Predictors for critical care admission among children presenting to emergency department with recurrent wheezing

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ABSTRACT

Context: Children with recurrent wheezing contribute to a significant burden of inpatient hospital admission in developing countries. However, many patients could be managed at home following a short observation period in emergency unit. Aim: This study aimed to determine the predictors of critical care admission in a population of children aged 6 months to 2 years attending pediatric emergency department (ED) for recurrent wheezing. Setting and Design: This is a case–control study conducted in pediatric ED of a tertiary care center in North India. Patients and Methods: Demographic and clinical details were recorded for children aged 6 months to 2 years who presented to ED for “recurrent wheezing” within 48 h of onset of symptoms. Those who were admitted to critical care unit were considered cases and those who were discharged within 6 h of stay at short observation units of ED were considered controls. Statistical Analysis: Logistic regression model was used to determine which of the various demographic and clinical factors best predicted the need for critical care admission.

Results: The cases (n = 58) had significantly higher number of emergency visits in the preceding 1 month (P = 0.018), had more episodes of wheezing in the last 3 months (P = 0.025), had higher respiratory rate (P < 0.001), and had higher clinical severity score (P < 0.001) when compared to control (n = 58) group. Logistic regression model revealed incomplete immunization status of children (P = 0.005) to be a significant risk factor that determine the need for critical care admission.

Conclusion: The present cross-sectional study with limited sample size revealed incomplete immunization status of children to be a significant risk factor that determined the need for critical care admission among children below 2 years of age presenting to ED with recurrent wheezing.

Key Words: Child, immunization, India, recurrent wheezing

INTRODUCTION

Wheezing is a common symptom in early life, especially among infants and children under 2 years of age. It is estimated that 20% of children will have an episode of wheezing before 1 year of age, one-third might have such an episode in the first 3 years, and almost half of them have until 6 years of age.[1] In a large multicentric study conducted across Latin America and Europe, it was observed that recurrent wheezing was associated with a significant morbidity in terms of severe episodes (59.4%), visits to the emergency department (ED) (71.1%), and hospital admissions (26.8%).[2] Acute episodes of wheezing in young children are predominantly viral in origin; other causes include allergic tendencies, congenital malformations of respiratory

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tract, congenital lung disease, chronic heart disease, foreign body aspiration, and gastroesophageal reflux.[8] The risk factors found to be associated with recurrent wheezing include a family history of asthma, neonatal hospitalization, and parental history of allergic rhinitis.[4]

The need for hospitalization in such children is most often a decision of the attending emergency physician. Hospitalization of children who would otherwise settle down within the next 24 h would add to burden of the health-care system. Hence, in the absence of clear predictors for wheezy episodes warranting hospitalization, there could be wastage of precious time and resources. On the other hand, a sick infant with recurrent wheezing needs to be shifted to critical care unit without wasting time in the observation units of ED.

It is estimated that preschool wheezers utilize 0.15% of the total health-care budget.[9] Short-term observation units have the ability to improve the quality of care given for the patients as they offer care for longer time than usual emergency visit and reduce the inpatient admission, liability, and health-care costs. This is particularly important within the context of developing countries with meager health-care resources. In this context, it would be good if we can predict as to who requires critical care admission and who can be managed at short observation unit of ED among children who present with recurrent wheezing. Hence, the present study was designed to determine the predictors of critical care admission in children aged 6 months to 2 years presenting with recurrent wheeze.

PATIENTS AND METHODS

This case–control study was conducted in a pediatric ED of a tertiary care center in North India catering to urban and rural population within the city and its neighboring districts. The recruitment of children was done over a period of 4 months from June 2013 to September 2013 after obtaining informed written consent from the caregiver and permission from the Institutional Ethics Committee.

Study participants

Children aged 6 months to 2 years hospitalized for “recurrent wheezing” (defined as three or more significant attacks of wheezing episodes in the past 6 months) who presented to ED within 48 h of the onset of symptoms were considered as cases. The attacks were considered “significant” when the wheezing persisted for a minimum of 24 h in each episode separated by a minimum of 1 week symptom-free interval. Controls were age- and gender-matched children with recurrent wheezing presenting to ED within 48 h of the onset of symptoms, but discharged within 6 h of stay at short observation units of ED. Children diagnosed with any acute or chronic neurological illness, chronic systemic ailments such as congenital heart disease, chronic liver disease, chronic renal failure, pulmonary tuberculosis, and chronic lung disease were excluded from the study.

Sample size

A sample size of 116 children (58 cases and 58 controls) was estimated based on a previous population-based cohort study on children with a history of recurrent wheezing, estimating the proportion of them with a family history of asthma (one of the risk factors for recurrent wheezing) in both the parents being 8.2%.[8] The odds ratio (OR) of positive family history of asthma among hospitalized children with recurrent wheezing was estimated at 2.34 based on another previous study.[7] Power of the study was set at 80% with two-sided confidence level of 95% and 1:1 proportion of cases and controls.

Baseline clinical data

Consecutive children aged 6 months to 2 years who presented with “recurrent wheezing” were enrolled in the study. A detailed history and complete physical examination, including the anthropometric measurements, was performed. Following data regarding the wheezy episodes, the following were recorded: age at onset, age at presentation, duration of disease, number of previous hospitalizations in the past 6 months, and time since the last attack. Risk factors for wheezy children were recorded in terms of duration of breastfeeding, history of prematurity (<37 weeks), prolonged neonatal (neonatal Intensive Care Unit [NICU]) stay (>7 days), immunization status (immunized/unimmunized or partially immunized), history of affected sibling, history of day care stay, socioeconomic status (revised Kuppuswamy classification), family history of asthma/atopy/smoking, and history of indoor air pollution. Immunization refers to administration of vaccine as per the National Immunization Schedule of India (bacillus Calmette–Guérin, oral polio vaccine, hepatitis B, diphtheria, pertussis tetanus, measles, and measles, mumps, rubella).

An examination focused on anthropometric variables (weight for age, weight for height, and height for age), use of accessory muscles (absent, mild, moderate, and severe), respiratory rate/pulse rate (percentage of mean for age and gender), breath sounds (normal/decreased), and rhonchi (absent, mild, moderate, and severe) was performed. In addition, each child was assigned a clinical severity score ranging from 0 to 8 based on scoring system.[8]

Treatment protocol

The need for hospitalization and further treatment course were strictly based on hospital unit protocols. Indications for critical care admission included a failed response to a trial of inhaled bronchodilators (if there is no clinical response to three nebulizations with salbutamol at 0.15 mg/kg spaced 20 min apart). The criteria for discharge were minimal or absent wheezing and absence of the use of accessory muscles. The investigator had no role in the decision to admit or discharge the child.

Study outcome

Outcome of admitted patients was recorded as discharged/ died/leave against medical advice/absconded. In addition, the duration of length of hospital stay was recorded. A child
was considered “improved” once respiratory distress settled, oral acceptance was well tolerated, and well and subjective improvement of more than 50% in cough as perceived by the parents. Controls were discharged after an initial short stay at the observation unit. They were contacted telephonically after 1 week to ascertain the duration of symptoms (time for clinical recovery).

**Statistical analysis**

The data were entered by two investigators into separate Microsoft Excel sheets; the sheets were compared, and any inconsistency was cross-checked with the original data. Categorical variables were presented as proportions and their comparison between cases and controls was computed using the Chi-square test. Continuous variables were presented as mean (standard deviation) and were compared using the unpaired Student’s t-test. The level of significance was assumed at 5%. All the study variables were compared between cases and controls and subjected to univariate analysis. The variables which differed significantly between the cases and controls were then subjected to multivariable logistic regression analysis.

**RESULTS**

A total of 58 cases and 58 controls were consecutively enrolled in the study. The cases and controls were comparable in terms of sociodemographic background and risk factors for recurrent wheezing except for lower immunization rates among cases ($P < 0.001$) [Table 1]. On comparison of disease characteristics, the children in the case group were found to have made significantly more number of emergency visits in the preceding 1 month ($P = 0.018$) and had more episodes of wheezing in the past 3 months ($P = 0.025$) [Table 2]. The symptoms such as running nose ($P < 0.001$), poor oral intake ($P = 0.003$), and altered sensorium ($P = 0.002$) were more common in cases when compared to controls. Similarly, duration of symptoms, including cough ($P = 0.001$), fever ($P = 0.001$), respiratory distress ($P = 0.001$), and poor oral intake ($P = 0.001$), were significantly more common among the cases as compared to controls [Table 2]. Cases had a significantly higher respiratory rate ($P < 0.001$), higher clinical severity score ($P < 0.001$), presence of rhonchi ($P = 0.002$), and use of accessory muscles ($P < 0.001$) as compared to control group [Table 2].

Logistic regression analysis model revealed that immunization status of children ($P = 0.005$) best predicted the need for critical care admission. Factors such as residence ($P = 0.2$), number of wheezing episodes in the past 3 months ($P = 0.47$), and number of emergency visits in the past 1 month ($P = 0.19$) did not have a significant association with the need for critical care admission.

**DISCUSSION**

The present study found that the factor that best predicted the need for critical care admission among children <2 years of age presenting with recurrent wheezing include incomplete immunization status of children. This could imply that incompletely immunized or un-immunized children presenting to the ED with recurrent wheezing could be considered for inpatient admission rather than observing them in short observation units.

There are a host of risk factors that are associated with recurrent wheezing in children below 5 years of age. In a population-based study from Brazil, it was observed that 12% (120/1534) of children below 4 years of age had recurrent wheezing. Among these children, maternal atopic dermatitis was found to be an independent risk factor for recurrent wheezing. However, family history of asthma and atopic dermatitis were comparable among the cases and controls in our study. We believe that although an important risk factor for recurrent wheezing, family history is downplayed by other risk factors such as poor immunization coverage, lower socioeconomic status, and poor personal hygiene. In another study from Brazil, it was seen that risk factors associated with recurrent wheezing included a history of previous

**Table 1: The baseline demographic comparison between cases and controls**

| Demographic characteristics | Cases (n=58) | Controls (n=58) | P |
|----------------------------|-------------|----------------|---|
| Age in months (median [IQR]) | 7.6 (3.6) | 7.8 (4.6) | 0.73 |
| Gender, n (%) | | | |
| Male | 47 (81) | 38 (65.5) | 0.06 |
| Female | 11 (19) | 20 (34.5) | |
| Residence, n (%) | | | |
| Urban | 47 (81) | 37 (65.6) | 0.03 |
| Rural | 11 (19) | 21 (36.4) | |
| Parental education, n (%) | | | |
| Graduate | 8 (13.80) | 11 (19) | 0.37 |
| Up to high school | 42 (70.68) | 43 (74.1) | |
| Illiterate | 9 (15.52) | 4 (6.9) | |
| Occupation, n (%) | | | |
| Profession | 8 (13.8) | 8 (13.8) | 0.18 |
| Clerk/shop/farmer | 6 (10.34) | 26 (42.6) | |
| Skilled worker | 9 (15.52) | 9 (14.6) | |
| Unskilled | 35 (60.34) | 25 (44.0) | |
| NICU stay, n (%) | | | |
| No | 44 (70.69) | 51 (87.9) | 0.078 |
| Yes | 14 (24.2) | 7 (12.1) | |
| Exclusive breastfeeding, n (%) | | | |
| Yes | 39 (67.24) | 42 (72.4) | 0.544 |
| No | 19 (32.76) | 16 (27.6) | |
| Immunization, n (%) | | | |
| Immunized till date | 45 (77.58) | 56 (96.5) | <0.001 |
| Partially/unimmunized | 13 (22.42) | 2 (3.5) | |
| Pneumococcal vaccine, n (%) | | | |
| Received | 1 (1.72) | 0 | 0.315 |
| Not received | 57 (98.28) | 58 (100) | |
| Family history of asthma, n (%) | | | |
| Yes | 10 (17.24) | 14 (24.2) | 0.359 |
| No | 48 (82.76) | 44 (75.8) | |
| Family history of atopy, n (%) | | | |
| Yes | 5 (8.62) | 10 (17.2) | 0.126 |

IQR: Interquartile range, NICU: Neonatal Intensive Care Unit, SD: Standard deviation
Our study population was dominated by urban population, low parental education, and lower socioeconomic status with male predominance. Breastfeeding is known to have protective effects for occurrence of wheezing among children.[13,18] In a large multicentric study across Latin America and Europe, it was observed that breastfeeding for >3 months protected children from recurrent wheezing (OR: 0.8 [0.71–0.89] in Latin America and 0.77 [0.63–0.93] in Europe).[17] Although we observed that the number of infants who were exclusively breastfed were lower in cases when compared to controls, it did not reach statistical significance. This finding appears to be incidental rather than a point to argue, as it is well known that exclusive breastfeeding protects the child from wheezing episodes. Surprisingly, we did not find it to be a significant predictor for the need of critical care admission. In contrast to our findings, previous studies have found previous NICU admission (OR = 7.2, 95% CI = 1.85–27.7) to be a predictor of hospitalization in children with acute asthma.[13]

We observed that family history of asthma and atopy was not a significant predictor for the need of critical care admission; the findings are consistent with other studies.[7] However, in a study by Quah et al.,[14] it was found that family history of asthma (OR = 6.36, 95% CI = 4.45–9.09), maternal (OR = 2.12, 95% CI = 1.31–3.41) or paternal history of allergic rhinitis (OR = 1.52, 95% CI = 0.95–2.43), is a risk factor associated with wheeze in children aged 1–5 years.

It was observed that children who required admission (cases) had a significantly higher number of emergency visits in the preceding 1 month and larger number of previous episodes of wheezing in the past 3 months. However, the logistic model did not reveal its independent contribution in critical care admission. It is not surprising to know that children who visit EDs regularly are more prone to get admitted as compared to infrequent visitors. Previous authors have found wheezing before 3 years as a poor predictor of developing asthma at a later stage in life.[15] However, children with more frequent wheezing before 3 years of age in addition to a parental history of asthma or allergies were found to have an increased risk of asthma at 7 years of age.[19] In the present study, severity of illness was determined by clinical severity scoring developed by Wang et al.,[24] where we found that cases had significantly higher scores than the control group.

The present study addresses an important and pertinent research question to decrease the burden of ED. Limitation of the study includes small sample size, cross-sectional study design, and lack of long-term follow-up. Hence, future studies could be performed among larger sample size with a cohort study design to compare the long-term outcome of children who were managed successfully in short observation units vis a vis those who required long-term hospitalization or critical care admission.

CONCLUSION

The present cross-sectional study with limited sample size found incomplete immunization status of children to be a significant predictor.
predictor for the need of critical care admission among those below 2 years of age presenting with recurrent wheezing. This finding re-emphasizes the need for complete immunization among children with recurrent wheezing.

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**Conflicts of interest**
There are no conflicts of interest.

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