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Variations in Influenza and Pneumonia Immunizations For Medicare Beneficiaries Served by Rural Health Clinics

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Abstract

The availability of rural health clinic (RHC) database over the period of six years (2008 through 2013) offers a unique opportunity to examine the trends and patterns of disparities in immunization for influenza and pneumonia among rural Medicare beneficiaries in the southeastern states. The purpose of this exploratory study was twofold. First, it examined the rural trends and patterns of immunization rates before (2008 through 2009) and after (2010 through 2013) the ACA enactment by state and year. Second, it investigated how contextual, organizational, and aggregate patient characteristics may influence the variations in immunization for influenza and pneumonia of Medicare beneficiaries served by RHCs. Four data sources from federal agencies were merged to perform a longitudinal analysis of the influences of contextual, organizational, and aggregate patient characteristics on the disparities in immunization rates of rural Medicare beneficiaries for influenza and pneumonia. We included both time-varying and time-constant predictors in a multivariate analysis using Generalized Estimating Equation. This study reveals the increased immunization rates for both influenza and pneumonia over a period of six years. The ACA had a positive effect on increased immunization rates for pneumonia, but not for influenza, of rural Medicare beneficiaries in the eight states. The RHCs that served more dually-eligible patients had higher immunization rates. For influenza immunization, provider-based RHCs had a higher rate than the independent RHCs. For pneumonia immunization, no organizational variables were relevant in the explanation of the variability. The results also show that no single dominant factor influences health care disparities. This investigation suggested further improvement of preventive care needed to target the poor and isolated rural beneficiaries. Furthermore, the

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integration of immunization data from multiple sources is critically needed for understanding health disparities.

Keywords

Immunization rates for influenza and pneumonia; Disparities; Period effect of the Affordable Care Act; Rural health clinics

Introduction

The National Center for Health Statistics has reported negligible differences in adult immunization rates between rural and urban areas (Eberhardt et al., 2001; Hutchison & Peck, 2010), although trends and patterns of immunization for older adults by state have not been systematically analyzed. As noted by the American Lung Association (2014), immunizations for influenza and pneumonia among the elderly are imperative for health promotion. Research studies on multiple barriers to influenza and pneumonia immunization for adults have specified financial barriers (Gorshka-Ciebiada et al., 2015; Hebert et al., 2005; National Vaccine Advisory Committee, 2011), low health literacy (Sudore et al., 2006), ineffective reminder system (Johnson, Nichol, & Lipcznski, 2008; Multuck & Flower, 2008) and poor access to primary care services (Pennant et al., 2015).

A nationally representative study in the United States found that the expansion of annual influenza vaccination of healthy persons may reduce overall rates of pneumonia and influenza hospitalizations and inpatient deaths (Chang et al., 2015). Castilla et al. (2015) indicated that the influenza vaccination has a moderate preventive effect in all-cause mortality, especially for the elderly. The enactment of the Patient Protection and Affordable Care Act (ACA) on March 23, 2010 was expected to improve preventive care. Influenza and pneumococcal vaccines and their administration at clinics are paid at 100 percent of reasonable cost according to the Centers for Medicare and Medicaid Services (CMS), because the beneficiary coinsurance and deductibles are waived. Because Medicare beneficiaries can be immunized by a variety of providers, such as rural health clinics (RHCs), Federally Qualified Health Centers (FQHCs), pharmacies, and public health departments, there is no centralized data system to capture all relevant immunization records. Thus, little is known about how Medicare beneficiaries, including those residing in rural areas, have been immunized for influenza and pneumonia. The availability of data from Medicare beneficiaries served by RHCs over a period of six years (2008 through 2013) offers a unique opportunity to examine trends and patterns of rural disparities in immunization.

Previous research on preventive care has focused on the analysis of individual differences in preventive care use. Disparities in immunization rates of Medicare beneficiaries between the African Americans and Whites are well documented in prior research (Pennant et al., 2015). Using national data from the Behavioral Risk Factor Surveillance System to perform a multilevel analysis of health care coverage, Anderson and Fullerton (2012) showed that the causal mechanisms of the gaps were attributable to racial residential segregation and poverty.

They also found an inverse relationship between African American-White segregation and the likelihood that African American residents would carry health insurance.

We explored the variation in influenza and pneumonia immunization in rural Medicare beneficiaries from a social system perspective to identify the potential of various contextual, organizational, and aggregated patient characteristics of rural health clinics to explain the variability in immunization. The first component of this system framework refers to contextual or environmental factors. For example, regional variation in health care and health care outcomes is a critical topic for policy analysis. The Department of Health and Human Services (DHHS) Region 4 (which includes Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), has a large proportion of impoverished populations and also copes with environmental threats, such as storms and hurricanes. The rurality of the region may accentuate racial disparities in primary prevention. Rural populations also experience high rates of obesity and low levels of access to primary care services. State variations in influenza and pneumonia immunization are well documented by the Centers for Disease Control and Prevention (CDC). Estimates show that older adults are inadequately immunized against these potentially life-threatening infectious conditions (CDC, 2011).

The second component of the system constitutes organizational attributes of RHCs. Particularly when one examines the potential effect of the ACA with its emphasis on prevention and improvement of health insurance coverage for the uninsured, the Act may help to reduce the gaps in immunization rate that exist in rural settings. An investigation of the ACA's effect on state variations in immunization of rural populations is needed.

The third component of the system is related to aggregate patient characteristics or ecological variables at the RHC level. For instance, race and socioeconomic status (SES) are frequently cited as dominant contributing factors to health disparities (Farmer & Ferraro, 2005; Sarrazin et al., 2009; Williams, 2012; Williams & Mohammed, 2013; Williams and Jackson, 2003;). However, Williams and Mohammed (2013) and their colleagues (Farmer & Ferraro 2005) suggest that neither race nor ethnicity can be the only factors contributing to health care disparities. The interaction effect of race and SES should be explored to help disentangle the causal mechanisms of preventive health care and outcomes in the United States. In addition, the dual eligibility status of Medicare beneficiaries reflects the poverty and medical needs of rural elderly residing in various rural communities in the Region.

The purpose of our study was twofold: first, to examine rural trends and patterns of immunization rates before (2008 through 2009) and after (2010 through 2013) the ACA enactment by state and year; and second, to investigate how contextual, organizational, and aggregate patient characteristics may influence the variation in immunization rates of Medicare beneficiaries served by RHCs.

Our study addresses two questions on immunization disparities for rural Medicare beneficiaries. First, what are the trends and patterns of immunization practice disparities of rural areas in Region 4? Second, what are the relative influences of contextual/ecological,

organizational, and aggregate patient factors in explaining the variation in immunization rates for influenza and pneumonia?

We hypothesized that immunization rates at the RHC level for influenza and pneumonia would be inversely related to rurality, poverty and SES, while they would be positively associated with the enactment of the ACA (using the pre- and post-ACA periods as a proxy indicator) when other factors were taken into account. Then, we hypothesized that organizational factors of RHCs would exert a stronger influence on variations in immunization rates of influenza and pneumonia than any other contributing factors.

Methods

Design and Data Sources

We conducted a longitudinal analysis of administrative data for 513 RHCs. We first collected data from several sources including: 1) the Centers for Medicare and Medicaid Services (CMS) Chronic Condition Data Warehouse master beneficiary summary file, 2) the Institutional Outpatient Claims File, 3) the Area Health Resources File, and 4) the Provider of Services File. Immunization rates from 2008 through 2013 were assessed using the Medicare claims data and calculated as the total number of rural Medicare beneficiaries who were vaccinated for influenza or pneumonia within one calendar year, regardless of which facility provided the service, divided by total patients assigned to the RHC. While the immunization rates were relatively low compared to self-reported data generated from the Behavioral Risk Factor Surveillance System and the National Health Interview Survey of older adults, our analysis focused on rural disparities within Region 4 so that variations in immunization rates could be accounted for by contextual, organizational, and aggregate patient factors. The immunization disparities among rural Medicare beneficiaries in the eight states of Region 4 were compared.

We then conducted analyses using several RHC patient characteristics. The total number of rural older adults studied each year ranged from 258,186 patients in 2008 to 232,677 patients in 2013. Of 828 RHCs identified initially from the database, we retained 513 RHCs with complete information for the GEE analysis.

The CMS Cost Report files document the number of seasonal influenza virus vaccines and pneumococcal vaccines provided by RHCs. Because the Cost Report had a very large number of RHCs with missing values for immunizations administered, we used the CMS Outpatient Revenue Center file to extract the relevant immunization HCPCS/CPT codes (Healthcare Common Procedure Coding System/ Current Procedural Terminology codes) to impute missing values. Immunization procedure codes were utilized and retrieved from the Medicare Immunization billing document. Our study excluded the seasonal influenza virus vaccine codes (i.e., codes G0008, 90686, 90688, Q2034, Q2035, Q2036, Q2037, Q2038, and Q2039) for patients under the age of 65 years old. The pneumococcal vaccine codes included codes G0009, 90669, 90670, and 90732. We created two new variables for identifying whether or not a beneficiary had received 1) the seasonal influenza vaccine and 2) the pneumococcal immunization, irrespective of the location or facility where it was received.

Measurements

The predictor variables included contextual, organizational, and aggregate patient factors. The contextual variables, derived from the Health Resources and Services Administration's (HRSA's) Area Health Resources File, included the percentage of the older, female and those in the poverty, racial composition, rurality (urbanized, large rural, small rural, and isolated areas) and the ACA period. We created a dichotomized predictor variable of the ACA period effect on immunizations, where the years before 2010 (2008 through 2009) were coded as 0, and the years after 2010 (2010 through 2013) were coded as 1. Organizational factors included the RHC's number of years certified as such, staff mix and size, provider-based practice and ownership. We also included personal attributes of Medicare beneficiaries served by RHCs, such as size of patient population served, percent of female patients served, average patient age, racial composition served, and percent of dually-eligible patients. Further details on the measurement of each study variable together with its operational definition and its data source are available from the first correspondent author.

Dependent Variables (Disparities in Influenza and Pneumonia Immunization Rates)

The formulas for computing the immunization rates were as follows: 1) **An annual rate for receiving seasonal influenza vaccine** = (the number of patients receiving seasonal influenza vaccine divided by the number of outpatient visits at each RHC) * 100; and 2) **an annual rate for receiving pneumococcal vaccine** = (the number of patients receiving pneumococcal vaccine divided by the number of outpatient visits at each RHC) * 100.

The disparity in immunization rates refers to the deviation from an average rate or a norm when the immunization rates of rural Medicare beneficiaries are compared. Here the average immunization rate of all study RHCs in 2009 was used as a reference value. The disparity is the percentage deviation (the difference between a given RHC and an average rate in 2009) from an average rate of a specific immunization.

To handle the problem of missing values in the claims data file and relatively lower immunization rates documented by the CMS payment/reimbursement files for RHCs, longitudinal data from 2008 to 2013 were pooled for the analysis. Thus, the unit of analysis for a dependent variable is referred to as "RHC-year," with an immunization rate deviated from the average rate of immunization in 2009 of all eight states among 513 RHCs. The use of this disparity ratio had several advantages. First, the percentage of deviation from a reference point displayed the variation when considering the impact of the ACA in an easily-interpretable manner. Second, the distribution of ratios was somewhat normalized so that the analysis of variability can detect the trajectories of change. A positive value of this ratio refers to Medicare beneficiaries of an RHC having a higher rate of immunization than the average RHCs, whereas a negative value refers to a lower or deficit rate. Third, it showed the slopes or changes in multiple years of the immunization practice for influenza or for pneumonia.

Analytical Methods—We used descriptive statistics and multivariate statistical methods to analyze the pooled data in a process similar to a time-series without using a panel group

of RHCs in the longitudinal analysis. We then regressed each dependent variable on selected predictor variables clustered in three broad categories by a generalized estimating equation (GEE) method (Liang & Zeger, 1986a 1986b; Diggle, Liang, & Zeger, 1994), using the pooled data and analysis with IBM SPSS statistics version 22.0 (IBM, 2013).

The reasons for performing GEE to identify the relevance of selected predictors in accounting for the disparity in immunization rates were: 1) the presence of a repeated measure of immunization disparity rate of RHCs over six years as the dependent variable; 2) missing values for some predictor variables; 3) availability of robust standard estimates for performing statistical significance test; and 4) the availability of the Quasi-likelihood Information Criterion [QIC] to reflect the relative quality of the proposed model in fitting the data (Hanley et al., 2003; Hardin & Hilbe, 2003; Liang & Zeger, 1986b; Zheng, 2000). The detailed statistical description of GEE used for this analysis is available from the corresponding author.

Results

Descriptive Statistical Analysis

Comparing Immunization Rates of Rural Medicare Beneficiaries between the Pre- and Post-ACA Periods—For influenza immunization rates at the RHC level, Table 1 shows that all eight states in Region 4 had relatively lower rates. The rates were slightly higher in the post-ACA period than in the pre-ACA period through 2013, particularly in 2011. Kentucky had higher rates than the other Region 4 states in all years. Tennessee had the lowest rates throughout the six year study period.

For pneumonia immunization rates, state variations were observed in Region 4. South Carolina had the lowest rate in 2008, but its rate doubled in 2013. There was a steady increase in pneumonia immunization since 2011. The post-ACA period had a slightly higher rate of immunization against pneumonia than the pre-ACA period.

Trends for Disparities in Immunization Rates of Rural Medicare Beneficiaries for Influenza and Pneumonia—For each of the six years, we compared the immunization rate of rural Medicare beneficiaries for each RHC to the average rate for 2009 in the pre-ACA period as to arrive at a baseline. The computation of percentages of deviations from this mean shows that the higher the positive value, the higher the immunization rate. In 2012 (5.15%) and 2013 (6.33%) had a slightly increased rate in influenza immunization (see Figure 1). However, a steadily increasing rate in pneumonia immunization ranged from 4.7% increase in 2010 to 21.51% increase in 2013 (see Figure 2).

Correlation between the Two Immunization Rates by Year

Auto-correlations are a potential methodological issue that must be examined in longitudinal analysis of data. Table 2 shows that the immunization rates of influenza had a moderately positive association, ranging from 0.59 to 0.86. However, the correlation coefficients among pneumonia immunization rates were small and positively associated, ranging from 0.20 to 0.49. These associations appear to be much lower than those found in influenza

immunization rates. The potential threat of autoregression of disparities in influenza immunization rates had to be further explored in multivariate analysis.

Generalized Estimating Equation (GEE) Analysis

For the examination of repeated measures, such as disparities in immunization rates for 2,530 RHC-years from 513 RHCs in Region 4, GEE provides a unique opportunity for analysis. Tables 3 and 4 present substantively meaningful results for each immunization measure. To identify the relative importance of each predictor included in the model, we present the standardized regression coefficients (parameter estimates) and relevant statistics. A positive regression coefficient suggests an increase in the immunization rate as a function of a given predictor variable, whereas a negative coefficient indicates a decrease in the immunization rate.

GEE for Predictors of Immunization Rates for Influenza—Table 3 reveals several statistically significant findings. First, among the nine contextual variables, the percentages of county population living at 200% of the poverty level, females, and Whites were positively associated with influenza immunization rates. No variation was accounted for by rurality. The ACA had no effect on the influenza immunization rates. Second, the provider-based practice variable reflecting an organizational characteristic was the only significant organizational predictor of the variation in immunization for influenza. Medicare beneficiaries served by provider-based RHCs had a higher rate than did the independent RHCs. Third, the RHCs that served more dually-eligible patients had higher immunization rates. Similarly, the older the Medicare beneficiaries served by RHCs, the higher rate of influenza immunization was observed. The GEE Fit Criteria QIC value was 163.38.

GEE for Predictors of Immunization Rates for Pneumonia—Table 4 shows 21 predictor variables of rural disparities in immunization rates for pneumonia. The key findings revealed by this table are: 1) a positive and net period effect of the ACA on immunization for pneumonia; 2) RHCs located in counties with more African-Americans and Whites had higher rates of immunization; 3) Medicare beneficiaries served by RHCs located in isolated rural areas had the lowest immunization rates for pneumonia of all rural areas; 4) no variability in pneumonia rates was accounted for by organizational characteristics; and 5) RHCs serving more dually-eligible patients were more likely to have them vaccinated for pneumonia. The GEE Fit Criteria QIC value was 113.08.

Discussion

By exploring longitudinal data compiled from the CMS administrative data and the HRSA county-level health and social indicators, we found interesting comparative information concerning the differences in immunization rates for influenza and pneumonia observed in Region 4. The examination of the two research questions in regard to the explanatory power of the predictor variables reveals mixed results.

Based on the data, immunization rates for both influenza and pneumonia for RHCs have been steadily increasing. The immunization practice disparities of rural areas in Region 4 show that the variability in immunization rates for both influenza and pneumonia was

predicted by the percentage of dually-eligible beneficiaries. RHCs serving more dually-eligible patients had higher immunization rates. The relative influences of contextual/ecological, organizational, and aggregate patient factors in explaining the variation in immunization rates for influenza and pneumonia reveal differences between the two immunizations. For influenza immunization, Medicare beneficiaries served by provider-based RHCs had higher immunization rates than did those served by independent RHCs. This organizational feature may relate to its differences in operation and performance for primary care. However, no organizational variables selected for this study were statistically significant in explaining the variability in pneumonia immunization. A positive ACA period effect was observed in immunization rates for pneumonia of rural Medicare beneficiaries in the eight states. However, no ACA period effect was observed in influenza immunization rates at the RHC level. Our investigation has generated results that should be confirmed by extending the observational period from six to ten years. Also, in-depth site visits of RHCs should be conducted using a mixed method approach.

Although our findings are relatively robust, they are subject to several methodological limitations. This study used Medicare claims data to classify the status of influenza and pneumococcal vaccinations, and vaccination rates were lower than the self-reported values as noted in a previous publication (Locher et al., 2015). For example, 31.3 percent and 30.0 percent of Medicare beneficiaries aged 65 years and older in Region 4 reported that they did not receive influenza and pneumococcal vaccinations, respectively. Since our estimates of RHC-based immunization rates were based on the CMS's Outpatient Revenue Center file, the immunization variables captured in the administrative and payment data for RHCs may underestimate the magnitude of immunization for influenza and pneumonia in rural areas.

Given the purpose of this exploratory investigation to analyze the variability in immunization rates, identification of older rural Medicare beneficiaries served by RHCs with a very low average immunization rate in 2009 for the two immunizations suggests the need for further improvement of primary preventive services in rural areas. On the other hand, higher rates for immunization practice in RHC-years have also been identified as the model for best immunization practices. Again, validation or confirmation of "best practices" in immunization is needed.

Our study did not explore regional variation in immunization practice among RHCs because our data were limited to the eight states. However, rural Medicare beneficiaries in remote areas in Region 4 as a whole had lower immunization rates for pneumonia than did other rural categories (e.g., urbanized, large and small rural areas).

The impact of the ACA on rural health requires more thorough investigation to determine the relative effects of the ACA on the performance variation in immunization practices of the affiliated versus non-affiliated RHCs. Notwithstanding the limitations noted above, this investigation establishes that RHCs are serving the needy. Rural people in isolated areas are underserved as a result of lack of access to primary care (CDC, 2011). Future studies should take a significant step forward in addressing the gaps of immunization of rural Medicare beneficiaries.

Conclusions

Our findings suggest that RHCs might benefit from evidence-based management to guide the optimization of federal resources in funding development of rural preventive services, particularly as related to the integration of information sources capturing immunization data at the local, state, and federal level.

Our study contributes to the literature on health disparities from the contextual, organizational, and aggregate patient perspectives through a longitudinal analysis of claims data. The results show that no single dominant factor influences health care disparities. Certainly, it cannot be assumed that race or ethnicity alone causes the differences observed in immunization practices for rural Medicare beneficiaries (Health Research and Educational Trust, 2013; Yoo, Hasebe, & Szilagyi, 2015). The investigation of the interplay or synergy among multilevel factors is a necessary step for understanding the determinants and consequences of rural health disparities in immunization.

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Figure 1.
Trend Plot for Disparities in Immunization Rates for Influenza of Rural Medicare Beneficiaries in 513 RHCs by Year

Figure 2.
Trend Plot for Disparities in Immunization Rates for Pneumonia of Rural Medicare Beneficiaries in 513 RHCs by Year

Table 1
Immunization Rates (IR) of Rural Medicare Beneficiaries by Pre- and Post-ACA Periods and by State

Immunization Type/State	Pre-ACA		Post-ACA			
	2008	2009	2010	2011	2012	2013
Influenza IR	3.54%	3.79%	3.61%	3.80%	3.99%	4.03%
Region 4						
Alabama	2.69%	2.79%	3.09%	2.67%	3.11%	4.48%
Florida	2.73%	3.42%	3.26%	3.02%	3.21%	3.57%
Georgia	2.51%	3.23%	2.28%	3.88%	4.07%	3.37%
Kentucky	5.30%	5.44%	5.31%	5.65%	5.92%	4.81%
Mississippi	4.71%	4.70%	4.57%	4.62%	4.09%	5.08%
North Carolina	2.77%	2.87%	2.27%	2.08%	2.83%	2.71%
South Carolina	2.81%	2.83%	3.06%	3.56%	3.65%	3.69%
Tennessee	2.18%	2.75%	2.46%	2.42%	3.26%	2.93%
Pneumonia IR	0.90%	1.14%	1.20%	1.28%	1.38%	1.39%
Region 4						
Alabama	0.77%	0.97%	0.84%	1.03%	1.21%	1.19%
Florida	1.21%	1.70%	1.37%	1.84%	1.69%	1.52%
Georgia	0.75%	0.95%	1.13%	1.41%	1.62%	1.30%
Kentucky	1.21%	1.48%	1.29%	1.28%	1.52%	1.15%
Mississippi	0.75%	0.77%	0.97%	0.88%	1.00%	1.46%
North Carolina	0.79%	0.99%	0.97%	0.96%	1.38%	1.21%
South Carolina	0.72%	1.03%	1.73%	1.86%	1.52%	1.74%
Tennessee	0.74%	1.19%	1.36%	0.95%	0.97%	1.64%

Correlation Matrix for Influenza Immunization and Pneumonia Immunization Rates of Rural Medicare Beneficiaries by Year (With Listwise Deletion for Missing Values)

Table 2

	IIR 08	IIR 09	IIR 10	IIR 11	IIR 12	IIR 13	PIR 08	PIR 09	PIR 10	PIR 11	PIR 12	PIR 13
IIR 08	1											
IIR 09	.86	1										
IIR 10	.77	.81	1									
IIR 11	.67	.68	.79	1								
IIR 12	.70	.71	.74	.78	1							
IIR 13	.59	.61	.63	.67	.69	1						
PIR 08							1					
PIR 09							.36	1				
PIR 10							.42	.32	1			
PIR 11							.20	.28	.47	1		
PIR 12							.37	.27	.39	.43	1	
PIR 13							.26	.22	.38	.40	.49	1

Note: IIR = influenza immunization rate; PIR = pneumonia immunization rate.

All correlation coefficients are statistically significant at $P < 0.01$.

Analysis of GEE Standardized Parameter Estimates for Influenza Immunization of Rural Medicare Beneficiaries in RHCs (N=2,530 RHC Years)

Table 3

Variables	Beta	Standard Error	95% Wald Confidence Interval		P-value
			Lower	Upper	
Intercept	-.68	.15	-.97	-.39	.00
Contextual Factors					
Percent older population	-.03	.03	-.09	.03	.27
Percent poverty population	.00	.00	.00	.00	.03
Percent female population	.16	.06	.04	.27	.01
Percent African American population	.07	.04	-.01	.14	.10
Percent Hispanic population	-.06	.04	-.14	.02	.17
Percent Native American population	-.03	.05	-.12	.06	.55
Percent White population	.08	.03	.02	.14	.01
Rurality Level					
Urban (reference group)					
Large Rural	.00	.01	-.01	.01	.97
Small Rural	.00	.01	-.01	.01	.71
Isolated	-.00	.01	-.01	.01	.80
ACA Period effect					
Pre-ACA (2008–2009) (reference group)					
Post-ACA (2010–2013)	.00	.00	-.00	.00	.72
Organizational Factors					
The years of RHC operation	.00	.00	-.00	.00	.74
Staff mix and size	.00	.00	-.00	.00	.29
RHC type					
Independent (reference group)					
Provider-based	.02	.01	.01	.03	.00
Ownership type					
Government (reference group)					
Profit	-.01	.01	-.03	.01	.48

Variables	Beta	Standard Error	95% Wald Confidence Interval		P-value
			Lower	Upper	
Non-profit	-.01	.01	-.03	.01	.51
Aggregated Personal Factors					
Size of Medicare beneficiary population served	.00	.00	-.00	.00	.47
Average patient age	.01	.00	.01	.01	.00
Percent of female patient served	.02	.02	-.02	.07	.32
Percent of African American patients served	-.14	.12	-.37	.09	.24
Percent of Hispanic patients served	.07	.17	-.26	.40	.66
Percent of Native American patients served	-.12	.17	-.44	.21	.48
Percent of White patients served	-.09	.11	-.30	.12	.42
Percent of patient dually eligible	.07	.02	.03	.11	.00

Notes:

GEE model information: Probability distribution: Normal; Link Function: Identity; Working Correlation Matrix Structure: AR(1).

GEE Fit Criteria: QIC=163.38^a

^aInformation criteria are in smaller-is-better form.

Table 4

Analysis of GEE Standardized Parameter Estimates for Pneumonia Vaccination of Rural Medicare Beneficiaries in RHCs (N=2,530 RHC Years)

Variables	Beta	Standard Error	95% Wald Confidence Interval		P-value
			Lower	Upper	
Intercept	-.07	.06	-.19	.05	.27
Contextual Factors					
Percent older population	.02	.01	-.00	.04	.08
Percent poverty population	.00	.00	-.00	.00	.51
Percent female population	-.00	.02	-.04	.03	.89
Percent African American population	.03	.01	.00	.06	.02
Percent Hispanic population	-.01	.01	-.03	.01	.49
Percent Native American population	.01	.02	-.02	.05	.37
Percent White population	.03	.01	.01	.06	.02
Rurality Level					
Urban (reference group)					
Large Rural	-.00	.00	-.01	-.00	.01
Small Rural	-.00	.00	-.01	-.00	.01
Isolated	-.01	.00	-.01	-.00	.00
ACA Period effect					
Pre-ACA (2008–2009) (reference group)					
Post-ACA (2010–2013)	.00	.00	.00	.00	.00
Organizational Factors					
The years of RHC operation	-.00	.00	.00	.00	.67
Staff mix and size	.00	.00	.00	.00	.30
RHC type					
Independent (reference group)					
Provider-based	.00	.00	-.00	.00	.21
Ownership type					
Government (reference group)					
Profit	.00	.00	-.00	.00	.44

Variables	Beta	Standard Error	95% Wald Confidence Interval		P-value
			Lower	Upper	
Non-profit	.00	.00	-.00	.01	.23
Personal Factors					
Size of Medicare beneficiary population served	.00	.00	-.00	.00	.53
Average patient age	.00	.00	.00	.00	.00
Percent of female patient served	-.01	.06	-.02	.01	.29
Percent of African American patient served	-.03	.058	-.14	.08	.60
Percent of Hispanic patient served	.09	.09	-.10	.28	.34
Percent of Native American patient served	-.04	.09	-.21	.14	.67
Percent of White patient served	-.03	.06	-.14	.08	.64
Percent of patient dually eligible	.01	.01	.00	.02	.01

Notes:

GEE model information: Probability distribution: Normal; Link Function: Identity; Working Correlation Matrix Structure: AR(1).

GEE Fit Criteria: QIC=113.08^a

^aInformation criteria are in smaller-is-better form.