Standardized diagnosis of pneumonia in developing countries

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The World Health Organization recommends the use of raised respiratory rate and chest wall indrawing to enable health workers in developing countries to diagnose pneumonia. We evaluated the current World Health Organization guidelines for management of the child with cough or difficult breathing in Manila, Philippines and Mbabane, Swaziland using an identical protocol in both countries. Raised respiratory rate was defined as ≥50/minute for children ages 2 to 12 months and ≥40/minute for children 12 months to 5 years. Chest wall indrawing was defined as inward movement of the bony structures of the lower chest wall with
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The definition of chest wall indrawing used includes
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vere and requiring admission to hospital. This would
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The study described in this paper was designed to
assess whether the respiratory rate which defines fast
breathing should be 50/minute for all children be-
tween 2 months and 5 years or 50/minute for children
2 to 12 months old and 40/minute for children 1 to 5
years old. The second objective was to assess the effect of
restricting the definition of chest wall indrawing to include only inward movement of the bony structures
of the lower chest wall, thus excluding intercostal
indrawing. These issues were studied in two very
different developing countries: the Philippines and
Swaziland.

INTRODUCTION
In 1989 there were still 57 countries reporting mor-
tality in children younger than 5 years of more than
100/1000 live births. It has been estimated that of 15
million deaths annually worldwide in children less
than 5 years, at least 4 million are caused by acute
respiratory infections (ARI). The main objective of the
World Health Organization (WHO) Programme
for the Control of Acute Respiratory Infections, which
was initiated in 1982, is to reduce mortality caused by
ARI. The main strategies are case management and
immunization.

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The study described in this paper was designed to
assess whether the respiratory rate which defines fast
breathing should be 50/minute for all children be-
and clinically severe malnutrition. Because these symptoms are more often indicative of severe disease other than pneumonia, they were not included in the analysis of this study. All wheezing children were excluded from the calculations so that results coming from different sites would be comparable and not biased by the differing prevalences of bronchiolitis and asthma.

Continuous variables were compared using the Wilcoxon rank sum test; 2 x 2 tables were compared using Fisher’s exact test.

RESULTS

A total of 730 patients were studied in the 2 centers, 368 in Manila and 362 in Mbabane. Both groups had a median age of 19 months (range, 1 to 60). A history of prior use of antibiotics was more common in Manila than Mbabane (27 vs. 5%, P < 0.001). Compared with Mbabane there were more children in Manila presenting with difficult breathing (37 vs. 29%, P < 0.05), and more children admitted to hospital (13 vs. 3%, P < 0.001). Other aspects of history and examination were similar in the 2 groups. After exclusion of children with wheeze, the pediatricians concluded that 102 children in Manila and 26 children in Mbabane had pneumonia.

Despite the marked difference in the prevalence of pneumonia between the two study populations, the sensitivities and specificities of the modified WHO protocol at different respiratory rates were very similar (Table 1). The positive predictive value of the protocol was lower in the study from Mbabane where the prevalence of pneumonia was lower. As reported by the Manila midwives, the sensitivity of the protocol with various respiratory rate thresholds for the prediction of pneumonia was similar to that found by the pediatrician, but the specificities and positive predictive values were lower, indicating that there were more false positives. This was not observed at Mbabane. When these simple criteria were used by both pediatricians and health workers, the health workers in Manila and Mbabane agreed with the pediatrician on the presence or absence of pneumonia in 70 and 81% of the cases, respectively (Table 2). The conclusion of “pneumonia” was reached by the pediatricians but not by the health workers in 7% of cases in Manila and 8% in Mbabane. The conclusion of “pneumonia” was reached by the health workers but not by the pediatricians in 23% of cases in Manila but only 12% in Mbabane.

With the use of the pediatricians’ observations, children from both studies with pneumonia who would have been missed by the WHO protocol were compared with all other pneumonia cases. The missed cases had significantly less intercostal chest wall indrawing (2 of 25 vs. 34 of 103, P < 0.05) and fever (>38°C; 7 of 25 vs. 55 of 103, P < 0.05), suggesting that they were in fact milder cases. By definition they did not have fast breathing or lower chest wall indrawing. They did not differ with respect to age, duration of symptoms or the presence of malnutrition.

To assess the effect of restricting the definition of chest wall indrawing to children with distortion of the bony structures of the lower chest wall, children in both studies with lower chest wall indrawing were compared with those with intercostal indrawing only. Those with intercostal indrawing only were older (median age, 19 months vs. 8 months; P < 0.001) and less likely to be regarded by the pediatrician as having severe pneumonia (3 of 36 vs. 27 of 51, P < 0.001).

DISCUSSION

In the Manila study a surprisingly high proportion of ARI cases had clinical pneumonia. This was not found in Swaziland and probably reflects the extreme

<table>
<thead>
<tr>
<th>Health Worker’s Conclusion</th>
<th>Pediatrician’s Conclusion</th>
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<tr>
<td>No pneumonia</td>
<td>Pneumonia, not severe</td>
</tr>
<tr>
<td></td>
<td>Severe pneumonia</td>
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<td>a. Manila</td>
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<tr>
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<td>b. Mbabane</td>
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<tr>
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<td>30</td>
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* Respiratory rate 50 or more in children under 12 months, 40 or more in those 12 months or older.
poverty of the urban population served by the San Lazaro Hospital in Manila. A high measles prevalence in Manila also contributed to the higher pneumonia prevalence there.

The modified WHO treatment protocol produced similar measures of sensitivity and specificity for the prediction of pneumonia in these two very different settings, suggesting that raised respiratory rate and chest wall indrawing predict pneumonia in a similar fashion in different populations. Some children with clinical pneumonia were missed by application of the protocol, but they tended to be older with less severe disease. Relatively untrained health workers, given a short period of instruction, showed good agreement with the pediatricians in positive cases but found more false positives. With any physical sign of constant sensitivity and specificity, the positive predictive value will vary with the prevalence of the disease. This effect was observed in the present study where the prevalence of pneumonia, and consequently the positive predictive values of the treatment protocols, was lower in Mbabane than Manila.

There are three previously published studies evaluating respiratory rate as a predictor of pneumonia (Table 3). The important considerations in these studies are the definition of pneumonia and the choice of study population. The definition of pneumonia determines the need for antibiotics in children with acute respiratory infection. It has been well shown that children with clinical and radiologically apparent pneumonia benefit from antibiotic therapy,

<table>
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<tr>
<th>Authors</th>
<th>RR &gt;40</th>
<th>RR &gt;40 + indrawing</th>
<th>RR &gt;50</th>
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<td>Shann et al.</td>
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<td>Campbell et al.</td>
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<tr>
<td>Redd et al. (submitted for publication)</td>
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<td>0.62/0.92</td>
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<td>0.77/0.83</td>
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<tr>
<td>Swaziland (present study)</td>
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...rate of 40 was used for children older than 12 months, sensitivity was improved, but there was an equivalent loss of specificity.

Cherian et al. studied 682 children with ARI at Vellore, India. They defined all children with any auscultatory findings or radiographic abnormalities as having "lower respiratory tract infections" requiring antibiotics, thus throwing the net considerably wider than Shann et al. did. The study population of Cherian et al. included a mixture of outpatients and inpatients with ARI. They concluded that the respiratory rate producing the most favorable combination of sensitivity and specificity was 50 for children younger than 12 months and 40 for those older than 12 months. Neither of these studies was conclusive. The narrow end point and absence of radiology in the study of Shann et al. would have excluded some pneumonia cases, whereas uneven inclusion criteria and the presence of wheezing as a positive end point introduced biases into the study of Cherian et al.

A community-based study by Campbell et al. carried out in a rural area of the Gambia arrived at the same conclusion as that of Cherian et al., but with much higher sensitivities and specificities than the other studies. In that study respiratory rates were obtained by field workers in the patient’s home. If the rates were more than 50 they were repeated and if the respiratory rate was consistently more than 50, or the child was febrile or had chest wall indrawing, the child was evaluated by a physician and a chest radiograph was taken. The study of a healthy population and repeated measurement of respiratory rate resulted in a high measured specificity, whereas failure to examine and obtain roentgenograms for children who did not have tachypnea, chest wall indrawing or fever resulted in a high measured sensitivity.

A recent study by Redd et al. (submitted for publication) examined 950 children presenting to a hospital in Lesotho with respiratory symptoms. They used radiologic consolidation as the end point. Children assessed by a nurse as being at “high risk” of pneumonia, and a random sample of the remainder, were examined and radiographs were obtained. The results were adjusted to account for the sampling of the “low risk” group. Sensitivities and specificities in that study were lower than all the other studies, particularly
those for respiratory rate ≥50. This study which was designed to avoid verification bias, suggested that a significant number of children with clinically mild ARI have radiologic findings, whereas a number with apparently more severe ARI have normal chest radiographs.

For the studies presented in this paper, the assumption was made that the most useful definition of childhood pneumonia is the clinical judgment of a pediatrician who has access to a chest radiograph. In most of the pneumonia cases found, crackles were found on auscultation, but in some tachypnea was the only physical sign and the chest radiograph showed consolidation. Thus some cases that would have been missed in the study of Shann et al. were included. The presence of wheezing does not rule out bacterial lower respiratory infection, but crackles and radiologic consolidation frequently accompany wheezing in children and are not a reliable guide to the presence of infection. Wheezing children were excluded from the analysis of this study.

The study population chosen for each of these studies was composed of nonreferred children younger than 5 years presenting with cough or difficult breathing to a busy primary care facility. Although the two studies are from very different environments, they are both representative of the populations for whom ARI case management protocols are intended.

When applied in realistic situations in developing countries, the current WHO case management protocol for children 2 months to 5 years presenting with cough or difficult breathing gives a favorable combination of sensitivity and specificity for predicting pneumonia, and thus the need for antibiotics. Using this protocol children younger than 12 months with a respiratory rate of 50/minute or more and children 12 months or more with a respiratory rate of 40/minute or more are given antibiotics. Children with chest wall indrawing or danger signs suggestive of severe disease are admitted to hospital. The studies described in this paper support the use of this protocol for the management of ARI in developing countries.

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REFERENCES