The incidence of acute otitis media in New Zealand children under five years of age in the primary care setting

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ABSTRACT

INTRODUCTION: Acute otitis media (AOM) is a common childhood infection. Baseline data are required to evaluate potential changes in the epidemiology of AOM with new public health measures.

AIM: To estimate the incidence of AOM in children under five years of age in primary care in New Zealand.

METHODS: Using a cohort study design, consultation notes from 1 November 2008 to 31 October 2009 from 63 primary care facilities were analysed for new and recurrent episodes of AOM, complications, antimicrobial use and outcome.

RESULTS: There were 19 146 children in the sample. The raw incidence of AOM was 273 per 1000 children (27.3%; 95% CI 216–330). Of the 3885 children, 2888 (74%) had one episode of AOM and 152 (4%) of these children developed recurrent AOM. Incidence declined with age. There was no difference in incidence between Maori, Pacific and 'Other' ethnicities. Antibiotics were used to treat 2653 (51%) AOM episodes and 113 (4.3%) of these children re-presented within three days of antibiotic therapy for persistent symptoms. Tympanic membrane perforation was the only complication noted, observed in 62 (1%) episodes.

DISCUSSION: These data indicate that AOM is an important and frequent childhood infection in New Zealand. The show a significant decline in the use of antibiotics to manage AOM in concordance with accepted best practice. The complication rate of AOM is likely under-represented. This study enables future research into the effectiveness of current and future immunisations and changing management practices in New Zealand.

KEYWORDS: Otitis media; incidence; child, preschool; New Zealand, antibiotic

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Introduction

Acute otitis media (AOM) remains a frequent global infection of childhood, with up to 80% of children having at least one episode by three years of age.[1] Ten to 30% have recurrent episodes,[2,3] and 2–25% will have persistent middle ear effusion extending beyond three months,[1] many of which require tympanostomy tube insertion.[4,5] Persistent tympanic membrane perforation and otorrhoea are significant issues, particularly in specific populations.[5–7] Otitis media and eustachian tube disorders are the third leading diagnosis in GP consultations between 0 and 14 years,[8] and myringotomy and tube insertion the most frequent childhood surgical procedure in the USA.[9] AOM is also the commonest reason for prescribing antibiotics to children in developed countries,[2] contributing to concerns of emerging antibiotic resistance.[6]

The current incidence of AOM in New Zealand is not known. Tilyard et al. reviewed otitis media (OM), including AOM, treatment in general prac-

J PRIM HEALTH CARE 2012;4(3):205–212.

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Table 1. Geographic distribution and proportion of subjects in the study population by District Health Board

District Health Board	Study population n	Population under five years of age N	Proportion of the DHB population included in study (%)
Auckland	1480	28680	5
Bay of Plenty	1697	14410	12
Canterbury	780	33290	2
Capital & Coast	136	19440	1
Counties Manukau	2686	41200	7
Hawkes Bay	1824	11290	16
Hutt Valley	877	10620	8
Lakes	466	8050	6
MidCentral	354	11470	3
Nelson Marlborough	461	8545	5
Northland	1357	11240	12
Otago	1771	10550	17
South Canterbury	267	3285	8
Southland	0	7890	0
Tairawhiti	1015	3905	26
Taranaki	294	7675	4
Waikato	1097	27070	4
Waitemata	1950	37290	5
Wairarapa	0	2680	0
West Coast	395	2125	19
Whanganui	239	4370	5
All	19146	305075	

tice in New Zealand from 1993 to 1994 across all age groups,[10] and Ryan et al. surveyed the management of AOM by GPs further in 2002.[11] Historical studies show rural Maori children have some of the highest rates of chronic suppurative otitis media (CSOM) in the world.[12–14] A more recent New Zealand study demonstrated an incidence of 3871 hospital admissions for OM per 100 000 of the population of children under five years of age, with higher rates of medical admissions amongst Maori and Pacific children.[15]

The incidence of AOM may have been affected by the introduction of a pneumococcal conjugate vaccine (PCV7) to New Zealand in June 2008. There has been a modest reduction in incidence of all-cause AOM in clinical trials of this vaccine in other countries.[16,17] A new pneumococcal conjugate vaccine that targets the two predominant bacterial pathogens of AOM (*Streptococcus pneumoniae* and non-typeable *Haemophilus influenzae*) has been correlated with a greater effect based on an AOM clinical efficacy study with a precursor formulation.[18] This new vaccine was due to replace the PCV7 immunisation in the NZ immunisation schedule in 2011.

The term 'acute otitis media' as used throughout this paper can be interpreted as symptomatic, rapidly forming purulent fluid in the middle ear cleft which occasionally results in rupture of the previously intact eardrum causing discernable otorrhoea. 'Otitis media with effusion' (OME), meaning inflammation associated with fluid behind an intact eardrum without signs and symptoms of an acute infection, is not addressed in this study. 'Chronic suppurative otitis media', where alluded to, describes dry perforations, draining cholesteatomas or chronic discharge via a perforation. 'Otitis media' is used generally to

describe inflammation of the middle ear without regard to aetiology.

In this study, we have examined the current incidence of AOM in New Zealand preschool children presenting to primary care. We also assessed clinical features (including secondary complications and recurrent disease), antimicrobial use, and treatment failures. These data are important for resource management and establishing the impact of current and future vaccines.

Methods

This cohort study reviewed children less than five years of age enrolled in a sample of general practitioner (GP) practices in New Zealand from 1 November 2008 to 31 October 2009.

The study used the random sample of GP practices enrolled in HealthStat, an established primary care surveillance system in New Zealand (See Appendix 1 in the web version of this paper).[19] The 93 GP practices participating in the HealthStat surveillance panel at the time of the study were invited to take part. Sixty-seven of these practices responded, 63 practices accepted the invitation and four declined.

These 63 practices had 261 835 patients enrolled at the time of the study. Children were eligible for the study if they were under five years of age on 1 November 2008 and were continually enrolled in a participating practice from 1 November 2008 to 31 October 2009; 19 146 eligible children were retrospectively enrolled in the study. The geographical distribution of the study population by District Health Boards (DHBs) is detailed in Table 1. Nineteen of the 21 DHBs were represented in the study.

Anonymous data are automatically downloaded weekly from the HealthStat practice databases, using an encrypted messaging system. These data include dates of all consultations, diagnostic coding (and other classifications if recorded by clinicians), prescriptions, laboratory results and demographic data. Although up to three ethnicities were collected for each patient, only one ethnicity was coded per patient with precedence given for Maori, then Pacific, then 'Other'.

WHAT GAP THIS FILLS

What we already know: Acute otitis media (AOM) represents significant disease burden amongst children worldwide. Antibiotics are frequently prescribed for AOM although in most clinical scenarios this is no longer considered best practice. New immunisations targeted at common AOM pathogens have been associated with a decreased incidence of AOM in international studies.

What this study adds: This study presents an estimate of the incidence of AOM in children in New Zealand, and the demographics of the affected population and the management of AOM in primary care. It provides a baseline for future analyses of the impact of existing and new immunisations on the incidence of AOM and of changes in the management of AOM in primary care in New Zealand.

Data on the incidence of AOM were collected by a review of the text of clinical notes written during the study period. All notes with terms that either related to otological disease (e.g. 'AOM', 'OM', 'bulging') or to an otological history or examination (e.g. 'ear', 'drum', 'tymp') were electronically selected for analysis: a list of the search terms is given in Appendix 2 in the web version of this paper. These notes were then reviewed by a team of research nurses. Ambiguous terms were interpreted in context, e.g. 'tymps' was either understood to mean tympanic membrane(s) or tympanogram. In addition to these records, a random sample of 100 records from each practice was reviewed for idiosyncratic abbreviations that indicated a possible otological problem. When a new abbreviation was found, all notes from all the practices were re-examined for the new term.

Episodes of AOM were coded for diagnostic certainty according to the clinical evidence provided (Table 2). If a research nurse had difficulty coding a consultation in terms of diagnosis or diagnostic certainty, the consultation record was examined by the senior research nurse and, if necessary, a GP.

All consultation notes reviewed by the research nurses were examined to determine whether the case related to a new episode of AOM, recurrent AOM, 'treatment failure' or complicated AOM. A new episode of AOM was defined

Table 2. Ranking of criteria for the identification of acute otitis media based on terms used in the consultation notes

Level*	Criteria
Level 1	AOM subjects defined as children (<5 yrs) with diagnosis of AOM/OM.
Level 2	AOM subjects defined as children (<5 yrs) with diagnosis of AOM/OM and at least two clinical signs or symptoms: fever, otalgia, bulging tympanic membranes, or otorrhoea.
Level 3	AOM subjects defined as children (<5 yrs) with diagnosis of AOM/OM and/or clinical signs or symptoms (fever, otalgia, bulging tympanic membrane, otorrhoea) and microbiological results (*S.pneumoniae* culture positive, *H. influenzae* culture positive, serotype results if available).

*The higher the level, the greater the degree of clinical evidence supporting the diagnosis

Table 3. Age, gender and ethnicity demographics of patients in study sample, with comparison to the New Zealand population

	Study population N (%)	NZ population 2009 N (%)	p
Age			
0–5	23 109 (8.8)*	362 858 (8.4)	
Gender			
Male	9730 (50.9)	156 465 (51.3)	0.1982
Female	9416 (49.2)	148 610 (48.7)	
Ethnicity			
Maori	6358 (33.2)	86 930 (28.5)	0.0001
Pacific	1485 (7.8)	33 735 (11.1)	
Other	11 303 (59.0)	18 4410 (60.4)	

* Includes children five years old at 1 November 2008 who were excluded from the final study sample.

as an episode of AOM following a 30-day symptom-free interval. Therefore consultation notes from 1 October 2008 to 31 October 2008 were also reviewed to ensure these patients had not been consulted for middle ear symptoms in the 30 days prior to diagnosis. Recurrent AOM described three or more new episodes of AOM within six months or four or more new episodes of AOM within one year. 'Complicated AOM' was limited to complications which arose during the study period. Perforations were only included as a complication if there was AOM and a visible perforation on the same day. A tympanostomy tube was not regarded as a perforation. Otorrhoea alone or in the presence of a tympanostomy tube was not considered a complication. The prevalence of tympanostomy tube insertions was beyond the scope of this study. A case was considered 'treatment failure' if the physician assessed no improvement in symptoms after 48 hours of antibiotic therapy.

From the collected data, the raw incidence of new episodes of AOM was calculated using the following equation:

$$\text{Incidence} = \frac{\text{Number of new AOM episodes in children <5 years of age during the study period}}{\text{Total number of children <5 years of age in the study cohort from 2008 to 2009}}$$

Further data analyses were performed using SAS 9.2. The confidence intervals were calculated using SAS proc surveymeans (using the Wald method) to estimate the average number of AOM per child, allowing for clustering of children within practices.

Results

Between 1 November 2008 and 31 October 2009, 19 146 children younger than five years old were identified in participating practices representing 19 out of 21 DHBs. The demographics of the study versus the New Zealand population are shown in Table 3.

The number of consultations for AOM identified was 6261. Of these, 5225 related to new episodes of AOM. Hence, the incidence of AOM was 273 episodes per 1000 (27.3%) children under five years of age per annum (95% CI 216–330). The incidence definition includes multiple episodes of new AOM for the same child. The majority of children (74%) affected by AOM had only one episode of AOM during the study period (Table 4). Approximately 20% of children had two cases of AOM and nearly 7% had three or more cases in the 12-month analysis.

These episodes were stratified by age, gender and ethnicity (Table 5). The incidence was highest in children less than one year old and significantly declined with age. There were no significant ethnic group–related differences. Eighty-two percent of episodes met level 2 diagnostic criteria. Less than 1% of cases fulfilled level 3 diagnostic criteria, which required a microbiological result obtained from otorrhoea or tympanocentesis.

Table 4. Number of new episodes of acute otitis media per child from 1 November 2008 to 31 October 2009

New episodes of AOM	Number of children (N)	Total number of episodes (n)	Percentage of children with number of episodes (%)
1	2888	2888	74.3
2	731	1462	18.9
3	199	597	5.1
4	58	232	1.5
5	8	40	0.2
6	1	6	0.0
All	3885	5225	

Recurrent AOM was identified in 152 children, comprising 4% of all the children who had at least one episode of AOM (Table 6). Recurrent AOM was most frequently diagnosed in younger subjects; 6.5% children under one year of age developed recurrent AOM in comparison to less than 1% of four-year-old children.

Fifty-one percent of the AOM episodes were treated with antibiotics. In 4.3% of treated episodes, the child re-presented with persistent symptoms within three days of their initial presentation. The only complication noted in this study was visible perforation, present in 62 (1%) episodes.

Discussion

This retrospective study is the first major analysis of AOM incidence in young New Zealand children. It emphasises the major frequency, impact and socioeconomic burden of AOM. Two hundred and seventy-three episodes per 1000 children per annum is an incidence comparable

Table 5. Incidence of AOM by age, gender and ethnicity

	Number of children (N)	Number of new AOM episodes (n)	Percentage incidence of episodes (%)	95% CI (%)
Age*				
<1	3485	1740	49.9	39.8-60.0
1	4091	1377	33.7	25.8-41.4
2	3951	836	21.2	16.0-26.2
3	3733	688	18.4	13.7-23.1
4	3886	584	15.0	12.1-18.0
All	19146	5225	27.3	21.6-33.3
Gender				
Female	9416	2496	26.5	21.0-31.9
Male	9730	2729	28.0	22.1-32.8
All	19146	5225	27.3	21.6-33.3
Ethnicity				
Other	11303	3187	28.2	21.1-35.3
Maori	6358	1721	27.1	20.7-33.4
Pacific	1485	317	21.3	12.9-29.8
All	19146	5225	27.3	21.6-33.3

* At 1 November 2008

to other developed countries, although differences in study methodology need to be considered.[1,3,20–25] This study includes the first six months of PCV7 immunisation in New Zealand, but predates the introduction of vaccines with increased serotype coverage and activity against other pathogens such as non-typeable *Haemophilus influenzae*.

The gender distribution of the sample was comparable to the New Zealand population, but the ethnicity distribution significantly differed, with Maori being over-represented and Pacific children under-represented. However, calibration of the raw incidence to the New Zealand population by gender and ethnicity has minimal effect on the estimated incidence (i.e. 271/1000 children per annum). Applying this rate to the New Zealand population (July 2009 projection) suggests there are 83 000 new episodes of AOM annually in children less than five years of age.

Approximately half of the AOM episodes were treated with antibiotics. This is a significant decrease from a 96.6% prescription rate in Tilyard's New Zealand study from 1993 to 1994, and the 95% rate self-reported by GPs in Ryan's study in 2002.

The majority of diagnoses (82%) were well supported by at least two documented signs or symptoms, an accepted degree of diagnostic certainty across studies.[1,17,26] There were only three cases of Level 3 diagnostic certainty, as tympanocentesis (penetration of the tympanic membrane to aspirate middle ear contents for diagnostic purposes) is not a routine procedure in primary care in New Zealand.

The decline in incidence of new episodes of AOM with age is consistent with international studies.[1,16,20,27] There was no significant difference in the incidence of AOM across ethnic groups in this study. This was an unexpected finding as risk factors for otitis media (such as exposure to second-hand smoke and lower breastfeeding rates)[28] are more prevalent in the Maori population, and a high prevalence of CSOM in Maori has been previously reported.[12–14] Maori children have a greater 'unmet need' for GP services than non-Maori,[28] which may have contributed to lower AOM rates than anticipated. For children of Pacific ethnicity, recent research showed 1.9% of two-year-old Pacific children investigated for chronic otitis media were incidentally diagnosed with AOM.[29]

The incidence of recurrent acute otitis media was lower than reported in other studies, but an inverse association between recurrent AOM and age was still demonstrated.[1,2] One explanation for the lower incidence is that children in the study, although enrolled in the participating GP practices, may have presented to other general practices throughout the year.

The occurrence of complicated acute otitis media may be under-represented in this study. 'Mastoiditis' and other complications were not search terms used to detect AOM; therefore, complications were only identified if they were simultaneously present with features of AOM during the study period. In addition, New Zealand children with complex disease (e.g. mastoiditis, absence of clinical improvement, out-of-hours deterioration) often present directly to non-GP services such as hospital emergency departments. The only complications identified were 62 visible perforations. In some instances these may have been chronic perforations with acute otorrhoea.

Local data from Starship Hospital (the referral centre for acute otorhinolaryngology services for approximately one quarter of New Zealand's paediatric population) indicate there were 59 admissions consistent with mastoiditis in children less than five years of age from 1 January 2005 to 31 December 2009.[30] The incidence was disproportionately represented amongst Maori and Pacific populations (30.5% (18/59) New Zealand Maori, 27.1% (16/59) Pacific, 42.4% (25/59) 'Other') compared with population statistics 28.5% Maori, 11.1% Pacific, 60.4% 'Other'.[30]

Table 6. Number of cases of recurrent AOM by age

Age	Recurrent episodes		Number of children with non-recurrent AOM (N)	Proportion of children with AOM diagnosed with recurrent AOM (%)	Total number of children with ≥1 episode of AOM (N)
	Number of children with three AOM episodes in six months (N)	Number of children with four AOM episodes in one year (N)			
<1	38	38	1085	6.5	1161
1	27	18	962	4.5	1007
2	12	6	651	2.7	669
3	7	2	546	1.6	555
4	1	3	489	0.8	493
All	85	67	3733	3.9	3885

Approximately half of the AOM episodes were treated with antibiotics. This is a significant decrease from a 96.6% prescription rate in Tilyard's New Zealand study from 1993 to 1994, and the 95% rate self-reported by GPs in Ryan's study in 2002.[10,11] This decreasing trend complies with evidence for the management of AOM in developed countries with the exception of children less than six months of age for whom antibiotics are still recommended.[26,31] It also compares favourably with international antibiotic prescription rates.[20,23] Starship Children's Hospital data over five years does not reflect an increasing rate of mastoiditis with the decrease in antibiotic therapy.[30] All antibiotics prescribed were presumed to be oral antibiotics. The use of topical antibiotics as an adjunct or alternative to oral antibiotics or the presence of concurrent otitis externa was not reviewed.

Limitations of this retrospective study include the lack of independent assessment of the diagnoses and the bias inherent in reviewing and interpreting medical records. Although over 90% of children nationally are able to see their GP when needed,[28] some children may have presented to emergency departments, mobile 'ear clinics', or general practices not registered as their primary health care provider. This would lead to an underestimation of AOM incidence and related complications.

Only two-thirds of the invited general practices agreed to participate in the study. This is likely because of the short recruitment period, as study participation rates are typically around 90%. Some practices do not routinely accept study invitations before they have been discussed at practice meetings, which may occur only quarterly. In spite of this, our study sample represented over 6% of the New Zealand population.

This study demonstrates the importance of AOM in New Zealand children and creates baseline data to enable future analysis of the effect of changing management practices, including the effectiveness of current and future immunisations on the burden of AOM disease.

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FUNDING
We wish to acknowledge GlaxoSmithKline (GSK) for providing the funding for this study. GSK manufactures the new pneumococcal conjugate vaccine which targets the two predominant bacterial pathogens of AOM (*Streptococcus pneumoniae* and non-typeable *Haemophilus influenzae*).

COMPETING INTERESTS
None declared.

APPENDIX 1: Method of Selection of Original HealthStat Sample (2005)

The HealthStat sample was randomly selected in 2005 from all GP practices that used compatible software (MedTech32) for clinical records, i.e. 86% of GP practices in New Zealand at that time. Accident and Medical services were included if they provided general medical services to a registered population.

The sample was stratified according to New Zealand's 21 District Health Boards (DHBs). A quota was set for each DHB in proportion to the population of the DHB. A minimum of three practices were selected from each DHB to protect data anonymity. The sample was selected by listing the practices within a DHB by suburb or town order on an Excel spreadsheet. A random start point was chosen using the Microsoft Excel random number generator and every 'nth' practice was chosen. The sampling fraction was determined according to the number of practices required from each DHB.

In total, 122 GP practices were selected and 103 (84%) of these practices agreed to participate in the HealthStat® programme. Since 2005, eight practices have closed or merged and two practices have withdrawn from the programme, reducing the sample size to 93.

APPENDIX 2: Complete list of search terms used for the consultation notes of the study sample

Text	Action*	Code
<sp>OM	Set	OM
<sp>ROM	Set	OM
LOM	Set	OM
AOM	Set	OM
BAOM	Set	OM
RAOM	Set	OM
LAOM	Set	OM
OTM	Set	OM
BOM and not BOMIAN	Set	OM
DRUM	Set	DRUM
BULGING	Set	DRUM
<sp>EAR<sp>	Set	EAR
<sp>EARS<sp>	Set	EAR
<sp>/EARS	Set	EAR
EARS:	Set	EAR
EARS NAD	Cancel	EAR
EARS CLEAR	Cancel	EAR
EARS FINE	Cancel	EAR
EARS NORMAL	Cancel	EAR
EARS OK	Cancel	EAR
EARS AND CHEST NAD	Cancel	EAR
EARS AND THROAT NAD	Cancel	EAR
<sp>TM	Set	TM
<sp>RTM	Set	TM
<sp>LTM	Set	TM
TYMP	Set	TM
O MEDIA	Set	OMEDIA
OMEDIA	Set	OMEDIA
OTITIS MEDIA	Set	OMEDIA

*Set indicated the notes needed to be reviewed. Cancel indicated notes review was not necessary.