicated admission suggest oseltamivir may have a different effect on children with complicated influenza disease, influencing readmission rates. This finding needs to be repeated.

This study has several limitations. First, although there was no effect of oseltamivir in the patients with uncomplicated influenza, the effect size may be so small as to be undetectable. The diagnoses that we used to define complications of influenza were arrived at using the validated ESSENCE II list of ICD-9-CM list of discharge diagnoses used in the military for influenza surveillance and pediatric-specific lists that remain unvalidated but tried to use well-described complications of influenza.[40] Unmeasured confounding or residual confounding by indication for oseltamivir therapy may occur. We adjusted for several factors associated with greater severity of illness during the index hospitalization, including ICU admission and LOS during index hospitalization, to minimize the impact of such confounding. Furthermore, we did not control for timing of oseltamivir dose or for duration of illness before hospitalization or receipt of oseltamivir before admission.

Previous studies suggest that oseltamivir appears less effective at limiting influenza complications when given later in the infectious course.[7,19] We were unable to assess the duration of therapy in these patient. However, these data reflect care provided during the pandemic and so represent the effect of the common practice of treating with oseltamivir. Oseltamivir receipt could only be determined during the hospitalization, so patients who received a complete course of oseltamivir before or after their index hospitalization would have been classified as not having received oseltamivir. Our inability to account for prehospital oseltamivir would alter our assessment of the influence of oseltamivir in preventing H1N1 influenza-associated readmissions. Additionally, late administration of oseltamivir (ie, oseltamivir prescribed after discharge) may limit its ability to prevent long-term complications of H1N1. Such late prescribing would not meaningfully affect our study conclusions. Patients may have been started on oseltamivir before the results of the influenza test and then discharged before obtaining the result. This would bias the results toward null because this scenario would be more likely in uncomplicated patients with shorter LOS. Also, we could not determine whether patients received a full course of oseltamivir. Incomplete courses of oseltamivir would cause us to underestimate the potential benefit of oseltamivir. Although the positive predictive value of ICD-9-CM codes for seasonal influenza is high, ~88%,[32] the accuracy of ICD-9-CM codes for novel H1N1 influenza is not known. Additionally, although the ESSENCE II ICD-9-CM codes have been validated for H1N1 influenza, other codes used to identify influenza complications have not previously been validated. The resulting misclassification, although likely minimal, would bias our results toward finding no difference. We were unable to examine hospital course and thus identify possible premature discharge. However, the low rate of readmission within 3 days (2%) makes the possibility of early discharge relatively small. Finally, we could not be certain that readmissions were casually related to the initial H1N1 infection, and thus we may have overestimated readmissions for both treated and untreated patients.

CONCLUSIONS

Readmissions after discharge for uncomplicated influenza are relatively uncommon, whereas readmissions after complicated index hospitalization with influenza are significantly more frequent. Pneumonia/empyema, acute respiratory failure, sepsis, and asthma exacerbation account for most readmissions. Treatment with oseltamivir during the index hospitalization was not associated with fewer 30-day readmissions among those discharged with uncomplicated H1N1 influenza infection but appears to be associated with lower odds of readmission rates in children who experienced complications of influenza at initial hospitalization.

REFERENCES

1. Centers for Disease Control and Prevention. Swine influenza A (H1N1) infection in two children—Southern California, March–April 2009. *MMWR Morb Mortal Wkly Rep*. 2009;58(15):400–402. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm58d0421a1.htm. Accessed June 20, 2014.
2. Thompson WW, Shay DK, Weintraub E, et al. Influenza-associated hospitalizations in the United States. *JAMA*. 2004;292(11):1333–1340.
3. Jain S, Kamimoto L, Bramley AM, et al; 2009 Pandemic Influenza A (H1N1) Virus Hospitalizations Investigation Team. Hospitalized patients with 2009 H1N1 influenza in the United States, April–June 2009. *N Engl J Med*. 2009;361(20):1935–1944.
4. Sills MR, Hall M, Fieldston ES, et al. Inpatient capacity at children's hospitals during pandemic (H1N1) 2009 outbreak, United States. *Emerg Infect Dis*. 2011;17(9):1685–1691.
5. Dutkowski R, Thakrar B, Froehlich E, Suter P, Oo C, Ward P. Safety and pharmacology

of oseltamivir in clinical use. *Drug Saf*. 2003;26(11):787–801.

6. Treanor JJ, Hayden FG, Vrooman PS, et al; US Oral Neuraminidase Study Group. Efficacy and safety of the oral neuraminidase inhibitor oseltamivir in treating acute influenza: a randomized controlled trial. *JAMA*. 2000;283(8):1016–1024.
7. Falagas ME, Koletsi PK, Vouloumanou EK, Rafailidis PI, Kapaskelis AM, Rello J. Effectiveness and safety of neuraminidase inhibitors in reducing influenza complications: a meta-analysis of randomized controlled trials. *J Antimicrob Chemother*. 2010;65(7):1330–1346.
8. Nicholson KG, Aoki FY, Osterhaus AD, et al; Neuraminidase Inhibitor Flu Treatment Investigator Group. Efficacy and safety of oseltamivir in treatment of acute influenza: a randomised controlled trial. *Lancet*. 2000;355(9218):1845–1850.
9. Heinonen S, Silvennoinen H, Lehtinen P, et al. Early oseltamivir treatment of influenza in children 1-3 years of age: a randomized controlled trial. *Clin Infect Dis*. 2010;51(8):887–894.
10. Kaiser L, Wat C, Mills T, Mahoney P, Ward P, Hayden F. Impact of oseltamivir treatment on influenza-related lower respiratory tract complications and hospitalizations. *Arch Intern Med*. 2003;163(14):1667–1672.
11. McGeer A, Green KA, Plevneshi A, et al; Toronto Invasive Bacterial Diseases Network. Antiviral therapy and outcomes of influenza requiring hospitalization in Ontario, Canada. *Clin Infect Dis*. 2007;45 (12):1568–1575.
12. Johnston SL, Ferrero F, Garcia ML, Dutkowski R. Oral oseltamivir improves pulmonary function and reduces exacerbation frequency for influenza-infected children with asthma. *Pediatr Infect Dis J*. 2005;24(3):225–232.
13. Li IW, Hung IF, To KK, et al. The natural viral load profile of patients with pandemic 2009 influenza A (H1N1) and the effect of oseltamivir treatment. *Chest*. 2010;137(4):759–768.
14. Poeppl W, Hell M, Herkner H, et al. Clinical aspects of 2009 pandemic influenza A (H1N1) virus infection in Austria. *Infection*. 2011;39(4):341–352.
15. Viasus D, Paño-Pardo JR, Pachón J, et al; Novel Influenza A(H1N1) Study Group of the Spanish Network for Research in Infectious Diseases (REIPI). Timing of oseltamivir administration and outcomes in hospitalized adults with pandemic 2009 influenza A(H1N1) virus infection. *Chest*. 2011;140(4):1025–1032.
16. Viasus D, Paño-Pardo JR, Pachón J, et al; Novel Influenza A(H1N1) Study Group of the Spanish Network for Research in Infectious Diseases (REIPI). Pneumonia complicating pandemic (H1N1) 2009: risk factors, clinical features, and outcomes. *Medicine (Baltimore)*. 2011;90(5):328–336.
17. Ebell MH, Call M, Shinholser J. Effectiveness of oseltamivir in adults: a meta-analysis of published and unpublished clinical trials. *Fam Pract*. 2013;30(2):125–133.
18. Jefferson T, Jones MA, Doshi P, Del Mar CB, Hama R, Thompson MJ, Spencer EA, Onakpoya I, Mahatani KR, Nunan D, Howick J, Heneghan CJ. Neuramindase inhibitors for preventing and treating influenza in healthy adults and children. *Cochrane Database Syst Rev*. 2014;4:CD008965.
19. Launes C, García-García JJ, Jordán I, Martínez-Planas A, Selva L, Muñoz-Almagro C. 2009 Influenza A H1N1 infections: delays in starting treatment with oseltamivir were associated with a more severe disease. *Pediatr Infect Dis J*. 2011;30(7):622–625.
20. Yu H, Liao Q, Yuan Y, et al. Effectiveness of oseltamivir on disease progression and viral RNA shedding in patients with mild pandemic 2009 influenza A H1N1: opportunistic retrospective study of medical charts in China. *BMJ*. 2010;341:c4779.
21. Piedra PA, Schulman KL, Blumentals WA. Effects of oseltamivir on influenza-related complications in children with chronic medical conditions. *Pediatrics*. 2009;124(1):170–178.
22. Mongelluzzo J, Mohamad Z, Ten Have TR, Shah SS. Corticosteroids and mortality in children with bacterial meningitis. *JAMA*. 2008;299(17):2048–2055.
23. Shah SS, Hall M, Srivastava R, Subramony A, Levin JE. Intravenous immunoglobulin in children with streptococcal toxic shock syndrome. *Clin Infect Dis*. 2009;49(9):1369–1376.
24. Centers for Disease Control. Seasonal influenza. Available at: http://www.cdc.gov/flu/weekly/pastreports.htm. Accessed July 7, 2011.
25. Global Emerging Infections System. ESSENCE: Electronic Surveillance System for the Early Notification of Community-based Epidemics Available at: http://www.geis.fhp.osd.mil.offcampus.lib.washington.edu/GEIS/SurveillanceActivities/ESSENCE/ESSENCE.asp. Accessed July 7, 2011.
26. Lombardo JS, Burkom H, Pavlin J. ESSENCE II and the framework for evaluating syndromic surveillance systems. *MMWR Morb Mortal Wkly Rep*. 2004;53(suppl):159–165.
27. Marsden-Haug N, Foster VB, Gould PL, Elbert E, Wang H, Pavlin JA. Code-based syndromic surveillance for influenzalike illness by *International Classification of Diseases, Ninth Revision*. *Emerg Infect Dis*. 2007;13(2):207–216.
28. Schirmer P, Lucero C, Oda G, Lopez J, Holodniy M. Effective detection of the 2009 H1N1 influenza pandemic in U.S. Veterans Affairs medical centers using a national electronic biosurveillance system. *PLoS ONE*. 2010;5(3):e9533.
29. Chiu SS, Lau YL, Chan KH, Wong WH, Peiris JS. Influenza-related hospitalizations among children in Hong Kong. *N Engl J Med*. 2002;347(26):2097–2103.
30. Izurieta HS, Thompson WW, Kramarz P, et al. Influenza and the rates of hospitalization for respiratory disease among infants and young children. *N Engl J Med*. 2000;342(4):232–239.
31. Keren R, Wheeler A, Coffin SE, Zaoutis T, Hodinka R, Heydon K. ICD-9 codes for identifying influenza hospitalizations in children. *Emerg Infect Dis*. 2006;12(10):1603–1604.
32. O'Brien MA, Uyeki TM, Shay DK, et al. Incidence of outpatient visits and hospitalizations related to influenza in infants and young children. *Pediatrics*. 2004;113 (3 pt 1):585–593.
33. Feudtner C, Hays RM, Haynes G, Geyer JR, Neff JM, Koepsell TD. Deaths attributed to pediatric complex chronic conditions: national trends and implications for supportive care services. *Pediatrics*. 2001;107(6). Available at: www.pediatrics.org/cgi/content/full/107/6/E99.
34. Kangovi S, Grande D. Hospital readmissions—not just a measure of quality. *JAMA*. 2011; 306(16):1796–1797.

35. Embree J. Pandemic 2009 (A)H1N1 influenza (swine flu)—the Manitoba experience. *Biochem Cell Biol*. 2010;88(4):589–593.
36. Williams DJ, Hall M, Brogan TV, et al. Influenza coinfection and outcomes in children with complicated pneumonia. *Arch Pediatr Adolesc Med*. 2011;165(6):506–512.
37. Feudtner C, Pati S, Goodman DM, et al. State-level child health system performance and the likelihood of readmission to children's hospitals. *J Pediatr*. 2010;157(1):98–102, e1.
38. Chong CY, Tan NWH, Menon A, Thoon KC, Tee NW, Fu S. Risk factors for complicated influenza A (H1N1) 2009 Disease in children. *Ann Acad Med Singapore*. 2013;42(5):232–236.
39. Centers for Disease Control and Prevention. Updated interim recommendations for the use of antiviral medications in the treatment and prevention of influenza for the 2009–2010 season. Available at: http://www.cdc.gov/h1n1flu/recommendations.htm. Accessed May 10, 2014.
40. Dawood FS, Subbarao K, Fiore AE. Influenza viruses. In: Long SS, ed. *Principles and Practice of Pediatric Infectious Diseases*. 4th ed. Philadelphia: Elsevier Saunders; 2012:1149–1159.

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APPENDIX Complications of and Conditions Precipitated by Influenza

Influenza-related complications	
034	Streptococcal sore throat and scarlet fever
036	Diplococcal/meningococcal infections
038	Septicemia
041	Bacterial infection in conditions classified elsewhere
112.83	Candidal meningitis
320	Bacterial meningitis
321	Meningitis due to other organisms
322	Meningitis due to unspecified cause
422	Acute myocarditis
475	Peritonsillar abscess
481	Pneumococcal pneumonia
482	Other bacterial pneumonia
483	Pneumonia due to other specified organism
484	Pneumonia in infectious diseases classified elsewhere
485	Bronchopneumonia, organism unspecified
486	Pneumonia, organism unspecified
487.8	Influenza with other condition including encephalopathy
494	Bronchiectasis
510	Empyema
511	Pleurisy
512	Pneumothorax
513	Abscess of lung and mediastinum
518.4	Acute edema of the lung, unspecified
518.81	Acute respiratory failure
729.1	Myalgia and myositis, unspecified
780.31	Febrile seizure not otherwise specified
995.9	Systemic inflammatory response syndrome
Conditions precipitated by influenza	
493	Asthma
496	Chronic airway obstruction, not classified elsewhere
786.03	Apnea
786.07	Wheezing

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