Prevalence and Recurrence of Acute Otitis Media in Taiwan's Pediatric Population

Journal:	*Clinics*
Manuscript ID:	CLINICS-Aug-2010-OA-0312
Manuscript Type:	Original Article
Date Submitted by the Author:	17-Aug-2010
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Keywords:	Child, Cohort studies, Otitis media, Prevalence, Risk factors

PREVALENCE AND RECURRENCE OF ACUTE OTITIS MEDIA IN TAIWAN'S PEDIATRIC POPULATION

Abbreviated title: Acute Otitis Media in Children

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Financial support: none

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Research support: This study is supported by a grant (NSC 96-2314-B-227-005-MY2) from the National Scientific Council, Taiwan.

Objective: To report prevalence and recurrence of Acute Otitis Media in Taiwan's pediatric population.

Methods: Information from children (aged<=12 years) with a diagnosis of Acute Otitis Media was retrieved from the 2006 National Healthcare Insurance claim database. We calculated cumulative incidence rate and incidence density rate of recurrent Acute Otitis Media within one-year after initial attack in 2006. We performed multivariate logistic regression model to assess the predictors for Acute Otitis Media recurrence.

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

Conclusion: Acute Otitis Media remains a major threat to children's health in Taiwan. Male and very young child patients deserve more aggressive preventive strategies to reduce the risk of recurrence.

Keywords: Child; Cohort studies; Otitis media; Prevalence; Recurrence; Risk factors

INTRODUCTION

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

AOM is a disease prevalent in the pediatric population. Prevention and management of AOM are important from public health point of view. To improve clinical cares and properly allocate medical resources, it is important to know the epidemiological characteristics of AOM. There have been some epidemiological data currently available in the literature. Alho et al reported that the incidence of AOM was 0.93 incidence 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 the children had at least 1 episode of AOM; by the end of 3 years old, the proportion increased to 83%; and the peak incidence occurred during the first 6-month of life.[4] Although the recent US National Health Interview Survey described declining rates of AOM occurrence, antibiotic prescriptions, offices visits for AOM, and middle ear surgery since the licensure and routine use of pneumococcal conjugate vaccine in infants, the panel report also recommends more research on otitis media in order for further reduction of AOM incidence.[5]

Despite mounting data concerning the prevalence and incidence of AOM have been available in epidemiological studies, comparison and extrapolation of epidemiological data from those studies are very difficult, even not impossible, mainly due to dissimilarities in study design, sampling methodology, and the diagnostic consistence. [2-4] Although the threat that AOM may cause to children has been well recognized, limited information concerning the nationwide prevalence and recurrence of AOM can be available in Taiwan's children population. Using the 2006-2007 National Health Insurance (NHI) claim database, this study sought to investigate the epidemiological characteristics of pediatric AOM in Taiwan. We also aimed to identify those child AOM patients who are at greater risks 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, has been implemented in Taiwan since March 1995. Approximately 96% of the Taiwanese population 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 establish 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 for the ambulatory care claims (2006-2007) and inpatient claims (2006-2007), and updated registry for beneficiaries (2007). All NHI datasets can be interlinked with each individual's personal identification number (PIN). The study was approved by the IRB of the Cathay General Hospital.

Study Cohort

The study cohort consisted of all 283,084 children who appeared in the 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 in 2006. Dates of their first-time ambulatory care visit or hospitalization in 2006 was set as baseline (initial) attack. A number of baseline information was retrieved from claim data, including patient's date of birth, gender, place of care (clinics, district or regional hospitals, medical centers), and specialty of attending physician. Age of study subjects was calculated as the difference between date of baseline attack and date of birth.

Data Linkage and Definition of Recurrence

With the unique PIN, the study cohort can 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 the 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 one episode of AOM ambulatory care visit (or hospitalization) were considered as new

episodes (i.e., recurrence). With the 2007 updated registry for beneficiaries, we were able to calculate the person-years (PYs) for which each study subject had been observed from baseline attack to the date of either termination of the NHI policy (primarily due to death) or to the 365th day following baseline attack.

Statistical Analysis

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

RESULTS

In 2006, a total of 283,084 children <=12 years sought treatments for AOM, representing an annual prevalence rate of 64.5 per 1,000 children (283,084/4,385,779). The age-specific annual prevalence rate for children aged 0-2 years, 3-5 years, and 6-12 years was 71.7, 158.8, and 41.0 per 1,000, respectively. Male children had a higher prevalence rate than females (67.6 vs. 61.2 per 1,000) (data not shown in Tables). Table 1 shows the characteristics of the baseline episodes of AOM in 2006, as well as the characteristics of all episodes in one-year including baseline attacks and recurrent episodes. The mean (±standard deviation (SD)) age was 4.7

(±2.8) years for the patients at baseline, and male patients tended to dominate the study subjects (54.6% vs. 45.4%). Additionally, a majority (73.4%) of baseline episodes were treated at clinics. Nearly 80% of the patients were treated by otolaryngologists (32.2%) and pediatricians (46.3%). Distributions of the selected variables were almost the same after further 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 ID of 41.2 per 100 PYs noted for the patients aged 0-2 yeas, and it declined to 38.1 per 100 PYs and 26.7 per 100 PYs for those aged 3-5, and 6-12 years, respectively. The recurrent rate was slightly higher in male patients than in female patients (34.4 vs. 32.5 per 100 PYs). Additionally, the recurrent rates were around 32.7 to 34.4 per 100 PYs among the patients who sought cares at different levels of medical institutions. Higher IDRs were also noted in patients cared by otolaryngologists (34.0 per 100 PYs,) and pediatricians (34.7 per 100 PYs,) (Table 2).

Table 3 shows the adjusted ORs associated with the risk of recurrence in relation to the selected variables of interest. Compared to 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) both had significantly reduced OR of recurrence. Female patients also had a significantly lower OR of recurrence than male patients (OR=0.92, 95% CI=0.91-0.94). Additionally, compared to those cared at clinics, the patients cared in medical centers (OR=0.95) and in district/regional hospitals (OR=0.90) all had significantly reduced OR of recurrence. Moreover, the patients cared by otolaryngologists (OR=1.25, 95% CI=1.21-1.28), pediatricians (OR=1.16, 95% CI=1.13-1.18), and physicians of family medicine (OR=1.08, 95%

CI=1.03-1.13) were all associated with significantly increased ORs of recurrence.

DISCUSSION

Epidemiological Characteristics in General and in Taiwan

AOM is a public health concern among pediatric population owing to its high prevalence and serious adverse outcomes. Although the direct diagnosis and treatment for single episode of AOM does not cost much, the indirect cost associated with health cares for recurrent AOM, AOM related complications and parental absence from work for caring their children can be substantial.[1] According to the literature, most of the children may experience at least 1 episode of AOM during their childhood; 10-62% of children had had at least 1 episode of AOM by the age of 1 year. [1, 4, 9, 10] The annual incidence rate of AOM was 4.44% as reported by Pukander et al. in the pediatric population from two Finnish towns'.[11] Our data were generally compatible with previous studies showing that, in Taiwan, 64.5 per 1,000 children aged 12 or less may have experienced at least 1 episode of AOM in a year.

There have been limited epidemiological data on AOM currently available in Taiwan. Chen et al., examined 3013 Ethnic Chinese children (aged 3-6 years old) from 19 daycare centers in Kaoshiung city,[12] the biggest city in southern Taiwan, and estimated that the prevalence rate of otitis media was 9.82%. [11] Unfortunately, this cross-sectional survey did not specify the actual prevalence of acute middle ear infection. Parnn et al identified totally 119,773 cases with 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 by Parnn et al. to identify AOM were considered too few to be able to discover all AOM patients.[13]

Effect of Age

It is generally agreed that the risk of AOM may decrease with advanced age. The peak incidence rate of AOM was 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 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] Although design of the present study did not allow us to estimate AOM incidence rate in Taiwan's pediatric population, our data did show a peaked prevalence in children aged 3-5 years. The finding is compatible with data from other local pneumococcal studies of Taiwan. A very recent study by Wu et al. reported that the peak prevalence of invasive pneumococcal diseases (lobar pneumonia and empyema) was in children at aged 4-5 years.[15] Another reason that may possibly explain our finding was that many children who sought care for AOM at aged 3-5 were actually incurred this disease at earlier ages. As for the recurrence, our data were in compatible with other studies showing that the odds for recurrence does decline with age (41.2 per 100 PYs for aged 0-2; 38.1 and 26.7 per 100 PY, for aged 3-5, and 6-12).

Effect of Gender

Concerning the effect of gender on the risk of AOM, findings from previous studies reached inconsistent conclusions.[3,4,9,10,14] Teele et al. [4]

and Sipila et al. [14], found that male gender was a risk factor for AOM. To the contrary, Stangerup et al. [3], Homoe et al. [10], and Lundgren et al. [9] all concluded that no sexual differences were demonstrated with regard to incidence and prevalence of AOM. Our national sample showed that more male than female children (54.6% vs. 45.4% of female) suffered from AOM at baseline, and the prevalence rate of AOM in 2006-2007 was also higher in male children than on 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 the effect of gender on prevalence of AOM has yet to be identified.

Recurrence

AOM is prone to recurrence, which has long been a research interest. Traditionally, initial AOM attack at earlier age, co-morbid airway infection, sibling AOM history, bottle feeding, and day care condition have been considered as risk factors for recurrent AOM. [4,16-18] The recurrent rates reported in previous studies were variant, ranging from 20%- 27% in 6 months[16, 18] to 60% in 4 months.[19] Our data demonstrated a recurrent rate of 33.5% in a year in Taiwan's pediatric population, which is somewhat lower than the findings from previous reports. We also found in this study that younger age (0-2 years), male gender, and cared in clinics were all associated with significantly higher recurrent rates. Parnn et al.[13] reported that in Taiwan, hospital physicians were more likely than clinic physicians to follow the guideline in treating AOM patients. It is not known however whether non-adherence of physicians at clinics has contributed to higher recurrent rates among patients treated in clinics. Interestingly, we noted that otolaryngological and pediatric patients were also associated with

increased recurrent rates. We speculated that the patients cared by otolaryngology and pediatric specialists were severer than those cared by other physician specialties. More studies are needed to test this hypothesis in order for making more specific interpretations.

Strengths and Limitations

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

Our study also had the following limitations. The NHI database proves to be a useful data source for describing epidemiological characteristics of AOM. However, findings from the analysis of claim data can be limited by several factors and should be interpreted with caution. First, the accuracy of diagnostic coding from healthcare providers can affect the validity of data. Since 2000, the BNHI has been establishing several monitoring and cross-checking mechanisms to ensure the accuracy of diagnostic coding. [8] Second, there has been no laboratory data or chart information available to determine 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 under-estimate of actual prevalence and recurrent episodes of AOM.

Conclusion

Although comparison of prevalence rates of AOM between our study and findings from previous studies mainly owing to differences in diagnosis criteria, sampling methods, observation intervals, prevalence windows, and population characteristics, we still found that AOM remains one of the major threats to children's health in Taiwan. A total of 283,084 children <=12 years sought treatments for AOM in 2006 in Taiwan, representing an annual prevalence 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 deserves attention from clinicians and health care administrators. We therefore suggested that more intensive ontological care should be delivered to those children with elevated risk of recurrence including males, those aged 0-2 years, those cared at clinics, and those cared by otolaryngologists or pediatricians.

ACKNOWLEDGEMENT: This study is based in part on data from the National Health Insurance Research Database provided by the Bureau of National Health Insurance, Department of Health and managed by National Health Research Institutes. The interpretation and conclusions contained herein do not represent those of Bureau of National Health Insurance, Department of Health or National Health Research Institutes of Taiwan, Republic of China.

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Table 1 - Characteristics of the baseline acute otitis media episodes in 2006 and of all acute otitis media episodes within one-year period following baseline attack

Variables [a]	Baseline episodes in 2006 (N=283,084)		Baseline episodes plus all episodes in 1 year following baseline attack (N=437,289)	
	n	%		
Age (years)				
0-2	43404	15.3	62723	14.3
3-5	114040	40.3	186056	42.5
6-12	125640	44.4	188510	43.1
Mean (±SD)	4.7 (±2.8)		4.9 (±2.7)	
Gender				
Male	154692	54.6	242268	55.4
Female	128390	45.4	195019	44.6
Place of treatment				
Clinics	207762	73.4	322502	73.8
Hospital				
Medical center	21709	7.7	33310	7.6
District hospital	33614	11.9	50650	11.6
Regional hospital	19999	7.1	30827	7.0
Specialty of attending physician				
Ear, nose, and throat	91061	32.2	144959	33.1
Pediatrics	131001	46.3	203648	46.6
Family medicine	14548	5.1	25198	5.8
Internal medicine	3906	1.4	6890	1.6
Surgery	197	0.1	326	0.1
Others	42371	15.0	56268	12.9

[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 one-year period following 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	42776	17627	41.2
3-5	112674	42983	38.1
6-12	124557	33226	26.7
Gender			
Male	153014	52577	34.4
Female	126993	41259	32.5
Place of treatment			
Clinics	205757	69010	33.5
Hospital			
Medical center	21387	7198	33.7
District hospital	33143	10844	32.7
Regional hospital	19720	6784	34.4
Specialty of attending physician			
Ear, nose, and throat	90217	30640	34.0
Pediatrics	129391	44861	34.7
Family medicine	14396	4801	32.0
Internal medicine	3869	1177	30.4
Surgery	194	61	31.5
Others	41940	12496	29.8
Total	280007	93836	33.5

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

	Recurrence				Adjusted odds ratio	
	No		Yes			
	n	%	n	%	Estimate	95% CI
Age (years)						
0-2	25777	59.4	17627	40.6	1.00	
3-5	71057	62.3	42983	37.7	0.87	(0.85-0.89)
6-12	92414	73.6	33226	26.4	0.51	(0.50-0.52)
Gender						
Male	102115	66.0	52577	34.0	1.00	
Female	87131	67.9	41259	32.1	0.92	(0.91-0.94)
Place of treatment						
Clinics	138752	66.8	69010	33.2	1.00	
Hospital						
Medical center	14511	66.8	7198	33.2	0.95	(0.92-0.98)
District hospital	22770	67.7	10844	32.3	0.90	(0.88-0.93)
Regional hospital	13215	66.1	6784	33.9	0.97	(0.94-1.00)
Specialty of attending physician						
Others	29875	70.5	12496	29.5	1.00	
Ear, nose, and throat	60421	66.4	30640	33.6	1.25	(1.21-1.28)
Pediatrics	86140	65.8	44861	34.2	1.16	(1.13-1.18)
Family medicine	9947	68.4	4601	33.0	1.08	(1.03-1.13)
Internal medicine	2729	69.9	1177	30.1	1.06	(0.99-1.14)
Surgery	136	69.0	61	31.0	1.18	(0.87-1.60)
Total	189248	66.9	93836	33.1		