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# Epidemiology of Otitis Media: What Have We Learned from the New Century Global Health Disparities

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## Introduction

Otitis media (OM) is the most frequent reason for which children see a doctor and can be defined as a continuum of conditions that includes acute OM (AOM), OM with residual or persistent effusion, unresponsive OM, recurrent OM (ROM), OM with complications, and chronic OM. The pathogenic mechanisms of OM involve interactions among host characteristics, virulence factors of viral and bacterial pathogens, and environmental factors. A statistical report from the US Agency for Healthcare Research and Quality [1] examined childhood ear infections using the Medical Expenditure Panel Survey 2006 Full Year Consolidated File and showed that the expenditures for outpatient treatment and prescriptions totaled \$ 2.8 billion in 2006. Annual hospital discharge rates for OM declined by 73 % as determined from the National Hospital Discharge Survey (NHDS) [2, 3].

The literature has continued to expand, increasing understanding of the worldwide burden of OM in childhood. Population-based studies

confirmed reductions in OM prevalence. Although most studies concentrated on AOM or OM with effusion (OME), a few examined severe chronic suppurative OM (CSOM), a major public health problem in developing countries and for certain indigenous populations around the world.

For most children, progression to tympanic membrane perforation and CSOM is unusual (low-risk populations). Yet in some communities, more than 4% of the children are affected by chronic tympanic membrane perforation with chronic drainage (high-risk populations). In developing countries, where children have limited access to medical care, suppurative complications of OM are frequent with a high risk of permanent hearing loss. In developed countries, the most common morbidity of OM is conductive hearing loss due to middle ear effusion. Infants with severe and ROM and persistent middle ear effusion are at risk for problems in behavior and development of speech, language, and cognitive abilities.

Selection and spread of multidrug resistant bacterial pathogens arising from extensive use of antimicrobial agents for OM is a problem for management of all diseases due to the pathogens. The careful use of strict diagnostic criteria coupled with judicious use of antibiotic therapy will direct antibiotic treatment to only those patients likely to benefit from it. Parent stress is frequent. Evidence from a large number of randomized controlled trials can help when discussing treatment options with families. Referral to an otolaryngologist should be considered if medical therapy for recurrent AOM or chronic OME (COME) has failed or been poorly tolerated, and if chronic disease or complications are present.

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## Global Health Disparities

OM diagnoses in children and adolescents in the USA declined by 28% between 1997 and 2007, from 345 to 247 per 1000 children younger than 18 years [4]. The youngest children (younger than 3 years) had the highest rates of OM diagnoses, and OM diagnosis rates declined by 38% from 1160 per 1000 children in 1997 to 840 in 2006 and 724 in 2007 [4]. From 1994 to 2009, the percentage of 2- to 3-year-old Canadian children with frequent OM ( $\geq 4$  OM episodes) decreased from 26% in 1994–1995 to 12.6% in 2008–2009, a highly significant reduction ( $p < 0.001$ ). The percentage of 2- to 3-year-old children with at least one ear infection also declined significantly over this time period from 67% in 1994–1995 to 50% in 2008–2009 ( $p < 0.001$ ) [5].

The introduction of pneumococcal conjugate vaccines and the guidelines encouraging primary care providers to use more stringent criteria in diagnosing AOM are probably important factors in the decline in OM incidence and prevalence. The declining rates of OM have been also associated with the increase in smoke-free homes.

In contrast to the youngest children (younger than 3 years), OM diagnosis rates among children in the USA aged 3–5 years and 6–17 years increased (275–316 and 70–107, respectively) between 2006 and 2007. Males and non-Hispanic (NH) whites had higher reported OM-related physician visit rates in all age groups [6].

All children born in Southwest British Columbia, Canada, in 1999–2000 were followed until age 3 years. In this cohort of over 50,000 births, 49% had one or more OM diagnoses during the 3-year period of follow-up, whereas 8% had ROM, defined as four or more physician visits over 12 months or three or more visits during a 6-month period [7].

A prospective birth cohort study in Quebec, Canada, conducted home interviews with mothers of children from age 5 months annually until 8 years of age to determine the frequency of OM and other infections. In this cohort of 1238 families, children attending large group childcare centers had an increased OM incidence compared with those in home care before the age of

2.5 years (incidence rate ratio (IRR) = 1.62; 95% confidence interval (CI), 1.19–2.20) [8].

In 2006, the incidence rate for AOM in a study of Taiwan's pediatric population of children younger than 12 years of age was 65 cases per 1000 children [9]. The incidence density rate (IDR) per 100 child-years for ROM during a 1-year period following the baseline AOM attack was highest among children from birth to 2 years of age, with an IDR of 41.2 cases per 100 person-years, as compared with an IDR of 38.8 for 3- to 5-year-olds and an IDR of 26.7 for 6- to 12-year-olds. Boys had slightly higher IDRs than girls (34.4 vs. 32.5). The highest recurrence rates were from birth to age 2 years (40.6%) as compared with 3- to 5-year-olds (37.7%) and males (34.0%).

A cohort of all school-aged (5–14 years) Sicilian children in the primary school district of Sciacca, from September 2006 to June 2007, showed that the prevalence of OME was 6.8% for children overall and decreased with age from 12.9% in 5- to 6-year-old children to 3% among those 13–14 years old [10]. Multivariate analyses, stratified by atopy status, revealed two significant risk factors for the joint effect of atopy and OME: age (odds ratio (OR) = 2.10; CI, 1.70–2.57) and history of upper respiratory tract infection (URI; OR = 2.71; CI, 1.81–3.98).

The parents of an unselected population of 332 children at school entry (about age 5 years) in the East Berkshire district of the UK were sent postal questionnaires inquiring about various symptoms of OME, rhinitis, asthma, other atopic features, treatment for any of these problems, and possible family history of atopy [11]. About 33% had some otologic symptoms, and 6% had a high likelihood of OME. No significant correlations were found between scores of OME, eczema, urticaria, and food or drug allergies. Otologic and nasal symptoms for OME and rhinitis were highly correlated.

The prevalence of COME was 8.7% in a cohort of 1740 Turkish children aged 5–12 years. *Chronic* was defined as lasting 12 weeks (3 months) or longer [12]. Several risk factors were found to be significantly associated with COME in univariate analyses: center daycare,

frequent AOM and/or URI in the past year, history of allergies, number of siblings, low level of parent's education, and maternal smoking.

The Menzies School of Health Research has been conducting ear health research in the Northern Territory of Australia since the 1980s [13–15]. The largest OM surveys involved children aged between 6 and 30 months and took place in 2001 and 2003. In this 6- to 30-month age group was found that only 10% had aerated middle ears, and 15% had chronic secretory OM. Around 20% had a perforated tympanic membrane, and another 20% had AOM without perforation. Interestingly, most of these children had asymptomatic bulging eardrums.

Indigenous children in the USA, Canada, Northern Europe, Australia, and New Zealand experience more OM than other children. In some places, indigenous children continue to suffer from the most severe forms of the disease. Higher rates of invasive pneumococcal disease, pneumonia, and chronic suppurative lung disease (including bronchiectasis) are also seen.

## Conclusion

The impact of AOM on child health far exceeds the discomfort and suffering associated with individual episodes of disease. AOM is among the largest drivers of antibiotic use in children, providing support for the need of prevention of disease as an important strategy for reducing antibiotic prescribing and subsequently the emergence of resistance.

Recurrent AOM is common, with as many as 20–30% of children suffering three or more episodes before their second birthday, with the potential for persistent middle ear effusion and conductive hearing loss and subsequent delay or impairment in speech and language development.

CSOM also appears to have its origins in early-onset ROM. Although now uncommon in developed countries, CSOM remains an important cause of acquired hearing loss globally, including countries such as India, Australia, and Greenland [16–20].

Finally, AOM, its treatment, and its complications impose significant economic costs on society.

Epidemiologic research continues to expand with more sophisticated research designs being implemented in diverse communities.

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