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Respiratory Syncytial Virus-Associated Hospitalizations in Children With Neurological Disorders, 2006–2015

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Abstract

Background.—We quantified the risk of respiratory syncytial virus (RSV) hospitalizations and severe outcomes among children with neurological disorders.

Methods.—We estimated RSV-specific and RSV-associated hospitalization rates using International Classification of Diseases, Ninth Revision (ICD-9) codes from 2 insurance claims IBM MarketScan Research Databases (Commercial and Multi-State Medicaid) from July 2006 through June 2015. For comparison, a simple random sample of 10% of all eligible children was selected to represent the general population. Relative rates (RRs) of RSV hospitalization were calculated by dividing rates for children with neurological disorders by rates for children in the general population by age group and season.

Results.—The RSV-specific hospitalization rate for children with any neurological condition was 4.2 (95% confidence interval [CI]: 4.1, 4.4) per 1000 person-years, and the RSV-associated hospitalization rate was 7.0 (95% CI: 6.9, 7.2) per 1000 person-years among children <19 years of age. Among privately insured children, the overall RR of RSV hospitalization in children with neurological disorders compared with the general population was 10.7 (95% CI: 10.0, 11.4) for RSV-specific hospitalization and 11.1 (95% CI: 10.5, 11.7) for RSV-associated hospitalizations. Among children in Medicaid, the RSV-specific hospitalization RR was 6.1 (95% CI: 5.8, 6.5) and the RSV-associated hospitalization RR was 6.4 (95% CI: 6.2, 6.7) compared with the general population.

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Supplementary Data

Supplementary materials are available at the *Journal of the Pediatric Infectious Diseases Society* online.

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Conclusions.—Our population-based study of children with neurological disorders found that the risk of RSV hospitalization was 6 to 12 times higher among children with neurological disorders than among the general pediatric population. These findings should be considered when determining who should be targeted for current and future RSV interventions.

Keywords

hospitalizations; neurologic disorders; respiratory syncytial virus

Children with neurological disorders, including both neuromuscular and neurodevelopmental disorders, have higher rates of lower respiratory tract infection (LRTI) hospitalizations than the general pediatric population [1–3]. Several factors may contribute to the increased risk of LRTI, such as impaired mobility, decreased muscle tone, aspiration risk, inability to clear secretions, and likelihood of the underlying condition to be exacerbated by infection. Respiratory syncytial virus (RSV) is a leading cause of LRTI in children worldwide [4, 5]. Although RSV rarely causes death in the United States, RSV causes significant morbidity in young children; RSV is associated with more than an estimated 1.5 million outpatient visits, 500 000 emergency department visits, and 57 000 hospitalizations in children less than 5 years of age each year [6].

Quantifying the risk of severe RSV infections among children with neurological disorders has been difficult due to low prevalence of these conditions. Studies have shown higher rates of RSV-associated hospitalizations in children with Down syndrome compared with the general population [7–9]. Studies have also shown that children with neuromuscular disease hospitalized with RSV have more severe clinical outcomes than children without neuromuscular disease [10].

Currently, there is a monoclonal antibody product, palivizumab, that is recommended to prevent RSV hospitalization in certain high-risk populations [11]. The Committee on Infectious Diseases (COID) recommends that children below 1 year of age with neurological disorders be considered for palivizumab prophylaxis if their ability to “clear secretions from the upper airway because of ineffective cough” is impaired [11]. There are also several vaccines and monoclonal antibodies that are under development [12]. Estimating the burden of RSV in high-risk populations, including children with neurological disorders, has been identified as a priority in order to inform policies regarding potential new interventions [11, 13].

We sought to quantify the risk of severe RSV infections among children with neurological disorders. We used data from national insurance claims to calculate RSV hospitalization rates among children with neurological conditions and compared them with RSV hospitalization rates in all children.

METHODS

We analyzed insurance claims from 2 IBM MarketScan Research Databases (Commercial and Multi-State Medicaid) from July 2006 through June 2015. These MarketScan Databases contain de-identified person-level US healthcare claims from large employers, health plans,

and Medicaid programs. Data include inpatient and outpatient claims as well as annual enrollment records. As of 2015, there were approximately 28 million individuals nationwide contributing to the Commercial Database and 13 million individuals from 10 to 13 states in the Medicaid Database.

We defined the annual surveillance year as July 1 through June 30 of the following year. Children were included if they were <19 years of age as of July 1 of the surveillance year and enrolled in their insurance plan for at least 1 month that surveillance year as well as 1 month during the preceding surveillance year. A child was considered to have a neurological condition if he/she had at least 1 inpatient or outpatient visit with an International Classification of Diseases, Ninth Revision (ICD-9) code identifying a neurological condition during the preceding surveillance year (Supplementary Appendix Table 1). Patients with multiple or missing birth years or sexes within a season were excluded from analyses. Neurological disorders were categorized into groups by ICD-9 codes, which is similar to the approach used by Havers et al [1] (Supplementary Appendix Table 1). We used additional diagnoses as markers of severity (Supplementary Appendix Table 2). Children were counted for multiple surveillance years if they met eligibility criteria multiple years.

We estimated 2 separate RSV hospitalization rates: RSV-specific and RSV-associated. The RSV-specific rate included only RSV-specific discharge diagnosis codes (Supplementary Appendix Table 3). The RSV-associated rate was estimated using the RSV-specific discharge diagnosis codes plus the percent of laboratory-confirmed RSV-positive children with non-RSV-specific bronchiolitis (38%) and pneumonia (26% and 7% among children aged <5 years and 5 years, respectively) discharge diagnosis codes during November to April estimated from a population-based surveillance system for the years 2016–2019 (New Vaccine Surveillance Network, unpublished data). Patients with both a bronchiolitis and pneumonia diagnosis code listed were categorized having as a bronchiolitis-related hospitalization. Hospitalizations with diagnosis codes in any position in the discharge record were included. Hospitalizations within 14 days of a previous RSV-associated hospitalization were not considered unique events.

For patients with RSV-associated hospitalizations, we used revenue codes associated with an intensive care unit (ICU) to describe the percentage of patients with an ICU stay (Supplementary Appendix Table 4) [14]. In addition, we used a discharge status code (20—Died) to estimate the proportion of patients who died during their RSV-associated hospitalization.

Since only birth year was available, age was defined as year of age at the start of the surveillance year. We calculated the prevalence of neurological disorders and severity indicators by the number of children with each condition out of the number of unique patients <19 years of age each surveillance year. Patients could have multiple neurological conditions. We calculated RSV hospitalization rates using person-years, defined as the amount of time, by month, that each child was enrolled in the insurance plan during the study period. RSV hospitalization rates were calculated with and without epilepsy and recurrent seizures in order to assess the impact of removing the most common disorders. We

also calculated RSV hospitalization rates for those with at least 1 neurological disorder and a marker of severity defined as the presence of scoliosis, intellectual disability, deafness, or blindness/low vision [1].

For comparison, a simple random sample of 10% of all children meeting the same enrollment criteria as described for those with a neurological condition was selected to calculate RSV hospitalization rates in the general population. Relative rates (RR) of hospitalization due to RSV were calculated by dividing RSV hospitalization rates for children with neurological disorders by RSV hospitalization rates for children in the general population by age group and season. RR 95% confidence intervals (CIs) were calculated using approximation using the `fsmb` R package [15].

We used a logistic model to estimate the odds of RSV-specific hospitalizations in children with neurological disorders compared with those without, adjusting for diagnosis of chronic lung disease, congenital heart disease, prematurity <35 weeks, and age <2 years (see Supplementary Appendix Table 5) [16, 17]. We combined the cohort of children with neurological disorders and the simple random sample in each database, and, to reduce data size and correlation of observations, randomly included 1 RSV season among children enrolled for multiple seasons.

RESULTS

Prevalence of Neurological Conditions

Overall, there were 563 135 (0.7%) children with neurological disorders in the Commercial Database and 439 845 (1.3%) in the Medicaid Database during the study period (Table 1). Forty-six and 185 were excluded from the analyses due to multiple or missing birth years or sexes, respectively. Among all patients with neurological disorders, epilepsy and recurrent seizures were the most prevalent conditions (50.0%). The next most frequent neurological conditions were cerebral palsy (23.7%) and neural tube defects (20.5%) (Table 2). Twenty-two percent of children with a neurological disorder had at least 1 severity indicator (Supplementary Appendix Table 6). Overall, scoliosis was the most prevalent severity indicator (9.0%). Intellectual disability was more prevalent in the Medicaid population (14.8%) than the Commercial population (2.7%).

Rates of Hospitalizations Among Children With Neurological Conditions

RSV-specific hospitalization rates for children with neurological conditions were 4.2 (95% CI: 4.1, 4.4) per 1000 person-years, and RSV-associated hospitalization rates were 7.0 (95% CI: 6.9, 7.2) per 1000 person-years among children <19 years of age (Table 3). Children enrolled in Medicaid consistently had higher rates than privately insured children (Supplementary Appendix Table 7). The RSV-specific and RSV-associated hospitalization rates including data from both sources were 1.2 to 1.6 times higher, respectively, when children with only epilepsy and recurrent seizures were excluded from the analysis compared with when they were included (data not shown).

RSV hospitalization rates varied by the type of neurological disorder (Table 3; Supplementary Appendix Table 7). Children with traumatic brain injury had the highest

rate of both RSV-specific and RSV-associated hospitalization at 12.5 (95% CI: 10.8, 14.4) and 20.9 (95% CI: 18.6, 23.3) per 1000 person-years, respectively. The second highest rate of hospitalization was in children with chromosomal abnormalities with an RSV-specific hospitalization rate of 10.3 (95% CI: 9.7, 10.9) per 1000 person-years and an RSV-associated hospitalization rate of 16.7 (95% CI: 15.9, 17.5) per 1000 person-years. Of the children with chromosomal abnormalities, 84% were characterized as Down Syndrome, with an RSV-specific hospitalization rate of 9.7 (95% CI: 9.1, 10.4) per 1000 person-years and an RSV-associated hospitalization rate of 15.6 (95% CI: 14.8, 16.5) per 1000 person-years. The next highest rates occurred in children with metabolic disorders. The most prevalent neurological disorder, epilepsy and recurrent seizures, had the lowest rate of RSV-specific and RSV-associated hospitalizations with rates of 3.2 (95% CI: 3.0, 3.3) and 5.5 (95% CI: 5.3, 5.7) per 1000 person-years, respectively. Rates of RSV hospitalizations among children with neurological disorders excluding epilepsy can be seen in Supplementary Appendix Table 8. Children with neurological disorders who had at least 1 severity indicator had higher rates of RSV hospitalization compared with children with no severity indicators (Table 4).

Comparison of Rates Among Children With Neurological Conditions to the General Pediatric Population

In the general population, among the privately insured children, the RSV-specific hospitalization rate was 0.3 (95% CI: 0.29, 0.32) per 1000 person-years and the RSV-associated hospitalization rate was 0.5 (95% CI: 0.47, 0.51) (Table 5). Among Medicaid enrollees, the RSV-specific hospitalization rate was 0.9 (95% CI: 0.84, 0.91) per 1,000 person-years and the RSV-associated hospitalization rate was 1.3 (95% CI: 1.29, 1.37) (Table 6).

Among privately insured children, the overall RR of RSV hospitalizations in children with neurological disorders compared with the general population was 10.7 (95% CI: 10.0, 11.4) for RSV-specific hospitalizations and 11.1 (95% CI: 10.5, 11.7) for RSV-associated hospitalizations (Table 5). Among children in Medicaid, comparing those with neurological disorders to the general population, the RSV-specific hospitalization RR was 6.1 (95% CI: 5.8, 6.5) and the RSV-associated hospitalization RR was 6.4 (95% CI: 6.2, 6.7) (Table 6).

Children <1 year of age had the highest rates of RSV hospitalizations, both among children with neurological disorders and among the general population (Table 5 and Table 6). Among the privately insured children <1 year of age with neurological disorders, the rate of an RSV-specific hospitalization was 24.2 (95% CI: 20.9, 27.8) per 1000 person-years (compared with 5.3 [95% CI: 4.8, 5.7] in the general population). The rate of an RSV-associated hospitalization rate was 35.8 (95% CI: 31.8, 40.2) per 1000 person-years (compared with 7.0 [95% CI: 6.5, 7.5] in the general population) (Table 5). In Medicaid, children <1 year of age with neurological disorders had an RSV-specific hospitalization rate of 32.8 (95% CI: 29.1, 36.8) per 1000 person-years (compared with 8.8 [95% CI: 8.2, 9.4] in the general population) and an RSV-associated hospitalization rate of 45.3 (95% CI: 40.1, 50.0) per 1000 person-years (compared with 11.4 [95% CI: 10.7, 12.0] in the general population) (Table 6).

The RR of RSV hospitalization among children with neurological disorders compared with the general population increased with age, and the RR was highest in children aged 10–18 years (Table 5 and Table 6). In the Commercial Database, children with neurological disorders aged 10–18 years had an RSV-specific hospitalization rate that was 39.0-fold higher (95% CI: 28.0, 54.3) and an RSV-associated hospitalization rate that was 45.8-fold higher (95% CI: 37.7, 55.6) higher than children in the general population (Table 5). Children in Medicaid with neurological disorders aged 10–18 years had an RSV-specific hospitalization rate that was 23.0-fold higher (95% CI: 15.8, 33.5) and an RSV-associated hospitalization rate that was 16.1-fold (95% CI: 13.4, 19.3) higher than children in the general population (Table 6).

Other Risk Factors and Severity of Illness

Among children with neurological disorders in the Medicaid population, 33.1% had an ICU stay and 1.3% died during the RSV-associated hospitalization. This percentage of severe illness and death was higher than the general Medicaid pediatric population, of which 13.2% had an ICU stay and 0.2% died during the RSV-associated hospitalization.

Similarly, 34.4% of children with neurological disorders in the Commercial Database had an ICU stay during their RSV-associated hospitalization, and 1.1% died, compared with 14.0% of the general pediatric population who had an ICU stay and 0.03% died.

After adjusting for chronic lung disease, congenital heart disease, prematurity, and age, children with neurological disorders in the Commercial database had an odds of 6.0 (95% CI: 5.5, 6.6) times compared with children without neurological disorders of having an RSV-specific hospitalization. In the Medicaid database, after the same adjustments, children with neurological disorders had an odds of 4.6 (95% CI: 4.3, 5.1) times that of children without neurological disorders of having an RSV-specific hospitalization. For full model results, see Supplementary Appendix Table 9.

DISCUSSION

Our population-based study of children with neurological disorders found that the risk of RSV hospitalizations was substantially higher among children with neurological disorders than that of the general pediatric population. Overall, children with neurological disorders had 6 to 11 times more RSV-specific hospitalizations and 6 to 10 times more RSV-associated hospitalizations than children in the general population. Rates were higher across a broad spectrum of neurological disorders. Having an indicator of a severe neurological disorder further increased the risk of hospitalization. ICU admission and risk of death were also higher among children with neurological disorders as compared with the general population. After adjusting for known risk factors RSV hospitalizations, including chronic lung disease, congenital heart disease, and prematurity, children with neurological disorders had increased odds of having an RSV-specific hospitalization. Knowing who is at risk for severe RSV infections is important for targeting current and future interventions.

A previous study used a similar approach to estimate the risk of all respiratory infection-related hospitalizations in children with neurological disorders [1]. That study found that

children with at least 1 neurological disorder had 5 to 7 times higher rates of hospitalization for respiratory infections than the general population. Another study found that children with neurological and neuromuscular disorders had an odds of 6.6 of respiratory failure associated with influenza compared with children without [18]. Similar to the Havers et al [1] study, we found that the RR comparing RSV hospitalizations in children with neurological disorders to RSV hospitalizations in the general population increased with age. Children <1 year of age had the highest rates of hospitalizations both among the general population and among children with neurological disorders. However, the RRs comparing RSV hospitalizations among children with neurological disorders and the general population increased with increasing age. In fact, rates of RSV hospitalizations among children with neurological disorders 5 years of age were higher than rates in the general population for those 2–4 years of age. This finding suggests that while RSV typically causes severe disease in young children, RSV causes severe disease across a broader age spectrum among those with neurological disorders.

Few studies have specifically examined RSV hospitalization rates in children with neurological disorders, but findings have consistently shown a higher risk among this population. A recent review found that children with Down syndrome had 8.69 higher odds of RSV hospitalization compared with controls [19]. In our study, children with chromosomal abnormalities, for which Down Syndrome comprised 84%, had one of the highest rates of RSV hospitalization, and the rate of RSV-specific or RSV-associated hospitalization was 13 to 30 times higher compared with the general population. Our study expanded on these findings by providing RSV hospitalization rates for other specific diagnoses. Children with traumatic brain injuries and metabolic disorders in addition to those with chromosomal abnormalities had among the highest rates of RSV hospitalizations. Children with epilepsy, the most prevalent neurological disorder, had the lowest rates of RSV hospitalizations among those with neurological disorders, although their RSV hospitalization rate was more than 5 times higher than that of the general pediatric population.

The use of 2 national databases captured a large, diverse population. Children enrolled in Medicaid had higher rates of RSV hospitalization than children enrolled in private insurance, both in the general population and in the neurological disorder cohort. This finding is consistent with previous studies and suggests that Medicaid and private insurance reflect different populations [1, 20, 21]. Medicaid provides insurance to low-income families as well as those with certain types of disabilities and more severe disabilities. In addition, low income, low education, and lack of support network may contribute to the observed higher rates of hospitalization among the Medicaid population [20, 21].

Our study has several limitations. Discharge diagnosis codes may be inconsistent or inaccurate in identifying specific neurological conditions. Due to our inclusion criteria requiring enrollment at least 1 month during the previous surveillance year, we may have missed many of the children <1 year of age in our analysis. Since RSV hospitalization rates are highest among infants <2 months of age [22], rate estimates among children <1 year of age likely underestimate the true rate of RSV hospitalization. We relied on clinical coding without laboratory confirmation to determine RSV hospitalizations. We did limit

the analysis of the nonspecific RSV codes to the part of the year when RSV detections are highest [23]. By including both RSV-specific and RSV-associated hospitalization rates, we aimed to provide a realistic range of hospitalizations due to RSV. Lastly, children with neurological disorders may be more likely to be hospitalized, regardless of respiratory disease, which may cause an admission bias resulting in higher rates of hospitalization among children with neurological disorders and not more severe disease. However, when we examined ICU admission and death, we also saw more severe diseases among children with neurological disorders.

Previous studies were not able to look at the risk of RSV hospitalizations in children with neurological disorders since these disorders are relatively rare. Using large national databases, we found that children with a broad range of neurological disorders have very high rates of RSV hospitalization, especially among the youngest age groups. Although rates were highest in the youngest age groups, RRs comparing children with neurological conditions to those in the general population rose with age. These findings may be valuable when considering interventions in high-risk populations. Additionally, they may guide future decisions about the use of monoclonal antibodies and vaccines that are under development.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Characteristics of Study Population in Commercial and Medicaid Databases (2006–2015)

Table 1.

Characteristic	Commercial (N = 78 597 883)		Medicaid (N = 34 018 779)	
	No. of Children with Neurological Condition	No. of Children Random Sample	No. of Children with Neurological Condition	No. of Children Random Sample
Total	563 135 (100)	7 859 751 (100)	439 845 (100)	3 401 863 (100)
Age groups N, %				
<1	10 205 (1.8)	142 746 (1.8)	10 085 (2.3)	120 809 (3.6)
1	30 572 (5.4)	326 999 (4.2)	31 386 (7.1)	242 313 (7.1)
2–4	80 117 (14.2)	1 093 232 (13.9)	81 544 (18.5)	668 172 (19.6)
5–9	148 268 (26.3)	2 048 322 (26.1)	125 834 (28.6)	985 451 (29.0)
10–18	293 973 (52.2)	4 248 452 (54.1)	190 996 (43.4)	1 385 118 (40.7)
Male N, %	307 765 (54.7)	4 016 934 (51.1)	245 436 (55.8)	1 733 115 (50.9)

Prevalence of Neurological Disorders Among Children Enrolled in the Commercial and Medicaid Databases (2006–2015)^a

Table 2.

Group	Commercial, N (%)	Medicaid, N (%)	Both Databases, N (%)
Overall	563 135 (100)	439 845 (100)	1 002 980 (100)
Epilepsy and recurrent seizures	289 986 (51.5)	211 580 (48.1)	501 566 (50.0)
Cerebral palsy	106 340 (18.9)	131 216 (29.8)	237 556 (23.7)
Neural tube defects	116 305 (20.7)	89 657 (20.4)	205 962 (20.5)
Chromosomal abnormalities	66 781 (11.9)	53 689 (12.2)	120 470 (12.0)
Muscular dystrophies	13 712 (2.4)	9383 (2.1)	23 095 (2.3)
Metabolic disorders with neuro/muscular involvement	13 214 (2.3)	8488 (1.9)	21 702 (2.2)
Cerebral and other degenerative diseases of the central nervous system	10 184 (1.8)	7516 (1.7)	17 700 (1.8)
Traumatic brain injury	9115 (1.6)	8301 (1.9)	17 416 (1.7)
Motor neuron diseases	10 070 (1.8)	6364 (1.4)	16 434 (1.6)

^aSee Supplementary Appendix Table 1 for definitions of neurological groups.

Table 3. RSV Hospitalization Rates of Children With Neurological Disorders by Type of Disorder

Conditions	Combined Data (N = 1 002 980 ^c)			
	% With Severity Indicator	Person-Years	RSV-Specific Rate ^a (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)
Any neurological condition	21.8	864 192	4.2 (4.1, 4.4)	7.0 (6.9, 7.2)
Traumatic brain injury	21.3	14 722	12.5 (10.8, 14.4)	20.9 (18.6, 23.3)
Chromosomal abnormalities	32.8	104 403	10.3 (9.7, 10.9)	16.7 (15.9, 17.5)
Metabolic disorders with neuro/muscular involvement	24.3	18 480	8.2 (6.9, 9.6)	13.9 (12.2, 15.7)
Cerebral and other degenerative diseases of the central nervous system	37.4	15 130	7.5 (6.2, 9.0)	13.0 (11.3, 15.0)
Muscular dystrophies	29.7	19 933	6.7 (5.6, 8.0)	11.7 (10.3, 13.3)
Neural tube defects	26.6	176 183	6.7 (6.4, 7.1)	11.2 (10.7, 11.7)
Motor neuron diseases	34.0	14 194	6.6 (5.3, 8.0)	12.5 (10.7, 14.4)
Cerebral palsy	36.2	208 069	5.4 (5.1, 5.7)	9.4 (9.0, 9.9)
Epilepsy and recurrent seizures	17.0	431 988	3.2 (3.0, 3.3)	5.5 (5.3, 5.7)

Abbreviations: CI, confidence interval; RSV, respiratory syncytial virus.

^aHospitalization rates per 1000 person-years.

^bAdjusted rate includes 38% of bronchiolitis (466.1 excluding 466.1) hospitalizations and 26% of pneumonia codes (480–486 excluding 480.1) among children aged <5 y and 7% among those aged 5 y between November and April.

^cChildren may be counted multiple times if they met eligibility criteria for multiple RSV seasons.

Table 4.

RSV Hospitalization Rates of Children With Neurological Disorders by Severity Markers

Severity Indicator Among Neurological Cohort	Both Databases (N = 1 002 980)		
	Person-Years	RSV-Specific Rate ^a (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)
No severity indicator	672 563	3.2 (3.1, 3.3)	5.3 (5.1, 5.5)
At least 1 severity indicator	191 629	7.8 (7.4, 8.2)	13.2 (12.6, 13.7)
Scoliosis	78 866	7.9 (7.3, 8.5)	13.8 (13.0, 14.7)
Intellectual disability	72 356	6.1 (5.5, 6.7)	10.8 (10.1, 11.6)
Deafness	55 723	11.4 (10.5, 12.3)	18.9 (17.7, 20.0)
Blindness/low vision	14 234	12.4 (10.7, 14.4)	20.8 (18.5, 23.3)

Abbreviations: CI, confidence interval; RSV, respiratory syncytial virus.

^aHospitalization rates per 1000 person-years.

^bAdjusted rate includes 38% of bronchiolitis (466.1 excluding 466.11) hospitalizations and 26% of pneumonia codes (480–486 excluding 480.1) among children aged <5 y and 7% among those aged 5 y between November and April.

Table 5.

RSV Hospitalization Rates Among Children With Neurological Disorders and a Simple Random Sample From the General Pediatric Population Enrolled in the Commercial Database by Age Group

Age Groups (y)	Children with Neurological Condition (N = 563 135)				Comparison Group (N = 7 859 751)			
	Person-Years	RSV-Specific Rate ^a (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)	Person-Years	RSV-Specific Rate ^a (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)	RR RSV-Specific (95% CI)	RR RSV-Associated (95% CI)
<1	8064	24.2 (20.9, 27.8)	35.8 (31.8, 40.2)	114 094	5.3 (4.8, 5.7)	7.0 (6.5, 7.5)	4.6 (3.9, 5.4)	5.1 (4.5, 5.9)
1	25 110	14.9 (13.4, 16.4)	21.7 (19.9, 23.6)	265 414	2.6 (2.4, 2.8)	4.0 (3.7, 4.2)	7.2 (6.4, 8.2)	6.9 (6.3, 7.7)
2–4	66 221	9.0 (8.3, 9.7)	13.0 (12.2, 13.9)	889 863	0.6 (0.59, 0.65)	1.1 (1.05, 1.20)	15.1 (13.5, 17.0)	11.6 (10.6, 12.7)
5–9	123 781	1.8 (1.6, 2.1)	3.7 (3.3, 4.0)	1 687 639	0.06 (0.05, 0.07)	0.1 (0.12, 0.15)	30.3 (24.0, 38.3)	27.3 (23.3, 32.1)
10–18	247 181	0.5 (0.4, 0.6)	1.7 (1.6, 1.9)	3 534 679	0.01 (0.01, 0.02)	0.04 (0.03, 0.04)	39.0 (28.0, 54.3)	45.8 (37.7, 55.6)
Total	470 358	3.2 (3.07, 3.4)	5.5 (5.3, 5.7)	6 491 688	0.3 (0.29, 0.32)	0.5 (0.47, 0.51)	10.7 (10.0, 11.4)	11.1 (10.5, 11.7)

Abbreviations: CI, confidence interval; RR, relative rates; RSV, respiratory syncytial virus.

^aHospitalization rates per 1000 person-years.

^bAdjusted rate includes 38% of bronchiolitis (466.1 excluding 466.1) hospitalizations and 26% of pneumonia codes (480–486 excluding 480.1) among children aged <5 y and 7% among those aged 5 y between November and April.

Table 6.

RSV Hospitalization Rates Among Children With Neurological Disorders and a Simple Random Sample From the General Pediatric Population Enrolled in the Medicaid Database by Age Group

Age Groups (y)	Children with Neurological (N = 439 845)				Comparison Group (N = 3 401 863)			
	Person-Years	RSV-Specific Rate ^d (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)	Person-Years	RSV-Specific Rate ^a (95% CI)	RSV-Associated Rate ^{a,b} (95% CI)	RR RSV-Specific (95% CI)	RR RSV-Associated (95% CI)
<1	8761	32.8 (29.1, 36.8)	45.3 (40.1, 50.0)	105 954	8.8 (8.2, 9.4)	11.4 (10.7, 12.0)	3.7 (3.2, 4.3)	4.0 (3.6, 4.5)
1	26 867	22.9 (21.1, 24.8)	32.3 (30.2, 34.5)	198 222	4.4 (4.2, 4.8)	6.1 (5.8, 6.5)	4.1 (3.7, 4.6)	5.6 (5.1, 6.1)
2–4	72 631	11.5 (10.7, 12.3)	16.6 (15.7, 17.6)	567 096	1.0 (0.9, 1.1)	1.6 (1.5, 1.7)	11.4 (10.2, 12.7)	10.3 (9.4, 11.2)
5–9	113 570	2.4 (2.1, 2.7)	4.4 (4.0, 4.8)	844 053	0.14 (0.12, 0.17)	0.4 (0.35, 0.44)	16.8 (13.5, 20.8)	11.3 (9.8, 12.9)
10–18	172 005	0.7 (0.6, 0.8)	2.3 (2.1, 2.5)	1 172 334	0.03 (0.02, 0.04)	0.1 (0.12, 0.17)	23.0 (15.8, 33.5)	16.1 (13.4, 19.3)
Total	393 834	5.4 (5.2, 5.6)	8.6 (8.3, 8.9)	2 887 660	0.9 (0.84, 0.91)	1.3 (1.29, 1.37)	6.1 (5.8, 6.5)	6.4 (6.2, 6.7)

Abbreviations: CI, confidence interval; RR, relative rates; RSV, respiratory syncytial virus.

^aHospitalization rates per 1000 person-years.

^bAdjusted rate includes 38% of bronchiolitis (466.1 excluding 466.1) hospitalizations and 26% of pneumonia codes (480–486 excluding 480.1) among children aged <5 y and 7% among those aged 5 y between November and April.