CLINICAL SCIENCE

Incidence and recurrence of acute otitis media in Taiwan's pediatric population

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OBJECTIVE: To report the incidence and recurrence of acute otitis media (AOM) in Taiwan's pediatric population.

METHODS: Information from children (aged< = 12 years) with a diagnosis of AOM was retrieved from the 2006 National Healthcare Insurance claims database. We calculated the cumulative incidence rate and the incidence density rate of recurrent AOM within one year after the initial diagnosis in 2006. We used a multivariate logistic regression model to assess the predictors for recurrence of AOM.

RESULTS: The annual incidence rate of AOM was estimated to be 64.5 cases per 1,000 children. The overall one-year cumulative incidence rate of recurrence was 33.1%, and the incidence density rate was 33.5 cases per 100 person-years, with the highest figure (41.2 cases per 100 person-years) noted for children aged 0-2 years. Recurrence was significantly associated with age, gender, place of treatment, and physician specialty.

CONCLUSION: AOM remains a major threat to children's health in Taiwan. Male children and very young children require more aggressive preventive strategies to reduce the risk of recurrence.

KEYWORDS: Child; Cohort studies; Otitis media; Incidence; Recurrence; Risk factors.

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INTRODUCTION

Otitis media is defined as infection in the middle ear. Acute otitis media (AOM) is one of the most common infections in children under 15 years of age.[1] AOM can cause serious symptoms such as fever, otalgia, and otorrhea, all of which may be associated with the use of considerable medical resources. Otitis media with effusion (OME) resulting from AOM can impair hearing, affecting children's school performance and speech development. In general, AOM can disrupt a child's daily activities and have a profound negative impact on the quality of life.[2-4]

AOM is a disease that is prevalent in the pediatric population. Prevention and management of AOM are important from a public health point of view. To improve clinical care and properly allocate medical resources, the medical community must know the epidemiological characteristics of AOM. Although the recent US National Health Interview Survey described declining rates of AOM occurrence, antibiotic prescriptions, office visits for AOM, and middle ear surgery since the licensure and routine use of the pneumococcal conjugate vaccine in infants, the panel report also recommended more research on otitis media to further reduce AOM incidence.[5]

Although mounting data concerning the prevalence and incidence of AOM are available in epidemiological studies, the comparison and extrapolation of epidemiological data from these studies is difficult, if not impossible, mainly due to dissimilarities in study design, sampling methodology, and diagnostic consistency.[2-4] Although the threat that AOM poses to children has been well recognized, limited information is available concerning the nationwide incidence and recurrence of AOM in Taiwan's pediatric population. Using the 2006-2007 National Health Insurance (NHI) claims database, this study sought to investigate the epidemiological characteristics of pediatric AOM in Taiwan. We also aimed to identify the pediatric AOM patients who are at a greater risk of recurrence.

METHODS

Source of Data

A universal NHI program, which is administered by the Bureau of NHI (BNHI) under the jurisdiction of the Department of Health, was implemented in Taiwan in March 1995. Approximately 96% of the Taiwanese popula-

tion enrolled in the NHI program,[6] and the state-run BNHI had contracted with 97% of hospitals and 90% of clinics all over the country by the end of 1996.[7] The BNHI accumulates all administrative and claims data, and the National Health Research Institute (NHRI) cooperates with the BNHI to maintain an NHI research database. The NHRI protects the privacy and confidentiality of all beneficiaries and transfers the health insurance data to health researchers after ethical approval has been obtained. To ensure the accuracy of the claim files, the BNHI performs expert reviews on a random sample of every 50-100 ambulatory and inpatient claims in each hospital and clinic quarterly, and false reports of diagnosis receive a severe penalty from the BNHI.[8] In this study, we used data from the ambulatory care claims (2006-2007) and inpatient claims (2006-2007) and updated registry for beneficiaries (2007). All NHI datasets can be linked with each individual's personal identification number (PIN). The study was approved by the IRB of the Cathay General Hospital.

Study Design and Cohort

This study aimed to estimate the recurrent rate of AOM in Taiwan's child population and to identify the groups at high risk of recurrence. To meet these goals, we adopted a cohort study design. The study cohort consisted of all 283,084 children who had ambulatory care visits or were hospitalized with a primary or secondary diagnosis of AOM (International Classification Code 9th version Clinical Modification (ICD-9-CM): 381.xx or 382.xx) between January 14 and December 31, 2006. The dates of their first-time ambulatory care visit or hospitalization in 2006 were set as the baseline (initial) AOM attack. Baseline information was retrieved from claims data, including the patient's date of birth, gender, place of care (clinics, district or regional hospitals, medical centers), and the specialty of the attending physician. The age of the study subjects was calculated as the difference between the date of the baseline attack and the date of birth.

Data Linkage and Definition of Recurrence

With their unique PINs, the individuals who comprised the study cohort could be linked to the 2006-2007 ambulatory care and inpatient claims to identify the possible recurrence of AOM within 12 months following the baseline attack. Only subsequent ambulatory care visits (or hospitalizations) with a primary or secondary diagnosis of AOM and with a date of ambulatory care visit (or hospitalization) at least 15 days apart from the previous AOM ambulatory care visit (or hospitalization) were considered new episodes (i.e., recurrence). Using the 2007 updated registry for beneficiaries, we were able to calculate the person-years (PYs) for which each study subject had been observed from the baseline attack either to the date of termination of the NHI policy (primarily due to death) or to the 365th day.

Statistical Analysis

Characteristics of the study cohort were first assessed. We then calculated the cumulative incidence rate (CIR) and incidence density rate (IDR) per 100 PYs for AOM within one year of follow-up, according to various subjects' characteristics. The IDR was calculated as the ratio of the total number of AOM recurrences (i.e., frequency) to the total number of PYs observed. Last, we used a multivariate logistic regression model to assess the independent effects of age, gender, place of treatment, and physician specialty on the risk of 1-year AOM recurrence. All statistical analyses were performed with SAS (version 9.1; SAS Institute, Cary, NC). $p < 0.05$ was considered statistically significant.

RESULTS

In 2006, a total of 283,084 children $<=12$ years of age sought treatment for AOM, representing an annual incidence rate of 64.5 cases per 1,000 children (283,084/4,385,779). The age-specific annual incidence rates for children aged 0-2 years, 3-5 years, and 6-12 years were 71.7, 158.8, and 41.0 per 1,000 children, respectively. Male children had a higher incidence rate than females (67.6 vs. 61.2 per 1,000) (data not shown in tables). Table 1 shows the characteristics of both the baseline episodes of AOM in 2006 and all episodes in one year including baseline attacks and recurrent episodes. The mean ($\pm$standard deviation (SD)) age was 4.7 ($\pm$2.8) years for the patients at baseline, and male patients predominated (54.6% vs. 45.4%). Additionally, most (73.4%) baseline episodes were treated at clinics. Nearly 80% of the patients were treated by either otolaryngologists (32.2%) or pediatricians (46.3%). The distributions of the selected variables were almost the same after inclusion of all recurrent episodes during the study period.

The overall IDR of recurrence for the study cohort was 33.5 per 100 PYs, with the highest IDR of 41.2 per 100 PYs noted for the patients aged 0-2 years. The IDR decreased to 38.1 per 100 PYs and 26.7 per 100 PYs for those aged 3-5 and 6-12 years, respectively. The recurrence rate was slightly higher in male patients than in female patients (34.4 vs. 32.5 per 100 PYs). Additionally, the recurrence rate varied slightly (32.7-34.4 per 100 PYs) by place of treatment. Higher IDRs were also noted in patients treated by otolaryngologists (34.0 per 100 PYs) and pediatricians (34.7 per 100 PYs) (Table 2).

Table 1 - Characteristics of the baseline acute otitis media episodes in 2006.

Variables [a]	Baseline episodes in 2006 (N = 283,084)	
	n	%
Age (years)		
0-2	43,404	15.3
3-5	114,040	40.3
6-12	125,640	44.4
Mean ($\pm$SD)	4.7 ($\pm$2.8)	
Gender		
Male	154,692	54.6
Female	128,390	45.4
Place of treatment		
Clinics	207,762	73.4
Hospital		
Medical center	21,709	7.7
District hospital	33,614	11.9
Regional hospital	19,999	7.1
Specialty of attending physician		
Ear, nose, and throat	91,061	32.2
Pediatrics	131,001	46.3
Family medicine	14,548	5.1
Internal medicine	3,906	1.4
Surgery	197	0.1
Others	42,371	15.0

[a]Inconsistency between total population and population summed for individual variable was due to missing information.

Table 2 - Incidence density rate of recurrence of acute otitis media within a one-year period following the baseline attack in 2006 (N = 283,084).

	No. of person-years	No. of recurrent episodes	Incidence density rate (per 100 person-years
Age (years)			
0-2	42,776	17,627	41.2
3-5	11,2674	42,983	38.1
6-12	124,557	33,226	26.7
Gender			
Male	153,014	52,577	34.4
Female	126,993	41,259	32.5
Place of treatment			
Clinics	205,757	69,010	33.5
Hospital			
Medical center	21,387	7,198	33.7
District hospital	33,143	10,844	32.7
Regional hospital	19,720	6,784	34.4
Specialty of attending physician			
Ear, nose, and throat	90,217	30,640	34.0
Pediatrics	129,391	44,861	34.7
Family medicine	14,396	4,801	32.0
Internal medicine	3,869	1,177	30.4
Surgery	194	61	31.5
Others	41,940	12,496	29.8
Total	280,007	93,836	33.5

Table 3 shows the adjusted odds ratios (ORs) associated with the risk of recurrence in relation to the selected variables of interest. Compared with those aged 0-2 years, the patients aged 3-5 years (OR = 0.87, 95% CI = 0.85-0.89) and 6-12 years (OR = 0.51, 95% CI = 0.50-0.52) had significantly reduced odds of recurrence. Female patients also had significantly lower odds of recurrence than male patients (OR = 0.92, 95% CI = 0.91-0.94). Additionally, compared with those treated at clinics, patients treated in medical centers (OR = 0.95) and district/regional hospitals (OR = 0.90) had significantly reduced odds of recurrence. Moreover, the patients treated by otolaryngologists (OR = 1.25, 95% CI = 1.21-1.28), pediatricians (OR = 1.16, 95% CI = 1.13-1.18), and family medicine physicians (OR = 1.08, 95% CI = 1.03-1.13) all had significantly increased odds of recurrence.

Table 3 - Predictors for recurrent episodes of acute otitis media (N = 283,084).

	Recurrence		Adjusted odds ratio	
	n	%	Estimate	95% CI
Age (years)				
0-2	17,627	40.6	1.00	
3-5	42,983	37.7	0.87	(0.85-0.89)
6-12	33,226	26.4	0.51	(0.50-0.52)
Gender				
Male	52,577	34.0	1.00	
Female	41,259	32.1	0.92	(0.91-0.94)
Place of treatment				
Clinics	69,010	33.2	1.00	
Hospital				
Medical center	7,198	33.2	0.95	(0.92-0.98)
District hospital	10,844	32.3	0.90	(0.88-0.93)
Regional hospital	6,784	33.9	0.97	(0.94-1.00)
Specialty of attending physician				
Others	12,496	29.5	1.00	
Ear, nose, and throat	30,640	33.6	1.25	(1.21-1.28)
Pediatrics	44,861	34.2	1.16	(1.13-1.18)
Family medicine	4,601	33.0	1.08	(1.03-1.13)
Internal medicine	1,177	30.1	1.06	(0.99-1.14)
Surgery	61	31.0	1.18	(0.87-1.60)
Total	93,836	33.1		

DISCUSSION

Epidemiological Characteristics in General and in Taiwan

AOM is a public health concern in the pediatric population because of its high incidence and serious adverse outcomes. Although the direct costs of diagnosis and treatment for a single episode of AOM are not tremendously high, the indirect costs associated with health care for recurrent AOM, AOM-related complications, and parental absence from work to care for the children can be substantial.[1] Some epidemiological data are currently available in the literature. Alho et al. reported that the incidence of AOM was 0.93 incidents per child-year during the first 24 months of life.[2] Stangerup et al. estimated that the prevalence of AOM was fairly constant at about 25% during the first 5 years of life.[3] Teele et al., in a prospective cohort study on children from the greater Boston area, reported that by the end of the first year after birth, 62% of children had at least 1 episode of AOM; by the end of the third year of life, the proportion had increased to 83%, and the peak incidence occurred during the first 6 months of life.[4] Previous studies have also indicated that most children may experience at least 1 episode of AOM during their childhood; between 10% and 62% of children had at least 1 episode of AOM by the age of 1 year.[1,4,9,10] Pukander et al. reported an annual incidence rate of AOM of 4.44% in the pediatric population of 2 Finnish towns.[11] Our data were generally compatible with these previous studies. We found that in Taiwan, 64.5 per 1,000 children aged 12 or younger may have experienced at least 1 episode of AOM in a year.

Limited epidemiological data on AOM are currently available in Taiwan. Chen et al. examined 3,013 Ethnic Chinese children (aged 3-6 years) from 19 daycare centers in Kaoshiung City,[12] the largest city in southern Taiwan, and estimated that the prevalence rate of otitis media was 9.82%.[11] However, this cross-sectional survey did not specify the actual prevalence of acute middle ear infection. Parnn et al. identified a total of 119,773 cases of AOM (ICD-9-CM codes: 381.0, 381.4, 382.0, 382.4, and 382.9) from the 2001 NHI database, and most of the cases were under 5 years of age.[13] Parnn et al.'s nationwide study focused on patients' medical utilization and provided limited information on overall and specific rates of prevalence and recurrence. Moreover, the diagnostic codes employed by Parnn et al. to identify AOM were considered inadequate for identification of all AOM patients.[13]

Effect of Age

It is generally agreed that the risk of AOM may decrease with advanced age during childhood. The peak incidence rate of AOM is normally found to occur during the second half of the first year in most studies.[2-4,14] Alho et al. estimated that the CIR of the first episode of AOM was 42.4% (95% CI 40.4-44.4) up to the age of 1 year;[2] Stangerup et al. reported an incidence rate of 22%, 15%, 10%, and 2% at the age of 1 year, 2 years, 3-4 years, and 8 years,

respectively.[3] Our data showed a peak incidence in children aged 3-5 years. This finding is compatible with data from other local pneumococcal studies in Taiwan. A recent study by Wu et al. reported that the peak prevalence of invasive pneumococcal diseases (lobar pneumonia and empyema) was in children aged 4-5 years.[15] Another possible explanation for our finding was that many children who sought care for AOM at age 3-5 years actually incurred this disease at earlier ages. Regarding recurrence, our data were compatible with other studies showing that the odds of recurrence decline with age (IDRs of 41.2 per 100 PYs for age 0-2 years, 38.1 per 100 PYs for age 3-5 years, and 26.7 per 100 PYs for age 6-12 years).

Effect of Gender

Previous studies reached inconsistent conclusions on the effect of gender on the risk of AOM.[3,4,9,10,14] Teele et al.[4] and Sipila et al.[14] found that male gender was a risk factor for AOM. In contrast, Stangerup et al.,[3] Homoe et al.,[10] and Lundgren et al.[9] all concluded that no gender differences were found in the incidence and prevalence of AOM. Our national sample showed that more male than female children (54.6% vs. 45.4%) suffered from AOM at baseline, and the incidence rate of AOM in 2006-2007 was also higher in male children than in their female counterparts (67.6 vs. 61.2 per 1,000). Additionally, male children were more likely than female children to have recurrent AOM (34.4 vs. 32.5 per 1,000 PYs). The plausible mechanisms contributing to the effect of gender on the incidence of AOM have not yet been identified.

Recurrence

AOM is prone to recurrence, and this phenomenon has long been a target of research. Traditionally, initial AOM attack at an earlier age, comorbid airway infection, sibling AOM history, bottle feeding, and daycare condition have been considered risk factors for recurrent AOM.[4,16-18] The recurrence rates reported in previous studies range from 20%- 27% in 6 months[16,18] to 60% in 4 months.[19] Our data showed a recurrence rate of 33.5% in one year in Taiwan's pediatric population, which is somewhat lower than the findings from previous reports. We also found that younger age (0-2 years), male gender, and treatment in clinics were all associated with significantly higher recurrence rates. Parnn et al.[13] reported that in Taiwan, hospital physicians were more likely than clinic physicians to follow the guidelines in treating AOM patients. It is not known, however, whether physician nonadherence in clinics contributes to higher recurrence rates among patients treated in clinics. Interestingly, we noted that otolaryngological and pediatric patients also had increased recurrence rates. We speculated that the patients cared for by otolaryngology and pediatric specialists had conditions that were more severe than the conditions of those cared for by physicians with other specialties. More studies are needed to test this hypothesis and to make more specific interpretations.

Strengths and Limitations

Our study had several methodological strengths. First, we used the NHI dataset, which is nationally representative and with little risk of selection or recall bias, and there is a low likelihood of lack of response and loss to follow-up of cohort members. Second, the use of insurance claim data in clinical research provides easy access to the longitudinal records for a large sample of geographically dispersed patients, which greatly increases the representativeness of the study sample. Third, the large number of study subjects also made it possible for us to perform analyses concerning certain variables of interest including age, sex, physician's specialty, and hospital accreditation.

Our study also had the following limitations. The NHI database is a useful data source for describing epidemiological characteristics of AOM. However, findings from the analysis of claims data can be limited by several factors and should be interpreted with caution. First, the accuracy of diagnostic coding from health care providers can affect the validity of data. Since 2000, the BNHI has been using several monitoring and cross-checking mechanisms to ensure the accuracy of diagnostic coding. [8] Second, there were no laboratory data or chart information available to determine the disease severity of AOM, which might confound the associations of recurrence with selected potential predictors of interest observed in this study. Third, we defined ''AOM episode'' as ''all visits at least 14 days apart'' to overcome the maximum prescription restriction of 3 days for clinics and 7 days for hospitals, but this may cause an underestimation of the actual incidence and recurrence of AOM.

CONCLUSION

Despite differences in incidence rates of AOM between our study and findings from previous studies that are mainly due to differences in diagnosis criteria, sampling methods, observation intervals, and population characteristics, we still found that AOM remains a major threat to children's health in Taiwan. A total of 283,084 children $<=12$ years of age sought treatment for AOM in 2006 in Taiwan, representing an annual incidence rate of 64.5 per 1,000 children. We also found that the overall IDR of recurrence was high at 33.5 per 100 PYs, which requires attention from clinicians and health care administrators. We therefore suggest that more intensive ontological care should be delivered to children with elevated risk of recurrence including males, those aged 0-2 years, those treated at clinics, and those cared for by otolaryngologists or pediatricians.

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