

## **Increasing Rate of Pneumonia Hospitalizations among Older American Indian and Alaska Native Adults**

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### **Abstract**

*Objective.* To examine rates and trends of pneumonia hospitalization among older American Indian and Alaska Native (AI/AN) adults. *Methods.* Pneumonia hospitalizations for older AI/AN adults  $\geq 65$  years of age living in the Alaska and Southwest Indian Health Service (IHS) regions during 1988 through 2002 from the IHS hospital discharge data were analyzed. *Results.* The average annual hospitalization rate for first-listed pneumonia for older AI/AN adults in both the Alaska and the Southwest regions has increased (15.3 and 23.0 in 1988-1990 to 25.9 and 28.8 in 2000-2002 per 1,000 population, respectively), with the greatest increase seen among older AI/AN adults in the Alaska region. For both regions, the hospitalization rate increased with increasing age. The proportion of pneumonia hospitalizations with the co-morbid conditions of chronic heart disease, chronic lung disease and diabetes mellitus in the Alaska and the Southwest regions increased from 48.8% and 30.8% in 1988-1990 to 65.4% and 40.7% in 2000-2002, respectively. *Conclusions.* The rate of pneumonia hospitalizations among older AI/AN adults in the Alaska and the Southwest regions has increased substantially; the 2000-2002 rate was similar to or slightly higher than those reported for the general older US population. This rate increase and the increasing prevalence of chronic co-morbid conditions indicate a need for prevention efforts and health interventions among older AI/AN adults.

**Keywords:** American Indians, hospitalization, epidemiology, adults, pneumonia

**Abbreviations:** AI/AN, American Indian and Alaska Native; IHS, Indian Health Service; RR, risk ratio; CI, confidence interval; LRTI, lower respiratory tract infection

Lower respiratory tract infections (LRTIs) are a leading cause of hospitalization among American Indians and Alaska Natives (AI/ANs) and the general United States population.<sup>1-4</sup> Several studies among children have demonstrated a higher rate of hospitalizations associated with LRTIs among AI/AN infants and children compared to those for infants and children in the general US population.<sup>2,4,5</sup> Among all Indian Health Service (IHS) regions examined, the regional rates for AI/AN children were highest in the IHS Southwest and Alaska regions.<sup>4</sup> Less is known about LRTI hospitalization rates among AI/ANs aged  $\geq 65$  years of age (older adults). A recent study reported that almost half of all infectious disease hospitalizations and more than 10% of all hospitalizations among AI/AN adults aged  $\geq 65$  years of age were associated with pneumonia,<sup>1</sup> and that the rates for LRTI hospitalizations among older AI/AN adults were highest in the Southwest and the Alaska regions.<sup>1</sup> In the general US population of adults  $\geq 65$  years of age, recent studies have described an increase in pneumonia hospitalizations from the 1980s into the 2000s.<sup>6-8</sup> Interestingly, the increase in pneumonia hospitalization rates among older adults in the general US population has coincided with the increasing prevalence of co-morbid conditions that predispose to pneumonia, including chronic cardiac disease, diabetes mellitus, and chronic pulmonary disease.<sup>6,7</sup> These conditions are common among AI/AN adults and the prevalence of co-morbid conditions, such as diabetes mellitus and coronary artery disease, appears to be increasing.<sup>9-11</sup>

In this study, we examined the rates and characteristics of pneumonia hospitalizations among AI/AN adults  $\geq 65$  years of age living in the Alaska and Southwest IHS regions who received medical care through the IHS. In addition, we compared our findings to those for the general US population of adults  $\geq 65$  years of age.

## Methods

Hospital discharge data for older AI/AN adults from the IHS Direct and Contract Health Service Inpatient Dataset for calendar years 1988 through 2002 were analyzed.<sup>12</sup> The dataset is maintained by IHS and consists of all patient discharge records from IHS- and tribally-operated hospitals and from hospitals that have contracted with IHS or tribes to provide health care services to federally recognized AI/AN adults within the United States.<sup>13</sup> The present study focuses on the Southwest and Alaska IHS regions and represents AI/AN adults  $\geq 65$  years of age who received health care through IHS- or tribally-operated health care facilities.<sup>13, 14</sup>

Indian Health Service hospital discharge records for older AI/AN adults living in the Alaska and the Southwest IHS regions with pneumonia listed

as any one of the six listed discharge diagnoses were selected as defined by the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) codes.<sup>15</sup> The ICD-9-CM codes 480-486 and 487.0 were used to define a pneumonia-associated hospitalization for this study.<sup>6,15</sup> Hospitalizations for both first-listed and any-listed diagnosis of pneumonia were examined. Unless otherwise stated, pneumonia hospitalizations refer to first-listed pneumonia hospitalizations. Since individual patients could not be identified, multiple admissions per patient could not be accounted for and the unit of analysis was a hospitalization.

Any- and first-listed pneumonia hospitalization rates for the Alaska and the Southwest IHS regions were examined by age group (65-74, 75-84, and  $\geq 85$  years), gender, and time periods (1988-1990 and 2000-2002). All-cause (excluding those with any-listed pneumonia diagnosis) hospitalization rates were also examined for comparison. IHS regions were defined using the IHS Administrative Areas as follows: Alaska (Alaska), and Southwest (Albuquerque, Navajo, Phoenix, and Tucson).<sup>16</sup> The proportion of in-hospital fatalities, month of admission and length of stay were also examined.

Annual hospitalization rates with 95% confidence intervals (CIs) were calculated and expressed as the number of hospitalizations per 1,000 older AI/AN adults. Annual hospital fatality rates were also calculated and expressed as the number of hospital deaths per 100 hospitalizations. The population denominator for IHS hospitalization rates was determined for each year and region by using the IHS fiscal year 2005 user population estimates and adjusting retrospectively for annual changes in the IHS service population.<sup>13,14</sup> The user population includes all registered AI/AN adults who received IHS-funded health care service at least once during the most recent 3 years.<sup>13</sup> The service population is an estimate of AI/AN adults eligible for IHS-funded health care.

Comparisons of hospitalization rates by time period (1988-1990 versus 2000-2002) and characteristics for the most recent period were made by using risk ratios (RRs) with 95% CIs.<sup>17</sup> Pneumonia hospitalization rates for older AI/AN adults were also compared with those previously published for the general older US adult population that were based on analysis of the National Hospital Discharge Survey.<sup>6</sup> The National Hospital Discharge Survey does not include federally-funded hospital discharge data, such as the Indian Health Service/tribal inpatient data.

Other discharge diagnoses listed with a first-listed pneumonia diagnosis among hospitalizations for older AI/AN adults were examined. We limited our analysis to 4 co-morbid conditions that are common among the general U.S. population of persons  $\geq 65$  years of age, and that are associated with an increased risk of pneumonia: chronic cardiac disease, chronic pulmonary disease, diabetes mellitus, and neuro/musculoskeletal disorders.<sup>6</sup> The diag-

noses were classified into the following categories: chronic cardiac disease (ICD-9-CM codes 093, 391-398, 402, 404, 410-414, 416, 417, 421, 423-425, 427.1-427.5, 427.8, 428, 429, 440, 466, 745-747, V421, V450, V458.1, V458.2, 130.3, 112.81), chronic pulmonary disease (ICD-9-CM codes 011, 012, 0310, 135, 277.0, 277.6, 491-496, 500-506, 507.0, 507.1, 508, 510, 513-519, 748.4-748.6, 7593, 770.2, 770.7, V426), diabetes mellitus (ICD-9-CM codes 250, 251, 648.0, 357.2, 362.0, 362.11, 366.11), neuro/musculoskeletal (ICD-9-CM codes 290, 294.1, 318.1, 318.2, 330, 331, 333.0, 333.4-333.9, 334, 335, 340-343, 344.0, 358.0, 358.1, 359.1, 359.2, 438, 756.4).

## Results

### *Characteristics and Trends*

During the 15-year study period, the rate of hospitalization for first-listed and any-listed pneumonia increased among older AI/AN adults in the Alaska region and the Southwest region (Table 1, Figure 1). By region, 8.5% and 13.1% of all hospitalizations among older adults in the Alaska region and 12.5% and 16.4% among older adults in the Southwest region were first-listed and any-listed pneumonia hospitalizations, respectively. The proportion of all hospitalizations with either first-listed or any-listed pneumonia increased in both regions during the study period, and was higher in both regions than that reported for the general older adult US population for 1988-2002 (first-listed pneumonia 5.8%; any-listed pneumonia 9.1%).<sup>6</sup>

Although the average annual hospitalization rates for older adults with first-listed and any-listed pneumonia increased in both regions from 1988-1990 to 2000-2002, there were differences in the trends over time and the rates of pneumonia hospitalization between the Alaska and the Southwest regions (Table 1). The proportional increase in rates from 1988-1990 to 2000-2002 was highest in the Alaska region and was noted in each of the age subgroups. The rate for all hospitalizations (excluding any-listed pneumonia) also increased in the Alaska region within each age subgroup. In contrast, the rates of pneumonia hospitalization increased for older adults in the Southwest region from 1988-1990 to 2000-2002, while all-cause hospitalization rates did not increase. During 2000-2002, the rates of first-listed and any-listed pneumonia and all-cause hospitalization were much higher among persons  $\geq 85$  years of age in the Southwest region compared to this age group in the Alaska region. However, among the younger age groups, those 65-74 and 75-84 years of age, all-cause and any-listed pneumonia hospitalizations were higher in the Alaska region compared to those in the Southwest region.

For 2000-2002, the rates of hospitalization for the Alaska and the Southwest regions (Table 1) were slightly higher than those reported for the gen-

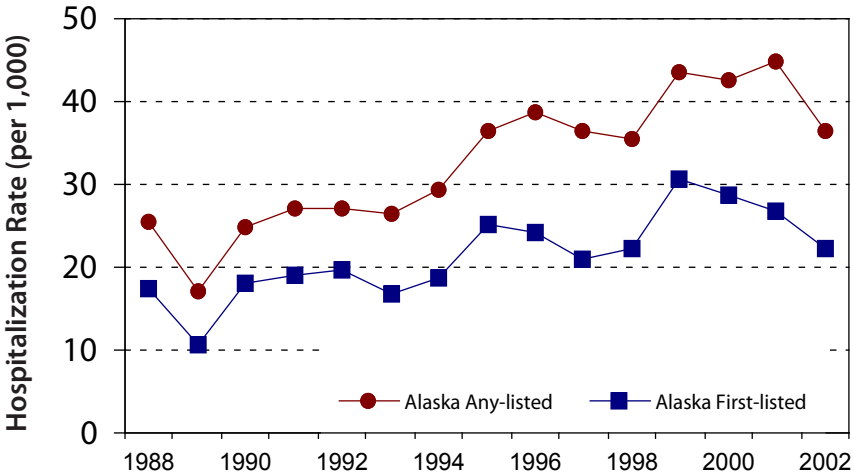
**Table 1. Rates of hospitalizations with first- and any-listed pneumonia and for all-causes (without first-listed pneumonia) by age group among American Indians and Alaska Natives ≥65 years of age in the Alaska and Southwest regions, IHS, 1988-1990 and 2000-2002.**

Region / Age group	1988-1990		2000-2002		% Rate Change 1988-1990 vs 2000-2002*	1988-1990/2000-2002 RR (95% CI)
	No.	Rate/1000 (95% CI)	No.	Rate/ 1000 (95% CI)		
<b>1st listed pneumonia hospitalizations§</b>						
<b>Alaska</b>	250	15.3 (13.5- 17.4)	552	25.9 (23.8- 28.1)	69.3 <sup>2</sup>	1.69 (1.45-1.95)
Age group						
65 – 74 Years	95	9.7 (7.9-11.9)	215	16.9 (14.7-19.3)	74.2 <sup>1</sup>	1.73 (1.37-2.20)
75 – 84 Years	116	22.6 (18.8-27.1)	238	35.5 (31.2-40.2)	57.1 <sup>2</sup>	1.57 (1.26-1.96)
≥85 Years	39	23.0 (16.6-31.7)	99	44.8 (36.8-54.5)	94.8 <sup>1</sup>	1.95 (1.35-2.80)
<b>Southwest</b>	1487	23.0 (21.9- 24.2)	2363	28.8 (27.7-30.0)	25.2 <sup>2</sup>	1.25 (1.18-1.33)
Age group						
65 – 74 Years	445	12.1 (11.0-13.3)	804	16.2 (15.1-17.4)	33.9 <sup>1</sup>	1.34 (1.19-1.50)
75 – 84 Years	619	33.3 (30.8-36.0)	878	35.2 (32.9-37.5)	5.7	1.06 (0.95-1.17)
≥85 Years	423	54.1 (49.2-59.4)	681	65.1 (60.5-70.0)	20.3 <sup>1</sup>	1.20 (1.07-1.35)
<b>Any-listed pneumonia hospitalizations§</b>						
<b>Alaska</b>	366	22.5 (20.3-24.9)	880	41.3 (38.6-44.0)	83.6 <sup>3</sup>	1.84 (1.63-2.07)
Age group						
65 – 74 Years	152	15.6 (13.3-18.3)	363	28.5 (25.7-31.6)	82.7 <sup>2</sup>	1.83 (1.52-2.20)
75 – 84 Years	163	31.7 (27.2-37.0)	368	54.8 (49.6-60.6)	72.9 <sup>3</sup>	1.73 (1.44-2.07)
≥85 Years	51	30.1 (22.7-39.7)	149	67.5 (57.5-79.0)	124.3 <sup>3</sup>	2.24 (1.64-3.05)
<b>Southwest</b>	1957	30.3 (29.0-31.7)	3115	38.0 (36.7-39.4)	25.4 <sup>2</sup>	1.25 (1.19-1.33)
Age group						
65 – 74 Years	596	16.2 (15.0-17.6)	1094	22.0 (20.8-23.4)	35.8 <sup>1</sup>	1.29 (1.23-1.50)
75 – 84 Years	811	43.6 (40.8-46.7)	1133	45.4 (42.8-48.1)	4.1	1.04 (0.95-1.14)
≥85 Years	550	70.3 (64.8-76.3)	888	84.9 (79.7-90.4)	20.8 <sup>1</sup>	1.21 (1.09-1.34)
<b>All-cause hospitalizations†</b>						
<b>Alaska</b>	3297	198.7 (192.7-204.3)	6044	279.0 (273.0-285.0)	40.4 <sup>3</sup>	1.40 (1.35-1.46)
Age group						
65 – 74 Years	1782	182.6 (175.0-190.4)	3110	244.0 (236.6-251.6)	33.6 <sup>3</sup>	1.34 (1.26-1.42)
75 – 84 Years	1204	234.3 (222.9-246.2)	2187	325.9 (314.6-337.2)	39.1 <sup>3</sup>	1.39 (1.30-1.49)
≥85 Years	311	183.6 (165.6-203.0)	747	338.3 (318.4-358.3)	64.3 <sup>3</sup>	1.84 (1.62-2.01)
<b>Southwest</b>	14149	224.2 (221.0-227.5)	18613	218.9 (216.1-221.7)	-2.4	0.98 (0.96-1.00)
Age group						
65 – 74 Years	6502	177.2 (173.3-181.1)	8962	180.6 (177.3-184.1)	1.9	1.02 (0.99-1.05)
75 – 84 Years	5268	283.4 (276.9-289.9)	6281	251.6 (246.2-257.0)	-11.2 <sup>1</sup>	0.89 (0.86-0.92)
≥85 Years	2379	304.2 (293.9-314.4)	3370	322.2 (313.2-331.2)	5.9	1.06 (1.01-1.12)

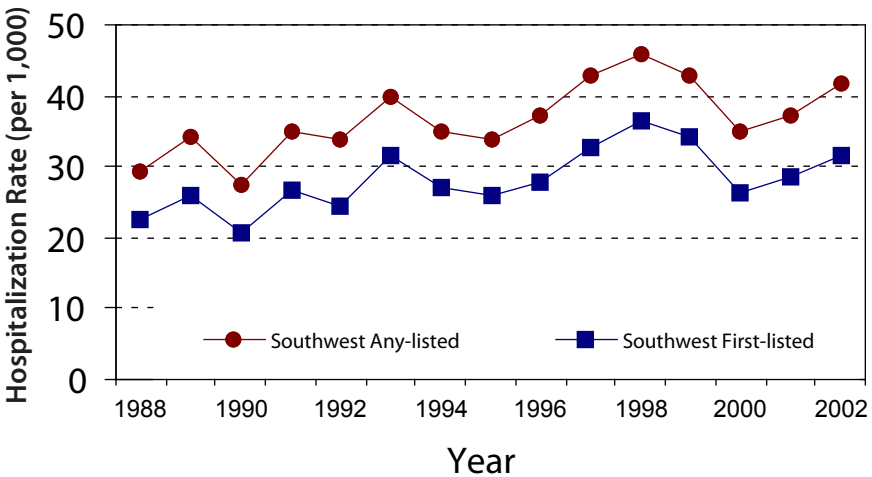
Comparing rates from 2000-2002 to 1988-1990: \* 0.01 < p < 0.05, † 0.001 < p < 0.01, ‡ p < 0.001. § Rates for US older adults from a previously published report are as follows.¶ The first-listed pneumonia hospitalization rate (per 1000 population) was 22 (22-23) for those ≥65 years of age and 12 (11-13), 26 (24-28), 51 (46-55) for the three age groups, respectively. The any-listed pneumonia hospitalization rate (per 1000 population) was 35 (33-37) for those ≥65 years of age and 20 (19-21), 41 (38-44), 82 (75-88) for the three age groups, respectively. † Excludes hospitalizations with any-listed pneumonia diagnosis.

**Figure 1. Hospitalization rates for first-listed and any-listed pneumonia among American Indians and Alaska Natives ≥65 years of age in the Alaska and the Southwest regions, IHS, 1988-2002.**

### A. Alaska



### B. Southwest



eral US population of older adults (first- and any-listed pneumonia hospitalization rates were 22 [95% CI=20-23] and 35 [95% CI=33-37] per 1,000 older US adults in 2000-2002, respectively).<sup>6</sup> Also, the rate increase for AI/AN adults aged  $\geq 85$  years of age was much higher than that noted in the general US population, where first listed and any-listed pneumonia rates increased by 4% (95% CI: 0%-20%) and 12% (95% CI: 0%-27%).<sup>6</sup>

The rate increase from 1988-1990 to 2000-2002 for first-listed pneumonia was seen among both males and females (17.2 to 25.9, RR=1.50, 95% CI=1.22-1.86) and 13.8 to 25.9, RR=1.88, 95% CI=1.53-2.30 respectively) in the Alaska region, but was only seen among females in the Southwest region (males 28.1 to 28.8, RR=1.03, 95% CI=0.93-1.13; and females 20.0 to 28.3, RR=1.41, 95% CI=1.29-1.54) (Table 1). During 2000-2002, the first- and any-listed pneumonia hospitalization rates for older AI/AN males and females were similar by region.

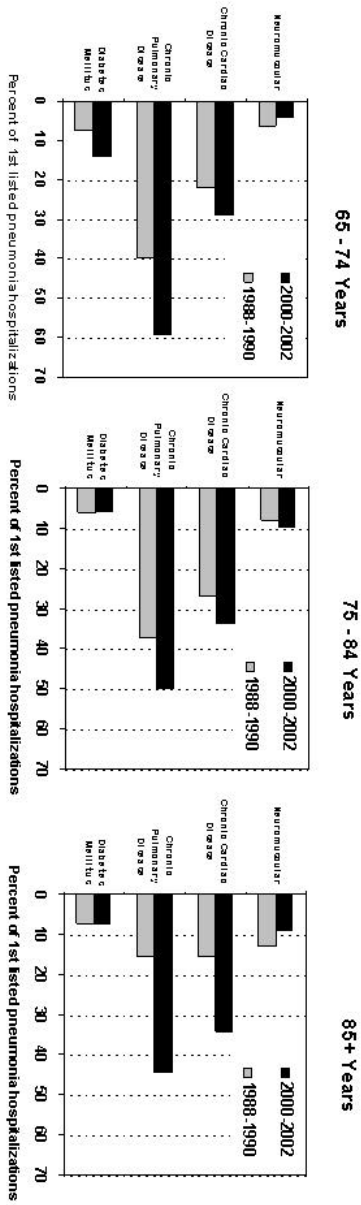
In the Alaska region, there was no substantial seasonal variation seen in the admission month for first-listed or any-listed pneumonia hospitalizations. The first-listed pneumonia hospitalization admissions appeared only slightly more frequent in the winter compared to the summer months in the Alaska region. A pronounced seasonal variation for first-listed and any-listed pneumonia hospital admissions was seen in the Southwest region, where almost one-half of the admissions occurred during December through March with the peak in January.

### ***Co-morbid conditions***

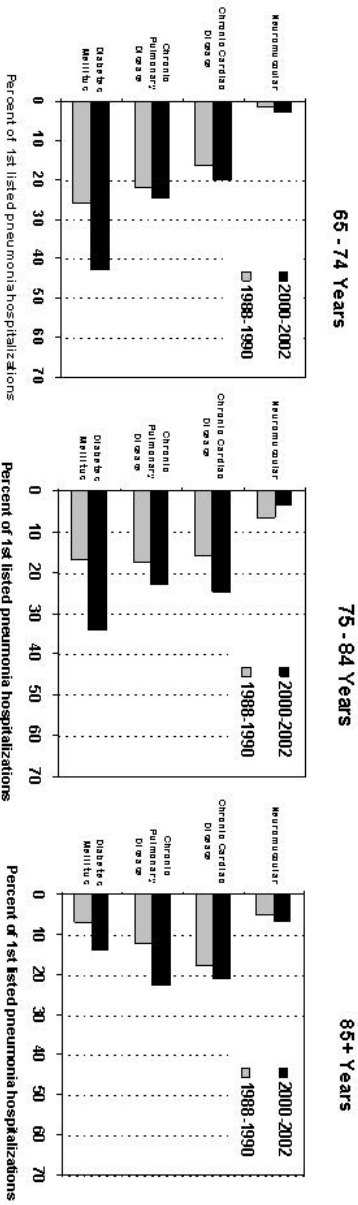
The proportion of pneumonia hospitalizations with co-morbid conditions listed increased during the study period for both regions (Figure 2). However, the proportion of pneumonia hospitalizations with chronic cardiac disease, diabetes mellitus, and/or chronic pulmonary disease was markedly different within each region. The proportion of first-listed pneumonia hospitalizations with one or more of these three conditions co-listed increased to a similar extent in the Alaska and the Southwest regions from 1988-1990 to 2000-2002 (32.1% and 34.0% increases, respectively,  $p < 0.001$ ). In the Alaska region, only chronic pulmonary disease and chronic cardiac disease significantly changed (50.9% [ $p < 0.001$ ] and 37.5% [ $p = 0.01$ ] increase, respectively) during the study period, while in the Southwest region, diabetes mellitus showed the greatest significant increases among the co-morbidities between 1988-1990 and 2000-2002 (96.2% and 88.0%, respectively;  $p < 0.001$ ). The proportion of pneumonia hospitalizations reporting chronic cardiac disease, diabetes mellitus, or chronic pulmonary disease among older AI/AN adults is increasing at a greater rate than for the all US older adults, and is approaching that proportion seen for all older US adults (general US older adult population 66% [SE=1.0%] in 1988-1990 to 77% [SE=0.8%] in 2000-2002, a 16% [95% CI=13%-20%] increase).<sup>6</sup>

Figure 2. Proportions of the four major co-morbid conditions reported with first-listed pneumonia hospitalizations among American Indians and Alaska Natives ≥65 years of age by age group in the A) Alaska region and B) Southwest region, IHS, 1988-1990 and 2000-2002.

A. Alaska region



B. Southwest region





The proportion of pneumonia hospitalizations reporting chronic cardiac disease, diabetes mellitus, or chronic pulmonary disease increased from 1988-1990 to 2000-2002 among older AI/AN adults in all three age groups in both regions (Figure 2). For 2000-2002, the proportion of pneumonia hospitalizations with one of the three co-morbid diagnoses in the Southwest region were 40.8% of AI/AN adults 65-74 years of age, 42.5% of those 75-84 years of age, and 38.2% of those  $\geq 85$  years of age; in the Alaska region, these proportions were higher (67.4%, 65.1%, and 61.6%, respectively). Among the adults in Alaska, chronic pulmonary disease was the most common co-morbid diagnosis for each age group. In the Southwest region, diabetes mellitus was most commonly listed as a co-morbid diagnosis for AI/AN adults 65-84 years of age, while chronic pulmonary diseases was most frequently listed among the  $\geq 85$  years. The proportion of pneumonia hospitalizations with chronic pulmonary disease increased from 1988-1990 to 2000-2002 for all age groups in the Alaska region, almost 3-fold among adults  $\geq 85$  years of age. In the Southwest region, chronic pulmonary disease significantly increased among the two oldest age groups with almost a 2-fold increase among adults  $\geq 85$  years of age. The proportion of older adults hospitalized for pneumonia with diabetes mellitus as a co-morbid condition in the Southwest region increased by 67.2% in the 65-74 year age group and 2-fold in the two older age groups. In the Alaska region, the proportion of pneumonia hospitalizations with diabetes mellitus did not change significantly for any of the age groups. The pattern of co-morbid diagnoses by age group in 2000-2002 for the Alaska region appears similar to that reported for the US older adults,<sup>6</sup> while the pattern for AI/AN adults in the Southwest region shows a higher proportion of diabetes mellitus.

### ***Hospital fatality rate and length of stay***

Among all hospital deaths of older AI/AN adults in the Alaska and Southwest regions during the study period, 11.1% and 16.0% were associated with first-listed pneumonia hospitalizations, and 25.6% and 29.0% with any-listed pneumonia hospitalizations, respectively. The in-hospital fatality rate for first-listed pneumonia among older AI/AN adults did not significantly change in either region over the study period (Alaska: 2.4% in 1988-1990 and 4.9% in 2000-2002, RR=1.03 [95% CI: 1.00-1.05]; and Southwest: 6.8% in 1988-1990 and 5.9% in 2000-2002, RR=1.15 [95% CI: 0.90-1.48]). In Alaska, the rate for any-listed pneumonia increased from 6.0% in 1988-1990 to 6.4% in 2000-2002, but this change was not significant (RR=1.00 [95% CI: 0.97-1.04]). However, the fatality rate for any-listed pneumonia in the Southwest region decreased, from 10.3% in 1988-1990 to 7.5% in 2000-2002 (RR=1.38 [95% CI: 1.15-1.65]). For both first- and any-listed pneumonia hospitalizations in both regions, the in-hospital fatality rates increased with age. During 2000-2002 the in-hospital fatality rates for first-listed pneumonia hospitalizations in the

Southwest region for 65-74, 75-85, and  $\geq 85$  year olds were 4.0%, 6.1%, and 10.6%, respectively. For any-listed pneumonia hospitalizations the in-hospital fatality rates for 65-74, 75-85, and  $\geq 85$  year olds were 4.6%, 7.7%, and 10.7%, respectively. The proportion of in-hospital deaths among first- and any-listed pneumonia hospitalizations for older AI/AN adults appeared lower than the proportion of hospital deaths described among older adults in the general US population (10% and 22%, respectively).<sup>6</sup>

First-listed pneumonia hospitalizations accounted for 9.1% and 12.7% of all hospital days in the Alaska and Southwest regions, while any-listed pneumonia hospitalizations accounted for 14.6% and 16.7% of all hospital days among older AI/AN adults during 2000-2002, respectively. The median lengths of stay in the Alaska and the Southwest regions for first-listed pneumonia hospitalizations were five (25% and 75% quartiles three and eight days) and five days (25% and 75% quartiles three and seven days), and six and five days for any-listed pneumonia hospitalizations, respectively. Length of stay did not differ by gender or age group in either region. The length of stay for all hospitalizations (excluding any-listed pneumonia) was four days in both Alaska and the Southwest.

## Discussion

Unlike the disparity in LRTI hospitalization rates between AI/AN children and the general US population of children, where the LRTI hospitalization rates for children living in the Alaska and the Southwest IHS regions were 2-3 fold greater than the rate for US children,<sup>4</sup> the present study demonstrates that the pneumonia hospitalization rates among older AI/AN adults living in the Alaska and the Southwest IHS regions appear only slightly higher than those for the older adult general US population.<sup>6</sup> However, the rate of pneumonia hospitalizations increased in both regions during the 15-year study period among all age groups. In addition, the proportion of hospitalizations due to pneumonia was higher in both regions compared to that of the older adult general US population.<sup>6</sup> Simultaneously, the proportion of pneumonia hospitalizations with chronic cardiac disease, chronic pulmonary disease and diabetes mellitus increased among older AI/AN adults in these regions. These findings could assist when planning strategies aimed at reducing pneumonia hospitalizations among older AI/ANs living in these regions.

The pneumonia hospitalization rate among older AI/AN adults in both the Alaska and the Southwest regions increased from 1988-1990 to 2000-2002. Increased overall infectious disease hospitalizations have been described among older AI/AN adults in the Southwest and the Alaska regions,<sup>1</sup> and similar or slightly higher rates of invasive pneumococcal disease have been

previously reported among older AI/AN adults living in these regions as well.<sup>5,18</sup> In contrast, the all-cause hospitalization rate (excluding any-listed pneumonia) did not increase in the Southwest region. Thus, it is likely that the increase in the rate of pneumonia hospitalizations in the Southwest was not due to a change in health care practices. In the Alaska region the all-cause hospitalization rate increased over time, however to a lesser degree than the pneumonia hospitalization rate. It is possible that improved access to health care, a change in health care seeking behaviors, and/or changes in health care provider practices may be partially responsible for the increase in pneumonia hospitalizations in the Alaska region. Interestingly, the proportion of hospitalizations with pneumonia increased in both regions from 1988-1990 to 2000-2002.

An increasing number of pneumonia hospitalizations among older AI/AN adults in the Alaska and the Southwest regions had the co-morbid conditions, chronic cardiac disease, chronic pulmonary disease and diabetes mellitus, co-listed as a diagnosis during the study period. The proportion of pneumonia hospitalizations with chronic pulmonary disease and with chronic cardiac disease increased in both regions, particularly among the oldest age group and more so in the Alaska region compared to the Southwest region. The proportion of pneumonia hospitalizations with diabetes mellitus among older adults in the Southwest region increased for all age groups. Other studies suggest that the prevalence of these co-morbid conditions appears to be increasing.<sup>9-11</sup> Prevention strategies that are targeted at preventing chronic lung and heart disease in both regions and diabetes in the Southwest region may be beneficial for reducing pneumonia in these populations.

The seasonal trends for pneumonia hospitalization admissions differed by region. Hospitalizations were more evenly distributed throughout the year in the Alaska region than in the Southwest region. These seasonal trends are similar to those reported for respiratory syncytial virus hospitalizations among AI/AN infants in these regions.<sup>19</sup> Respiratory syncytial virus has been recognized as an important pathogen for older adults and adults with chronic cardiac and lung disease.<sup>20</sup> Understanding the etiology of pneumonia among older adults, may improve the understanding of pneumonia seasonal and secular trends, and aid in focusing future interventions.

There are some limitations in the use of the IHS/tribal hospital discharge data. Hospital discharge diagnoses may have been incomplete or coded incorrectly. Although AI/AN adults may seek IHS/tribal medical care because prepaid IHS-funded care health care is provided to eligible AI/AN adults,<sup>14,21</sup> it is possible that older AI/AN adults eligible for IHS/tribal services received inpatient care outside of this system. In addition, hospital admission criteria, patterns for seeking health care, and diagnostic criteria may have varied

within the IHS/tribal system, as well as between the IHS/tribal and the general US healthcare systems. The present study represents older AI/AN adults who received direct or contract health care through IHS/tribal facilities. The hospital fatality rate for older AI/AN adults may underestimate the actual rate, because it does not reflect older AI/AN adults who may have died after being transferred to non-IHS-funded hospitals. Furthermore, lower life expectancy among AI/AN adults<sup>22</sup> may affect comparisons between the older AI/AN adults and the US general population of older adults.

Older AI/AN adults are likely to benefit from prevention strategies to reduce pneumonia that are applicable to the general population of US older adults, such as influenza and pneumococcal vaccinations. The increasing prevalence of chronic co-morbid conditions indicates a growing need for prevention efforts and health interventions among older AI/AN adults. Programs targeted at reducing chronic pulmonary and cardiac disease among older AI/AN adults in the Alaska and the Southwest regions, and diabetes mellitus in the Southwest region, may have secondary effects on reducing pneumonia hospitalizations. Additional studies to characterize the etiologies and risk factors for pneumonia among these populations may also further focus prevention efforts. The pneumonia hospitalization rate increase and the increasing prevalence of chronic co-morbid conditions indicate a need for prevention efforts and health interventions among older AI/AN adults.

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## References

1. Holman RC, Curns AT, Singleton RJ, et al. Infectious disease hospitalizations among older American Indians and Alaska Natives. *Public Health Reports* 2006;121:674-683.
2. Holman RC, Curns AT, Cheek JE, Singleton RJ, Anderson LJ, Pinner RW. Infectious disease hospitalizations among American Indian and Alaska native infants. *Pediatrics* 2003;111(2):E176-82.
3. Holman RC, Curns AT, Kaufman SF, Cheek JE, Pinner RW, Schonberger LB. Trends in infectious disease hospitalizations among American Indians and

- Alaska Natives. *Am J Public Health* 2001;91(3):425-31.
4. Peck AJ, Holman RC, Curns AT, et al. Lower respiratory tract infections among American Indian and Alaska Native children and the general population of U.S. Children. *Pediatr Infect Dis J* 2005;24(4):342-51.
  5. Davidson M, Parkinson AJ, Bulkow LR, Fitzgerald MA, Peters HV, Parks DJ. The epidemiology of invasive pneumococcal disease in Alaska, 1986-1990—ethnic differences and opportunities for prevention. *J Infect Dis* 1994;170(2):368-76.
  6. Fry AM, Shay DK, Holman RC, Curns AT, Anderson LJ. Trends in hospitalizations for pneumonia among persons aged 65 years or older in the United States, 1988-2002. *JAMA* 2005;294(21):2712-9.
  7. Kaplan V, Angus DC, Griffin MF, Clermont G, Scott Watson R, Linde-Zwirble WT. Hospitalized community-acquired pneumonia in the elderly: age- and sex-related patterns of care and outcome in the United States. *Am J Respir Crit Care Med* 2002;165(6):766-72.
  8. Niederman MS, Ahmed QA. Community-acquired pneumonia in elderly patients. *Clin Geriatr Med* 2003;19(1):101-20.
  9. Galloway JM. The epidemiology of atherosclerosis and its risk factors among Native Americans. *Curr Diab Rep* 2002;2(3):274-81.
  10. Kamel HK, Rodriguez-Saldana J, Flaherty JH, Miller DK. Diabetes mellitus among ethnic seniors: contrasts with diabetes in whites. *Clin Geriatr Med* 1999;15(2):265-78.
  11. Welty TK, Rhoades DA, Yeh F, et al. Changes in cardiovascular disease risk factors among American Indians. The Strong Heart Study. *Ann Epidemiol* 2002;12(2):97-106.
  12. Inpatient/CHS inpatient data fiscal years 1988-2002. National Patient Information Reporting System. Albuquerque NM: Indian Health Service. In: Indian Health Service; 2003.
  13. Trends in Indian health 2000-2001. In: Rockville, MD: Indian Health Service; 2004.
  14. Rhoades D, D'Angelo A, Rhoades E. Data sources and subsets of the Indian population. In: Rhoades E, ed. *American Indian Health: Innovations in Health Care, Promotion, and Policy*. Baltimore, MD: The Johns Hopkins University Press; 2000:93-102.
  15. International classification of diseases, 9th revision, clinical modification, 6th ed. (CD-ROM), Washington DC. In: Public Health Service and Health Care Financing Administration, US Department of Health and Human Services; 1997.

16. Regional differences in Indian health 2000-2001. In: Rockville MD: Indian Health Service.; 2003.
17. Kleinbaum D, Kupper L, Muller K, Nizam A. Applied Regression Analysis and Multivariable Methods. 3rd ed. Pacific Grove, CA: Duxbury Press; 1998.
18. Watt JP, O'Brien KL, Benin AL, et al. Invasive pneumococcal disease among Navajo adults, 1989-1998. *Clin Infect Dis* 2004;38(4):496-501.
19. Holman RC, Curns AT, Cheek JE, et al. Respiratory syncytial virus hospitalizations among American Indian and Alaska Native infants and the general United States infant population. *Pediatrics* 2004;114(4):e437-44.
20. Falsey AR, Hennessey PA, Formica MA, Cox C, Walsh EE. Respiratory syncytial virus infection in elderly and high-risk adults. *N Engl J Med* 2005;352(17):1749-59.
21. Cunningham PJ, Altman BM. The use of ambulatory health care services by American Indians with disabilities. *Med Care* 1993;31(7):600-16.
22. Facts on Indian health disparities. Indian Health Service, 2005. (Accessed May 20, 2005, at [http://info.ihs.gov/Health/11\\_DisparitiesFacts-Jan2005.doc](http://info.ihs.gov/Health/11_DisparitiesFacts-Jan2005.doc).)

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