Influenza antiviral treatment in spinal cord injury patients, 2007–2010

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Objective: This study assessed antiviral medication use for treatment of influenza-like illness (ILI) in Veterans with spinal cord injury or disorder (SCI/D) and examined whether antiviral prescribing improved over time.

Design: Retrospective cohort study of Department of Veterans Affairs (VA) facilities.

Participants: Veterans with SCI/D and matched non-SCI/D controls (matched by facility and date of visit/admission) who were diagnosed by a clinician with ILI during the period 1 October 2007 to 31 May 2010.

Main outcome measures: Antiviral receipt and appropriateness were examined. Appropriate antiviral prescribing was defined as patients who received an antiviral medication within 2 days of collection of a sample for diagnostic testing or within 2 days of symptom onset.

Results: We identified 101 influenza visits/admissions for veterans with SCI/D and 123 for controls. Antiviral prescribing for Veterans with SCI/D increased from 37.1% in 2007/2008 to 67.6% in 2009/2010 ($P = 0.01$) and appropriate antiviral prescribing increased from 20.0 to 41.2% ($P = 0.05$). Predictors of antiviral prescribing included being treated in the 2009/2010 influenza season (vs. 2007/2008) and having a cough. Fever, aches/myalgia, or a positive influenza test was associated with appropriate antiviral treatment. SCI/D was an independent predictor of receiving antiviral treatment (adjusted odds ratio = 1.16, 95% confidence interval 1.04–1.29), but having SCI/D was not associated with receiving appropriate treatment.

Conclusions: Influenza antiviral prescribing increased over time and in a larger proportion in veterans with SCI/D (vs. controls). This suggests that providers treating patients with SCI/D recognize treatment guidelines and their importance in a high-risk population. Continued efforts are needed to improve appropriate influenza antiviral prescribing.

Keywords: Influenza, Antivirals, Spinal cord injury, Appropriate prescribing

Introduction

The Centers for Disease Control and Prevention (CDC) have identified several high-risk groups for influenza and its complications; this includes persons with spinal cord injuries and disorders (SCI/D).¹ Persons with SCI/D are at increased risk of respiratory illness which is associated with increased morbidity and

mortality.^{2,3} Data from the Department of Veterans Affairs (VA) have shown that the annual rate of pneumonia and influenza in veterans with SCI/D is 30–35 annual outpatient visits per 1000 persons compared to the overall US population rate of 5.2–12.7 visits per 1000 persons.^{4–6} Persons with SCI are 37 times more likely to die from pneumonia and influenza than comparable individuals from the general population.⁷

The most effective method to prevent infection with influenza and its complications is annual influenza

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vaccination.^{8,9} The CDC recommends two antiviral medications, zanamivir and oseltamivir, as an adjunct to influenza vaccination due to their effectiveness for treatment of influenza and as a chemoprophylaxis after an exposure to influenza virus.¹⁰ In addition, antiviral treatment was recommended for all children and adults hospitalized with suspected or confirmed influenza during the 2009 influenza A (H1N1) pandemic.¹¹

The purpose of this study was to examine the use of antiviral medications to treat influenza infection or influenza-like illness (ILI) in veterans with SCI/D and assess whether antiviral prescribing has improved over a timeframe.

Methods

Study design and setting

A retrospective medical record review was conducted on the study sample of all visits and admissions associated with an influenza diagnosis and/or antiviral prescription that occurred at any of the 152 medical centers and their associated ambulatory or community-based outpatient clinics between 1 October 2007 and 31 May 2010. The study was approved by the local institutional review board. Two groups were identified: veterans with SCI/D and a comparison group of veterans who did not have SCI/D. The comparison group was included to determine whether antiviral prescribing practices differed for those in the SCI/D population compared to the general veteran population.

Data collection and data sources

The initial data for this cohort was obtained from the VA Medical SAS datasets. These are administrative databases including demographic and utilization data for all VA facilities and are updated nightly with patient medical record information from the local VA facility.^{12,13} The National Patient Care Database (NPCD) was used to identify all visits and admissions with a diagnosis of influenza using ICD9 codes 487 and 488 (codes 488.0 and 488.1 became effective from October 2009, the latter indicating “influenza due to identified H1N1 virus”) that occurred during the study timeframe.

The VHA Decision Support System was used to identify all outpatient and inpatient prescriptions for oseltamivir and zanamivir for each patient. Each prescription was associated with an outpatient visit (within 3 days of visit) or hospitalization. Once all visits and admissions with an influenza diagnosis and/or with an antiviral prescription were identified, a medical chart review was conducted to further define a clinical diagnosis of influenza and appropriateness of

treatment. The medical chart reviews were conducted by a qualified data abstractor who used a standardized data abstraction form to conduct the chart reviews. After identifying the sample with visits for influenza or antiviral prescriptions, a clinical diagnosis of influenza was defined as a patient with physician documentation in the medical record of influenza/ILI or positive rapid influenza cultures.

Study sample

Over 15 000 unique patients with SCI/D utilized VA facilities for any reason during the study time period and were eligible for inclusion. The sample was drawn based on having an influenza diagnosis and/or antiviral prescription during the study time period. The comparison group was a 1:1 matched sample of Veterans treated at VA facilities during the same timeframe who did not have SCI/D but also had a diagnosis of influenza and/or an antiviral prescription. The comparison group was matched by facility and date of visit/admission. For those who could not be matched by exact date, the timeframe was extended until a suitable match was achieved (maximum of 69 days from the encounter).

Measures

Demographics (age, ethnicity, sex), and comorbid diagnoses were extracted from the NPCD. Data collected from the medical chart review included a constellation of symptoms: the presence of and duration of fever (defined as temperature $>38.0^{\circ}\text{C}$), headache, sore throat, cough, myalgia, physical examination findings (i.e. signs of influenza), diagnostic testing, treatments during the encounter, vaccinations, and other complications. SCI/D characteristics were also collected including level of injury (paraplegia or tetraplegia), duration of injury, and ASIA impairment score which measures completeness of injury (A = complete, no motor or sensory function in the lowest sacral segment (S4–S5); B = incomplete, sensory function below neurologic level and in S4–S5, no motor function below neurologic level; C = incomplete, motor function is preserved below neurologic level and more than half of the key muscle groups below neurologic level have a muscle grade <3 ; D = incomplete, motor function is preserved below neurologic level and at least half of the key muscle groups below neurologic level have a muscle grade >3 ; E = normal).¹⁴

Appropriate antiviral prescribing was defined as patients who received an antiviral medication within 2 days of collection of a sample for diagnostic testing or within 2 days of symptom onset including: fever

(subjective and objective) and at least two additional symptoms including headache, sore throat, cough, or myalgia.¹⁵

Statistical analyses

The proportion of patients who received appropriate antiviral medications was calculated as the number of patients with appropriate antiviral treatment divided by the number of patients with a clinically or laboratory confirmed diagnosis of influenza. Antiviral treatment was described by SCI/D and non-SCI/D groups, demographics, SCI/D characteristics (age group, ethnicity, level of injury, traumatic vs. non-traumatic), and by the time periods. Matched analyses were conducted using McNemar's test. We compared the antiviral prescribing and appropriate prescribing by annual influenza season time periods (1 October 2007 to 30 September 2008, 1 October 2008 to 30 September 2009, and 1 October 2009 to 31 May 2010) using an overall test for trend. The last time period is shorter than the two previous time periods due to the availability of data at the time of analysis. Other factors associated with prescribing including time period, were included in GEE logistic regression models, accounting for clustering by facility for unmatched analyses. Some patients had more than one influenza encounter during the study timeframe; therefore, all analyses were conducted at the visit/admission level. For matched analyses, conditional logistic regression was used. All statistical analyses were considered statistically significant at the 0.05 level and performed using SAS version 9.2 (SAS Institute, Cary, NC, USA) and STATA SE version 11.0 (StataCorp LP, College Station, TX, USA).

Results

There were 176 visits/admissions for veterans with SCI/D identified with either a diagnosis of influenza or an antiviral prescribed during the study timeframe. A similar number of veterans without SCI/D were identified and matched to the SCI/D cohort. After excluding those that were admitted outside the study time period ($n = 3$), that had multiple sclerosis ($n = 21$), or had no indication of influenza or ILI but had been administered an influenza vaccine ($n = 51$), there were a total of 101 visits/admissions for 97 veterans with SCI/D with either an influenza diagnosis or suspected influenza. Similar exclusions were conducted with the comparison sample, resulting in 123 visits/admissions and 123 unique veterans without SCI/D. As a result, if part of a matched pair was excluded, the entire pair was removed for conditional

logistic regression, resulting in 82 matched pairs. All influenza visits/admissions included in the study occurred between October and April, except during the H1N1 pandemic where cases continued to occur between May and September 2009.

Table 1 describes the demographics and medical characteristics of the study sample at the visit/admission level. Veterans with SCI/D were primarily male and white, with a mean age of 54.7 years (median = 56.0). The majority had tetraplegia (61.4%) and of those with ASIA Impairment Scale (AIS) data, over one-third had a complete injury (AIS level A) (39.5%). However, ~25% of those with SCI were missing data on ASIA classification. Most encounters were outpatient visits and the majority of patients had been immunized against seasonal influenza. The SCI/D and control samples were similar across most of the patient and medical characteristics examined, with a few key exceptions. A statistically significant higher proportion of veterans with SCI/D were immunized against the H1N1 virus, had received the seasonal influenza vaccine, were diagnosed with pneumonia, and were admitted to the intensive care unit (ICU) compared to the control sample (Table 1).

Overall half (49.5%) of SCI/D patients in our sample received an antiviral during the study time period. Fig. 1 describes the percentage of influenza/ILI patient encounters with an antiviral prescribed or the percentage of prescribing that was appropriate. Antiviral prescribing for veterans with SCI/D increased from 37.1% in 2007/2008 to 67.6% in 2009/2010 (trend test $P = 0.01$) (Fig. 1). Appropriate antiviral prescribing increased from 20.0 to 41.2% (trend test $P = 0.05$). In addition, of the 50 patients with SCI/D who received an antiviral, the appropriateness of prescribing increased from 53.9 to 60.9%. Oseltamivir was prescribed in most instances (95.9%). Our matched comparison group had an even greater increase in antiviral prescribing between (17.4 and 58.5%, trend test $P \leq 0.0001$) and in the appropriateness of treatment (8.7 to 41.5%, trend test $P = 0.0005$). Reasons for inappropriate influenza antiviral prescribing included not having a fever and/or at least two of the symptoms (headache, sore throat, cough, or myalgia) (30% of all antiviral prescriptions) or having had influenza symptoms for more than 2 days (12% of all antiviral prescriptions).

Bivariate analyses of veterans with SCI/D, showed that patient and clinical factors associated with antiviral prescribing included: antiviral prescribing during the 2009/2010 influenza season, inpatient status, a diagnosis of pneumonia, having a cough, and having an abnormal chest X-ray (Table 2). Multivariable analyses

Table 1 Study sample characteristics

Demographic and medical characteristics	SCI Frequency (%) (N = 101)	Non-SCI Frequency (%) (N = 123)	Total Frequency (%) (N = 224)	McNemar's test P-value
Age (years)				
< 50	31 (30.7)	41 (33.3)	72 (32.1)	Reference
50–64	48 (47.5)	43 (35.0)	91 (40.6)	1.00
65 +	22 (21.8)	39 (31.7)	61 (27.3)	0.23
Mean, median (SD)	54.7, 56.0 (15.1)	56.7, 57.5 (15.7)	55.8, 57.0 (15.4)	0.35
Race				
White	73 (72.3)	82 (66.7)	155 (69.2)	Reference
Black	20 (19.8)	26 (21.1)	46 (20.5)	0.79
Other	8 (7.9)	15 (12.2)	23 (10.3)	0.77
Sex				
Male	93 (92.1)	109 (88.6)	202 (90.2)	Reference
Female	8 (7.9)	14 (11.4)	22 (9.8)	0.79
Smoking status				
Never smoked	33 (32.7)	45 (36.6)	78 (34.8)	Reference
Past smoker	36 (35.6)	40 (32.5)	76 (33.9)	1.00
Current smoker	32 (31.7)	38 (30.9)	70 (31.3)	0.27
Level				
Paraplegia	39 (38.6)			
Tetraplegia	62 (61.4)			
ASIA impairment level				
A	30 (29.7)			
B	12 (11.9)			
C	7 (6.9)			
D	27 (26.7)			
Missing	25 (24.8)			
Duration of injury				
< 10 years	26 (25.7)			
10–20 years	19 (18.8)			
> 20 years	30 (29.7)			
Missing	26 (25.8)			
Received seasonal influenza immunization	70 (70.0)	69 (59.5)	139 (62.1)	<0.01
Received H1N1 immunization	41 (44.1)	30 (27.8)	71 (31.7)	0.02
Inpatient encounter	26 (25.7)	21 (17.1)	47 (21.0)	0.11
Time period				
2007/2008*	35 (34.7)	46 (37.4)	81 (36.2)	Reference
2008/2009*	32 (31.7)	36 (29.3)	68 (30.4)	0.64
2009/2010†	34 (33.6)	41 (33.3)	75 (33.4)	0.79
Other documented respiratory diagnoses				
Upper respiratory infection	10 (9.9)	14 (11.4)	24 (10.7)	0.48
Bronchitis	2 (2.0)	1 (0.8)	3 (1.3)	1.00
Pneumonia	18 (17.8)	8 (6.5)	26 (11.6)	0.01
Reported symptoms				
Fever	61 (60.4)	86 (69.9)	147 (65.6)	0.08
Headache	23 (22.8)	28 (22.8)	51 (22.8)	0.35
Sore throat	29 (28.7)	32 (26.0)	61 (27.2)	0.73
Cough	65 (64.4)	92 (74.8)	157 (70.1)	0.19
Aches/myalgia	47 (46.5)	67 (54.5)	114 (50.9)	0.32
Confirmed flu case	64 (63.4)	90 (73.2)	154 (68.8)	0.30
Abnormal chest X-ray	21 (20.8)	24 (19.5)	45 (20.1)	0.50
Positive influenza culture	12 (36.4)	20 (45.5)	32 (41.6)	0.33
Severity measures				
Supplemental oxygen	16 (15.8)	7 (5.7)	23 (10.3)	0.15
Admitted to ICU	12 (11.9)	7 (5.7)	19 (8.5)	0.01
Ventilator support	5 (5.0)	3 (2.4)	8 (3.6)	1.00
Sepsis	6 (5.9)	4 (3.3)	10 (4.5)	1.00

*Time period is 1 October to 30 September.

†Time period is 1 October to 31 May.

Figure 1 Antiviral prescribing and appropriateness of prescribing in SCI/D and control group over time.

showed that a higher odds of antiviral prescribing was seen during the 2009/2010 influenza season (vs. 2007/2008 influenza season) and in those with a cough, after controlling for other factors (Table 2).

Table 3 describes patient and medical factors associated with appropriate antiviral prescribing in veterans with SCI/D. In bivariate analyses, having a fever, aches/myalgia, and/or having a positive influenza test were associated with receipt of appropriate antiviral treatment. Time period did not achieve statistical significance at the 0.05 level. After multivariable adjustment, the same factors were associated with appropriate prescribing (Table 3).

Characteristics associated with appropriate antiviral prescribing in multivariable analyses differed in the non-SCI control sample (not shown in table). Compared to those <50 years of age, the 50–64 age group were less likely to receive appropriate antiviral prescribing ($P = 0.006$). In addition, the later time period (2009/2010) was associated with a higher odds of receiving appropriate treatment ($P = 0.04$). Having a positive influenza test was also associated with appropriate antiviral prescribing ($P = 0.0004$) (not shown in table).

A conditional multiple logistic regression model including both the SCI/D and non-SCI/D control sample showed that having SCI/D was an independent predictor of receiving antiviral treatment (adjusted odds

ratio (OR) = 1.16, 95% confidence interval (CI) 1.04–1.29, $P = 0.008$) after controlling for age, race, other respiratory illness diagnoses, vaccination, symptoms, and testing. However, a similar conditional multiple logistic regression model found that SCI/D was not associated with receiving appropriate antiviral treatment (adjusted OR = 0.90, 95% CI 0.58–1.39, $P = 0.62$).

Discussion

Prescription of antivirals for treatment of influenza in Veterans with SCI/D has increased over the past few years (37.1% in 2007/2008 to 67.6% in 2009/2010). An earlier study showed that antiviral treatment was rarely used by practitioners treating patients with SCI/D, which may have been due to persons with SCI/D not contacting their practitioner in time for effective use of antivirals because of their limited mobility and/or due to late onset or lack of influenza symptoms.¹⁶ Furthermore, recent research found that among patient groups at high risk for influenza complications (including patients with disabilities and patients 65 years of age or older), self-reported ILI was greater but receipt of antiviral treatment was not, despite guidelines that recommend use in these cohorts.¹⁷ In this study, prescribing of antivirals was higher in those with SCI/D compared to the non-SCI/D control sample of Veterans; but still lower than what has been

Table 2 Factors associated with antiviral prescribing in Veterans with SCI (N = 101)

Demographic and medical characteristics	Antivirals prescribed		Unadjusted comparison OR (95% CI), P-value	Adjusted comparison OR (95% CI), P-value
	Yes Frequency (%) N = 50	No Frequency (%) N = 51		
Age				
<50	14 (28.0)	17 (33.3)	Reference	
50–64	22 (44.0)	26 (51.0)	1.03 (0.41–2.55), 0.95	
65 and older	14 (28.0)	8 (15.7)	2.13 (0.69–6.51), 0.18	
Race				
White	39 (78.0)	34 (66.7)	Reference	
Black	7 (14.0)	13 (25.5)	0.47 (0.17–1.31), 0.14	
Other	4 (8.0)	4 (7.8)	0.87 (0.20–3.75), 0.85	
Hispanic ethnicity	7 (14.0)	6 (11.8)	1.22 (0.38–3.93), 0.74	
Sex				
Male	45 (90.0)	48 (94.1)	Reference	
Female	5 (10.0)	3 (5.9)	1.78 (0.40–7.87), 0.44	
Smoking status				
Never smoked	15 (30.0)	17 (33.3)	Reference	
Past smoker	19 (38.0)	17 (33.3)	1.34 (0.52–3.46), 0.54	
Current smoker	16 (32.0)	16 (31.4)	1.20 (0.45–3.18), 0.71	
Level				
Paraplegia	23 (46.0)	16 (31.4)	Reference	
Tetraplegia	27 (54.0)	35 (68.6)	0.54 (0.24–1.21), 0.13	
ASIA impairment level				
A	13 (26.0)	17 (33.3)	Reference	
B	5 (10.0)	7 (13.7)	0.93 (0.24–3.62), 0.92	
C	5 (10.0)	2 (3.9)	3.27 (0.54–19.62), 0.18	
D	14 (28.0)	13 (25.5)	1.41 (0.50–4.00), 0.52	
Missing	13 (26.0)	12 (23.5)	1.41 (0.49–4.12), 0.52	
Duration of injury				
< 10 years	14 (28.0)	12 (23.5)	Reference	
10–20 years	10 (20.0)	9 (17.6)	0.95 (0.29–3.12), 0.94	
> 20 years	14 (28.0)	16 (31.4)	0.75 (0.26–2.15), 0.59	
Missing	12 (24.0)	14 (27.5)	0.73 (0.25–2.19), 0.58	
Received seasonal influenza immunization	35 (70.0)	35 (68.6)	1.07 (0.46–2.49), 0.88	
Received H1N1 immunization	18 (36.0)	23 (45.1)	0.68 (0.31–1.52), 0.35	
Inpatient status	19 (38.0)	7 (13.7)	3.85 (1.44–10.27), 0.01	1.26 (0.97–1.65), 0.08
Time period				
2007/2008*	13 (26.0)	22 (43.1)	Reference	Reference
2008/2009*	14 (28.0)	18 (35.3)	1.32 (0.49–3.50), 0.58	1.09 (0.88–1.35), 0.44
2009/2010†	23 (46.0)	11 (21.6)	3.54 (1.31–9.55), 0.01	1.29 (1.04–1.61), 0.02
Documented condition other than influenza				
Upper respiratory infection	8 (16.0)	2 (3.9)	4.67 (0.94–23.19), 0.05	
Bronchitis	1 (2.0)	1 (2.0)	1.02 (0.06–16.77), 0.99	
Pneumonia	13 (26.0)	5 (9.8)	3.23 (1.06–9.89), 0.03	0.98 (0.71–1.34), 0.88
Reported symptoms				
Fever	35 (70.0)	26 (51.0)	2.24 (0.99–5.08), 0.05	
Headache	10 (20.0)	13 (25.5)	0.73 (0.29–1.86), 0.51	
Sore throat	18 (36.0)	11 (21.6)	2.05 (0.85–4.94), 0.11	
Cough	39 (78.0)	26 (51.0)	3.41 (1.43–8.10), 0.01	1.23 (1.02–1.50), 0.03
Aches/myalgia	27 (54.0)	20 (39.2)	1.82 (0.83–4.01), 0.14	
Abnormal chest X-ray	16 (32.0)	5 (9.8)	4.32 (1.44–12.98), 0.01	1.12 (0.86–1.47), 0.41
Positive influenza culture	9 (18.0)	3 (5.9)	3.51 (0.89–13.84), 0.06	
Severity measure				
Admitted to ICU	8 (16.0)	4 (7.8)	2.24 (0.63–7.97), 0.21	
Supplemental oxygen	13 (26.0)	3 (5.9)	5.62 (1.49–21.18), 0.01	
Ventilator support	3 (6.0)	2 (3.9)	1.56 (0.25–9.78), 0.63	
Sepsis	3 (6.0)	3 (5.9)	1.02 (0.20–5.32), 0.98	

*Time period is 1 October to 30 September.

†Time period is 1 October to 31 May.

reported in the literature for the general patient population.¹⁸ However, the increase in use of antivirals overall as well as the onset of the H1N1 pandemic

suggests that providers treating patients with SCI/D are adhering more to the CDC recommendations for use of antivirals.¹⁰ In fact, the influenza season

Table 3 Factors associated with appropriateness of antiviral treatment in Veterans with SCI (N = 101)

Demographic and medical characteristics	Antiviral prescribed appropriately		Unadjusted comparison OR (95% CI), P-value	Adjusted comparison OR (95% CI), P-value
	Yes Frequency (%) N = 29	No Frequency (%) N = 72		
Age group				
< 50	11 (37.9)	20 (27.8)	Reference	
50–64	12 (41.4)	36 (50.0)	0.61 (0.23–1.62), 0.32	
65 and older	6 (20.7)	16 (22.2)	0.68 (0.21–2.25), 0.53	
Race				
White	20 (69.0)	53 (73.6)	Reference	
Black	6 (20.7)	14 (19.45)	1.14 (0.38–3.36), 0.82	
Other	3 (10.3)	5 (6.9)	1.59 (0.35–7.28), 0.55	
Hispanic ethnicity	4 (13.8)	9 (12.5)	1.12 (0.32–3.97), 0.86	
Sex				
Male	27 (93.1)	66 (91.7)	Reference	
Female	2 (6.9)	6 (8.3)	0.81 (0.15–4.29), 0.81	
Smoking status				
Never smoked	9 (31.0)	24 (33.3)	Reference	
Past smoker	11 (38.0)	25 (34.7)	1.17 (0.41–3.33), 0.76	
Current smoker	9 (31.0)	23 (32.0)	1.04 (0.35–3.09), 0.94	
Level				
Paraplegia	15 (51.7)	24 (33.3)	Reference	
Tetraplegia	14 (48.3)	48 (66.7)	0.47 (0.19–1.12), 0.09	
ASIA impairment level				
A	9 (31.0)	21 (29.2)	Reference	
B	4 (13.8)	8 (11.1)	1.17 (0.28–4.88), 0.83	
C	1 (3.5)	6 (8.3)	0.39 (0.04–3.71), 0.40	
D	6 (20.7)	21 (29.2)	0.67 (0.20–2.21), 0.51	
Missing	9 (31.0)	16 (22.2)	1.31 (0.42–4.06), 0.64	
Duration of injury				
< 10 years	5 (17.2)	21 (29.2)	Reference	
10–20 years	7 (24.1)	12 (16.7)	2.45 (0.64–9.44), 0.19	
> 20 years	10 (34.5)	20 (27.8)	2.10 (0.61–7.23), 0.24	
Missing	7 (24.2)	19 (26.3)	1.55 (0.42–5.70), 0.51	
Received seasonal influenza Immunization	22 (75.9)	48 (66.7)	1.57 (0.59–4.19), 0.37	
Received H1N1 immunization	12 (41.4)	29 (40.3)	1.05 (0.44–2.51), 0.92	
Inpatient status	8 (27.6)	18 (25.0)	1.14 (0.43–3.03), 0.79	
Time period				
2007/2008*	7 (24.1)	28 (38.9)	Reference	Reference
2008/2009*	8 (27.6)	24 (33.3)	1.33 (0.42–4.22), 0.62	1.10 (0.95–1.28), 0.20
2009/2010†	14 (48.3)	20 (27.8)	2.80 (0.96–8.19), 0.06	1.10 (0.92–1.32), 0.30
Other documented respiratory diagnoses				
Upper respiratory infection	5 (17.2)	5 (6.9)	2.79 (0.74–10.50), 0.12	
Bronchitis	1 (3.4)	1 (1.4)	2.54 (0.15–41.95), 0.50	
Pneumonia	6 (20.7)	12 (16.7)	1.30 (0.44–3.89), 0.63	
Reported symptoms				
Fever	27 (93.1)	34 (47.2)	15.09 (3.34–68.23), <0.01	1.38 (1.21–1.57), <0.01
Headache	8 (27.6)	15 (20.8)	1.45 (0.54–3.91), 0.46	
Sore throat	12 (41.4)	17 (23.6)	2.28 (0.91–5.72), 0.07	
Cough	23 (79.3)	42 (58.3)	2.74 (0.99–7.54), 0.05	
Aches/myalgia	20 (69.0)	27 (37.5)	3.70 (1.48–9.29), <0.01	1.26 (1.09–1.45), <0.01
Abnormal chest X-ray	7 (24.1)	14 (19.4)	1.32 (0.47–3.70), 0.60	
Positive influenza test	9 (31.0)	3 (4.2)	10.35 (2.56–41.90), <0.01	1.62 (1.22–2.14), <0.01
Severity measures				
Admitted to ICU	1 (3.4)	11 (15.3)	0.20 (0.02–1.61), 0.10	
Given supplemental oxygen	6 (20.7)	10 (13.9)	1.62 (0.53–4.95), 0.40	
Ventilator support	1 (3.4)	4 (5.6)	0.61 (0.07–5.68), 0.66	
Sepsis	1 (3.5)	5 (6.9)	0.47 (0.05–4.28), 0.50	

*Time period is 1 October to 30 September.

†Time period is 1 October to 31 May.

following the start of the H1N1 epidemic saw a 3.5 times increase in the odds of antiviral prescribing compared to the season prior to the H1N1 pandemic (2007/2008). Similar increases in antiviral prescribing during the pandemic season were shown in the CDC Emerging Infections Program data and in other literature.^{18–19}

The clinical factors associated with antiviral prescribing were not surprising. Factors included being an inpatient, having an abnormal chest X-ray, having a diagnosis of pneumonia, or a cough; although cough was the only variable to remain statistically significant in multivariable analyses. Similar clinical factors have been shown to be associated with antiviral prescribing in other studies and populations.^{13,18,20} The timing of administration can be a significant barrier to providing antivirals since it is recommended that treatment start within 48 hours of symptom development.²¹ In fact, we found a moderate increase in appropriateness of treatment in this population over time (20.0–41.2%), where in those who actually received an antiviral, a little over half were treated appropriately. A common reason for inappropriate use of an antiviral was that patients had experienced influenza symptoms for more than 2 days, similar to findings by Linder *et al.*¹⁵ However, the most frequent reason for inappropriate antiviral prescribing was that patients did not have a fever and/or at least two of other symptoms (headache, sore throat, cough, or myalgia). We hypothesize that reliance on symptom criteria may be a limitation in this patient population because weak respiratory muscles due to higher level injuries result in impaired cough.¹⁸ Patients with SCI/D may be less likely to present with cough as a result.²²

Study limitations

There are several limitations to this study including that it was retrospective review of medical datasets and records, which may have had incomplete or missing data for some characteristics. In addition, due to the rare use of influenza testing and the miscoding found for influenza or ILI diagnosis, this study may have underestimated the number of veterans with SCI/D who had influenza. However, we used a similar methodology to Linder *et al.*,¹⁵ using clinician documentation of influenza to identify the sample, potentially overestimating the number of true influenza cases. On the other hand, patients who did not visit a VA medical care facility or did not have severe illness would be undercounted in our sample.

In addition, we assessed data outside the traditional influenza season (after March/April) due to the unique timing of the H1N1 pandemic, which occurred

after traditional influenza season. However, we did find that all of our influenza cases occurred during the traditional influenza season (October to April) except during the H1N1 pandemic.

Although having a SCI/D (compared to not having SCI/D) was a significant predictor of receiving an antiviral, the appropriateness of treatment did not significantly differ between the two groups. This suggests that providers who treat patients with SCI/D recognize that they are an important at-risk patient population for influenza complications. Further efforts to work with providers as to when antiviral prescribing is appropriate are warranted, such as implementation of clinical reminders to guide appropriate treatment.²³ Appropriate treatment of patients with influenza depends on accurate and timely diagnosis; which could be improved through rapid influenza testing.²⁴ In addition, discussion as to whether cough is a valid symptom for influenza in SCI/D should also be considered.

Disclaimer statements

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Ethics approval This research was approved by the local Institution Review Board.

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