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Modelling Based Estimates for Severe Pneumonia and Pneumonia Deaths in Indian States

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Objective

This presentation highlights the use of mathematical model to estimate burden of disease in absence surveillance data. We estimated the burden of severe pneumonia, pneumococcal pneumonia and pneumonia deaths in Indian states using a mathematical model through application of vaccine probe methodology and attributable fraction.

Introduction

The Child Health Epidemiology Reference Group (CHERG) has predicted around 43 million pneumonia cases in India. It is recognized that for huge nation like India, which accounts for 23% of global pneumonia burden, the national estimates may hide regional disparities(1). In this context, we have generated Indian state specific burden of severe pneumonia, pneumococcal pneumonia and pneumonia deaths through use of mathematical model.

Methods

We developed a Microsoft Excel-based model to estimate number of new episodes of severe pneumonia for each Indian state. This model is based on the epidemiological concept of potential impact fraction(1) as follows:

$N_{e/cy} = (Pop_{<1yrs}) \times (Inc_{Ind}) \times \{1 + \Sigma_{(RF=1 \rightarrow n)} [(Prev_{RFn} - Prev_{RFnInd}) \times (RR_{RFn} - 1)]\}$,

where Ne/cy is the number of new episodes of clinical pneumonia per year in selected Indian state, $Pop_{<1yrs}$ is the population of children less than 1 years in each state, Inc_{Ind} is the estimated incidence of severe clinical pneumonia at all India level, $Prev_{RFn}$ is the prevalence of exposure to n-th risk factor among under-fives in the Indian state of interest, $Prev_{RFnInd}$ is the prevalence of exposure to n-th risk factor among under-fives at all India level and RR_{RFn} is the relative risk for developing clinical pneumonia associated with the n-th risk factor. We then estimated the number of pneumococcal pneumonia cases by applying the vaccine probe methodology to an existing Philippines trial. The study reported 19.8% efficacy against radiologic pneumonia ((95% CI: -8.8, 40.8) in children age less than 1 year(2). The 11 serotypes contained in the vaccine were estimated to account for 65.33% of IPD in India. With vaccine efficacy against vaccine-type pneumococcal disease of 83%(3), we observed that 23.8% of radiologic pneumonia cases are due to vaccine serotypes and 36.51% due to any pneumococcal serotypes. The mortality rate in hospitalized cases of severe pneumonia (1.95%) and pneumococcal pneumonia (16.7%) in children age less than 5 years was estimated from multi-centric studies.

Results

We estimated that in 2010, 3.57 million severe pneumonia cases and 0.35 million all cause pneumonia deaths occurred in children age less than 5 years in India. Three states requires specific mention, Uttar Pradesh contributed (24% of severe pneumonia cases and 26% of pneumonia deaths), Bihar (16% cases, 22% deaths) and MP (9% cases, 12% deaths) to the national figures. They were also top contributors pneumococcal pneumonia burden, i.e. UP (1,33,160 cases, 27,285 deaths), Bihar (91,574 cases, 23,202 deaths) and MP (52,247 cases, 13,043 deaths). The total numbers of severe pneumococcal pneumonia cases and deaths in 2010 were estimated to be 0.56 million and 95 thousand respectively. The contribution of pneumococcal pneumonia was 15.8% to all cause pneumonia cases and 20.8% to all cause pneumonia deaths. The In age specific analysis, we observed that pneumonia related morbidity was highest in 0-1 year age group (51 %) followed by 1-2 age group (22%), 2-3 years (11%), 3-4 years (9%) and 4-5 years (7%).

Conclusions

To summarize, the state-specific estimates are key for identification of states with high burden of pneumonia related morbidity and mortality and to target interventions for pneumonia prevention and control especially pneumococcal conjugate vaccines to achieve maximum impact.

Keywords

Mathematical Modelling; Pneumonia; Vaccine Probe; Pneumococcal Conjugate Vaccine; Pneumococcal Pneumonia

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