Original Article

Hospital-based surveillance for radiological pneumonia in children under 5 years of age in Uttar Pradesh and Bihar

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ABSTRACT

Background and rationale: Pneumonia is responsible for about 1.4 million deaths in children under five years of age, mostly in developing countries, including India. In India, *Streptococcus pneumoniae* (SP) and *Haemophilus influenzae* (HI) are the common bacterial etiologic agents of pneumonia, and often cause abnormal chest radiology. Vaccine against HI has already been introduced in India. Pneumococcal conjugate vaccine (PCV) roll out will begin in 2017–2018 in a phased manner using Gavi funding.
Objectives:
 (1) To estimate the annual incidence of radiological pneumonia in children between 2 and 59 months of age, in prespecified districts.
 (2) To document the clinical and demographic characteristics of cases of WHO-defined community-acquired pneumonia (CAP) with lower chest in-drawing (LCI) and severe CAP, by establishment of hospital-based surveillance network.
Study design: In a prospective design, surveillance for WHO-defined radiological pneumonia in patients hospitalized for CAP is being done in two districts each of Uttar Pradesh and Bihar. For this, a pneumonia surveillance network of public and private hospitals has been established. Data are abstracted from hospital records. One copy of routine chest X-ray is also collected, digitalized, and archived electronically. An independent panel of radiologists interprets the X-rays. Five milliliters of urine of a subset of cases is being stored at −20 °C for future antigen testing.
   In Phase I, procedures were standardized, hospital network established, and recruitments initiated from Lucknow district. This was expanded in Phase II to include Etawah district, Uttar Pradesh and Patna and Darbhanga districts of Bihar.
Progress: A pneumonia surveillance network was established, having 120 health facilities in Lucknow, 60 in Patna, 64 in Darbhanga and 17 in Etawah. From 1st January 2015 to 30th April 2016, 745 CAP cases were enrolled in Lucknow. From 1st January to 30th April 2016 Patna recruited 229, Darbhanga 321 and Etawah 80 cases. Chest X-rays of all cases have been archived for interpretation by the panel of radiologists.
Implications: Baseline incidence of radiological pneumonia in Uttar Pradesh and Bihar will be estimated and follow-up data will enable assessment of the impact of PCV introduction.

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1. Introduction

Pneumonia is responsible for about 1.4 million deaths globally in children under five years of age.[1] Most of the deaths occur in developing countries, India being one of them. Every 19 s, a child dies in India due to causes that are easily preventable, such as pneumonia, diarrhea, neonatal complications, and malnutrition. Within India, the states of Uttar Pradesh and Bihar are reporting some of the highest rates of infant and under-five mortality. Dedicated efforts are required to improve health systems in these states, as well as to focus on strategies to reduce pneumonia specific morbidity and mortality.

Annually, there are approximately 1.2 million deaths in children under 5 years of age in India, of which 27% in the state of Uttar Pradesh and 22% in Bihar are due to pneumonia.[2] This translates into about 1,09,296 pneumonia deaths annually in Uttar Pradesh or about 300 deaths per day and 12 per hour. In Bihar, there are about 40,480 pneumonia deaths annually or 100 plus deaths/day and 5 per hour. It is clear that if India is to bend the curve of pneumonia cases and deaths, success in Uttar Pradesh and Bihar is paramount.

Community-acquired pneumonia (CAP) could be of viral or bacterial etiology. The etiology varies from country to country and also across different time periods. Pediatric bacterial pneumonia is predominantly caused by *Streptococcus pneumoniae* (SP) and *Haemophilus influenzae* (HiB). Besides, there are other bacterial and viral pathogens associated with clinical cases of pneumonia, as defined by the World Health Organization (WHO).[3] Bacterial culture and molecular techniques for identification of most common pathogens, SP and HiB, are difficult and give variable yields, especially in children who have received prior antibiotic treatment. Radiological confirmation of pneumonia is more reliable and operationally easier, and when the film is interpreted by standardized procedures, it gives a good inter-rater reliability and sensitivity and specificity for diagnosing clinical pneumonia.[4,5] Therefore, radiological identification of pneumonia has been used in multiple studies worldwide as a reliable surrogate marker for bacterial etiology.[6]

The research hypothesis is that precise estimate of radiological pneumonia in children between 2 and 59 months of age will provide data for informed decision making for the introduction of pneumococcal conjugate vaccine (PCV) in India and then to assess its impact. It is also hypothesized the occurrence of radiological pneumonia among those with symptoms of CAP with lower chest in-drawing (LCI) and severe CAP in the last one year, in a specific geographical area, can be estimated through a hospital pneumonia surveillance network.

The primary objectives of this study are as follows: (a) to estimate the annual incidence of radiological pneumonia in children between 2 and 59 months of age, with CAP, as defined by WHO, residing in a prespecified district and (b) to document the clinical and demographic characteristics of cases of WHO-defined CAP with LCI and severe CAP, by establishment of hospital-based surveillance network. The secondary objectives are to estimate the annual incidence of radiological pneumonia as follows: (i) in children in age categories of 2–11 months, 12–23 months, and 24–59 months; (ii) among males and females; and (iii) in those residing in rural and urban areas; and (iv) by preserving 5 ml urine at −20 °C for future antigen testing for the cases with radiological pneumonia.

2. Study methodology

2.1. Geographic location

This project is being conducted in two North Indian States of India, Uttar Pradesh and Bihar, both of which have poor health indices. Infant mortality rate (IMR) and maternal mortality rate (MMR) in both states are higher than the national average (Table 1). Uttar Pradesh, the most populous and fifth largest state in India, is divided into 75 administrative districts. Bihar lies to the east of Uttar Pradesh. It is the third most populous state in India and is divided into 38 administrative districts.

2.2. Study site

The study sites are shown in Fig. 1. All of these sites are teaching, government medical colleges with tertiary care hospitals that have departments of pediatrics and radiology (or radio-diagnosis). KGMU, Lucknow has 170 pediatric beds, while Patna Medical College has 230, Darbhanga Medical College has 117, and Uttar Pradesh Rural Institute of Medical Science, Etawah has 70.

2.2.1. Inclusion and exclusion criteria

Included are (a) children aged 2–59 months; (b) hospitalized with symptoms of WHO-defined CAP with LCI and severe CAP; (c) residing in the prespecified district where the medical institution is situated (catchment area); (d) digital or analog chest X-ray picture available; and (e) whose parent provides consent for participation.

Excluded are those (a) whose cough and respiratory symptoms have been there for more than 14 days (to exclude tuberculosis); (b) whose pleural tap/intercostal drainage has been done prior to hospitalization (as radiological picture would have altered); and (c) who have been admitted within 14 days of discharge from a hospital facility (as they are likely to have nosocomial infections).

The study is being conducted after ethical approval of institutional ethics committee of the coordinating center and initial study site King George's Medical University (KGMU) and

Table 1
Infant mortality rate (IMR) and Birth indicators in project locations.

India/state/district	Population (million) [2011][a]	Literacy (%) [2011][a]	Infant mortality rate[b]			Crude birth rate[b]		
			Total	Rural	Urban	Total	Rural	Urban
India	1210.2	74.0	40	44	27	21.4	22.9	17.3
Uttar Pradesh	0204.2	67.7	50	53	38	27.2	28.1	23.3
Lucknow	0002.8	77.3	44	53	34	18.4	22.4	15.2
Etawah	0000.2	70.1	73	72	76	22.8	23.8	19.0
Bihar	0099.0	61.8	42	42	33	27.6	28.3	21.5
Darbhanga	0000.2	64.0	48	47	63	26.3	26.7	21
Patna	0001.6	70.6	39	46	30	21.8	25.8	18.0

Source:
[a] Census of India. Available from: http://censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf [accessed 25.05.16].
[b] Sample Registration System (SRS). Registrar General India. 2013. Available from: http://censusindia.gov.in/vital_statistics/SRS_Bulletins/SRS%20Bulletin%20-Sepetember%202014.pdf [accessed 25.05.16].