

Acute lower respiratory tract infections in children: possible criteria for selection of patients for antibiotic therapy and hospital admission

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Acute lower respiratory tract infections are a common cause of morbidity and mortality in children in the less developed countries. Considering the urgent need for rational protocols for the management of these infections in children and how little is known about the clinical signs that might predict the need for antibiotic therapy in a primary health care setting, a prospective study of the clinical signs in 200 paediatric outpatients presenting with a cough, 100 age-matched controls without cough, and 50 children admitted to hospital with pneumonia was carried out.

In children with cough, a respiratory rate greater than 40 or 50 per minute (or a qualitative impression of tachypnoea) is probably the best indicator of the need for starting antibiotic treatment by primary health workers. The presence of fever appeared to be a poor guide to the need for antibiotic therapy. The presence of chest indrawing is, however, a reliable indication that a child with cough should be admitted to a health centre or a hospital. Further prospective studies are needed to determine the ability of these clinical signs to predict the course of these infections.

Acute lower respiratory tract infections cause considerable morbidity and mortality, particularly in children in the less developed countries (1). From 1970 to 1979 at Goroka Base Hospital, in the Eastern Highlands of Papua New Guinea, pneumonia was responsible for 29% of the 18 605 paediatric admissions, and for 31% of the 1040 deaths of children in the hospital.

Since 1974, standard treatment protocols have been widely used in the management of diseases of children in Papua New Guinea — a slightly modified version of the current protocol for the management of cough is shown in Fig. 1. Simple and effective standard treatments for common diseases are essential if optimum use is to be made of the limited resources available for health care in the less developed countries, and whatever protocols are used should be carefully evaluated.

Criteria for the use of antibiotics and for admission to hospital with acute lower respiratory tract infections should be carefully defined, particularly when patients are managed by primary health workers. At present, it is not known which clinical findings in lower respiratory tract infections can best

predict the outcome or the need for antibiotics, nor which signs can most reliably be elicited by primary health workers. The present study investigated this problem, based on the clinical findings in children in Goroka who had acute lower respiratory tract infections of varying degrees of severity.

MATERIALS AND METHODS

We prospectively studied 200 children who were brought to the Goroka Hospital outpatient department with cough. Only children who had not had prior treatment were studied. The first 100 of the 200 children with cough were paired with 100 age-matched controls without cough. In addition, 50 children admitted to Goroka Hospital with pneumonia were studied. Thus, a total of 350 children were studied. In each case, a record was made of age, diagnosis, respiratory rate (in most cases with the child awake but quiet), chest indrawing (sternal recession), cyanosis, wheeze, pulse rate, liver size, crepitations, and forehead skin temperature (using the Fever Scan^a). The mother was asked if her child was breathless and whether he was feeding normally.

^a American Thermometer Co., Dayton, OH, USA.

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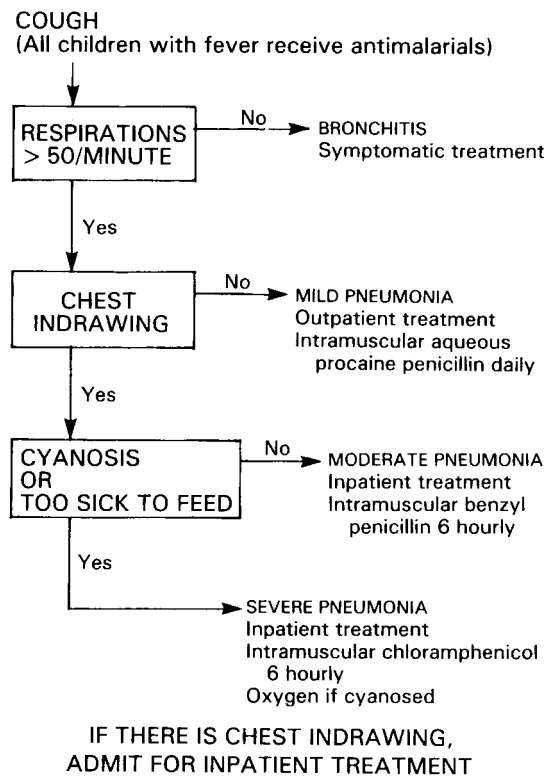


Fig. 1. Protocol for the management of children presenting with a cough in Papua New Guinea.

RESULTS

Of the 200 paediatric outpatients with cough, 115 (58%) had a respiratory rate greater than 40/min, 87 (44%) had a temperature greater than 37.5 °C, 74 (37%) were said by the mother to be breathless, 73 (37%) had a respiratory rate greater than 50/min, 67 (34%) had crepitations, 17 (9%) were said by the mother to be feeding poorly, 16 (8%) had a pulse rate greater than 160, 7 (4%) had a liver edge palpable

more than 2 cm below the costal margin in the mid-clavicular line, 4 (2%) had chest indrawing (all four had crepitations as well), one child was wheezing, and no child was cyanosed. Since the midpoint between the mean respiratory rates in children with and without crepitations was 50.3 breaths per minute (Table 1), this respiratory rate is likely to give the lowest number of false positive plus false negative results in predicting the presence or absence of crepitations (2). Table 1 shows that the child's age had little effect on the respiratory rate that best predicted the presence or absence of crepitations. A detailed analysis of the data on respiratory rate, temperature, and the mother's impression of breathlessness in the child is shown in Table 2.

Table 3 shows the respiratory rate by age in 300 outpatients: the 200 children with cough referred to in Table 2 and, in addition, 100 age-matched controls without cough. Among the 151 children aged 0-11 months, proportionately more of the 44 children with cough and crepitations had a fast respiratory rate than the 107 children who did not have crepitations (χ^2 38.270, 2df, $P < 0.001$). Among the 149 children aged 12 months or more, proportionately more of the 23 children with crepitations were breathing fast than the 126 children without crepitations (χ^2 27.397, 2df, $P < 0.001$). In both these age groups, the children with cough and no crepitations had similar respiratory rates to those with no cough.

Table 4 shows that the children with cough and crepitations had a faster mean respiratory rate than age-matched controls without cough ($t = 6.668$, 35df, $P < 0.001$), while children with cough but no crepitations had a similar respiratory rate to age-matched controls without cough. Table 5 shows the incidence of some of the clinical findings present in 50 children admitted to hospital with moderate or severe pneumonia.

DISCUSSION

Need for antibiotic treatment

Prospective studies are necessary to determine which children with acute lower respiratory tract

Table 1. Mean respiratory rate in 200 paediatric outpatients with cough

Age	Mean respiratory rate (breaths/min) in:		
	Children with crepitations	Children without crepitations	Midpoint between means (breaths/min)
< 12 months	62.6 (n = 44)	44.9 (n = 62)	53.8 (n = 106)
≥ 12 months	54.0 (n = 23)	37.4 (n = 71)	45.7 (n = 94)
All ages	59.7 (n = 67)	40.9 (n = 132)	50.3 (n = 200)

Table 2. Clinical signs in 200 paediatric outpatients presenting with a cough, with or without crepitations

Clinical sign	With crepitations (<i>n</i> = 67)		Without crepitations (<i>n</i> = 133)	
	No. with this clinical sign present = true positive	No. with this clinical sign absent = false negative	No. with this clinical sign present = false positive	No. with this clinical sign absent = true negative
Respirations > 40/min	60 (90) ^a	7 (10)	55 (41)	78 (59)
Respirations > 50/min	48 (72)	19 (28)	25 (19)	108 (81)
Rapid respiration ^b	52 (78)	15 (22)	36 (27)	97 (73)
Breathless (as stated by the mother)	43 (64)	24 (36)	31 (23)	102 (77)
Respirations > 50 or breathless	62 (93)	5 (7)	49 (37)	84 (63)
Temperature > 37.5 °C	35 (52)	32 (48)	52 (39)	81 (61)

^a Figures in parentheses are percentages.

^b Under 12 months old = respiration > 50/min. Aged 12 months or more = respiration > 40/min.

Table 3. Respiratory rate, by age and symptoms, in 300 outpatients

Age and symptoms	No. of children with the following respiratory rates (breaths/min):			Total
	0-40	41-50	≥ 51	
<i>0-11 months</i>				
Cough and crepitations	1 (2) ^a	8 (18)	35 (80)	44 (100)
Cough, no crepitations	26 (42)	19 (31)	17 (27)	62 (100)
No cough	19 (42)	14 (31)	12 (27)	45 (100)
<i>≥ 12 months</i>				
Cough and crepitations	6 (26)	4 (17)	13 (57)	23 (100)
Cough, no crepitations	52 (73)	11 (15)	8 (11)	71 (100)
No cough	41 (75)	7 (13)	7 (13)	55 (100)

^a Figures in parentheses are percentages.

infections need antibiotic treatment. In the absence of such studies, it seems reasonable to assume that children who are found to have crepitations are at risk if they do not receive antibiotics. In these children, the

crepitations are likely to be due to pus in the alveoli. (This is not so if the child is wheezing, but only one of the 200 outpatients with cough in this study in fact had a wheeze.) The value of crepitations as an index of the severity of lower respiratory tract infections is supported by our finding that the respiratory rate in children without cough was similar to that in children with cough but no crepitations, while children with cough and crepitations had a faster respiratory rate (Tables 3 and 4). Unfortunately, the detection of crepitations requires considerable skill, and is probably not a suitable sign for use by primary health workers. Consolidation in the lungs on a chest X-ray would probably be a better indication of the need for antibiotics in a child with cough than the presence of crepitations, but unfortunately it was not possible to perform chest X-rays in this study.

Our findings suggest that the respiratory rate can be used to decide which children presenting with a cough should be treated with antibiotics. Among the children we studied, if those with a respiratory rate of over 40 breaths per minute had been given antibiotics, 62 (31%) of the 200 children with cough would have been incorrectly treated: of these, 55 without crepita-

Table 4. Comparison of 100 children with cough and 100 age-matched controls without cough

Type of patient	Mean respiratory rate/min (± SD)	Mean difference in rates/min (± SD)	Paired <i>t</i> test
With cough and crepitations (<i>n</i> = 36)	57.7 (± 13.4)	15.1 (± 13.6)	<i>t</i> = 6.668; <i>P</i> < 0.001
Controls without cough (<i>n</i> = 36)	42.5 (± 11.6)		
With cough but no crepitations (<i>n</i> = 64)	39.5 (± 10.2)	2.5 (± 18.2)	<i>t</i> = 1.091; <i>P</i> > 0.1
Controls without cough (<i>n</i> = 64)	37.6 (± 12.2)		

Table 5. Frequency of selected clinical findings in 50 children admitted to hospital with pneumonia

Clinical finding	No. of children
Chest indrawing	50 (100) ^a
Crepitations	50 (100)
Respiration rate > 40/min	48 (96)
Breathless (according to mother)	45 (90)
Respiration rate > 50/min	43 (86)
Temperature > 37.5 °C	30 (60)
Pulse > 160/min	22 (44)
Feeds poorly (according to mother)	20 (40)
Liver palpable > 2 cm	18 (36)
Age ≥ 12 months	14 (28)
Cyanosis	8 (16)
Wheeze	6 (12)

^a Figures in parentheses are percentages.

tions would have been given unnecessary antibiotics, and 7 with crepitations would have been denied antibiotics. In contrast, if antibiotics had been given to children whose respiratory rate was more than 50 breaths per minute, only 44 (22%) of the 200 children with cough would have been incorrectly treated: of these, 25 without crepitations would have been given unnecessary antibiotics, and 19 with crepitations would have been denied antibiotics. The choice between 40 and 50 breaths per minute as the criterion is somewhat arbitrary—50 breaths per minute would result in fewer incorrect treatments overall and limit the antibiotic treatment to those who most need it, while denying treatment to some who might benefit from it; and 40 breaths per minute would mean that almost every child who needs antibiotics is treated, but would result in very considerable overtreatment of children who do not need antibiotics. On balance, 50 breaths per minute seems the better choice, at least until evidence from prospective studies of antibiotic therapy is available. There is no advantage in defining fast breathing as greater than 50 breaths per minute in children under 12 months of age, and greater than 40 breaths per minute in those aged 12 months or more (Table 2).

It is difficult for primary health workers to measure the respiratory rate, because the child should be awake but quiet, which can be difficult to achieve, and because many of these workers in developing countries do not own a watch. However, a 60-second egg timer or sand-glass could be used, instead of a watch, when measuring the respiratory rate.

Only 23% of the children without crepitations were

considered by the mothers to be breathless (Table 2), so that the use of this criterion to decide whether to give antibiotics would not have led to overtreatment. However, 36% of the children who had crepitations would not have received antibiotics. Although reliance on a history of breathlessness from the mothers would have led to some undertreatment, it is remarkable that this group of mothers with no medical training were able to select in this way a high proportion of the children who had crepitations. It is likely that primary health workers trained to recognize breathlessness would perform even better than the mothers.

If the children had been given an antibiotic because they either had a respiratory rate of over 50 breaths per minute or were considered by their mothers to be breathless, then only 7% of the 67 children with crepitations would not have been treated, but 37% of the 133 without crepitations would have been treated unnecessarily (Table 2). Using both criteria together (respiratory rate and mothers' impression of breathlessness) is considerably more complicated and gives no better results than using the respiratory rate alone.

Fever was a poor indicator of the presence of crepitations because 48% of the children with cough and crepitations were afebrile, and 39% of the children without crepitations were febrile.

Our findings are supported by a recent prospective study in American children (3) which showed that tachypnoea was the clinical sign that best predicted the presence of an infiltrate on chest X-ray. A history of rapid breathing reported by the mothers was almost as good an indicator as the physical finding of tachypnoea. Tachypnoea was a better sign than the presence of crepitations, fever, nasal flaring, pallor or grunting.

Need for admission to hospital or health centre

Fifty children admitted to Goroka Hospital with pneumonia were studied. All had crepitations and chest indrawing, 96% had a respiratory rate greater than 40 per minute, and 90% of the mothers thought that their child was breathless (Table 5). Among the children admitted to Goroka Hospital with pneumonia from 1970 to 1979, the mortality rate was 5.9% and, in the present study, all of the 50 children in this high-risk group (those admitted to hospital) had chest indrawing. In contrast, the vast majority of outpatients with a cough recover, and only 2% (4/200) of the outpatients with a cough in the present study were found to have chest indrawing. Chest indrawing is therefore an excellent sign for selecting those children who need to be admitted to hospital for more intensive treatment.

Conclusions

Not all children who present with a cough need antibiotic treatment. While the presence of crepitations (in the absence of a wheeze) suggests a need for antibiotic treatment, this sign is probably too subtle for widespread use by primary health workers. This study suggests that, in such cases, tachypnoea is a helpful sign in deciding whether to administer an antibiotic. If children with a respiratory rate greater than 40 per minute are given antibiotics, some over-treatment will occur; but if the tachypnoea is defined

as greater than 50 breaths per minute, then some children with crepitations would go untreated. A history of rapid breathing reported by the mother, or the clinical impression of tachypnoea by a trained health worker, may be almost as accurate an indicator as a true count of the respiratory rate (3).

There is now a pressing need for further studies to determine which clinical signs can best predict the need for antibiotic therapy in children with acute lower respiratory tract infections.

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RÉSUMÉ

INFECTIONS AIGUËS DES VOIES RESPIRATOIRES INFÉRIEURES CHEZ LES ENFANTS : CRITÈRES POSSIBLES DE SÉLECTION DES MALADES NÉCESSITANT UNE ANTIBIOTHÉRAPIE ET L'HOSPITALISATION

Les infections aiguës des voies respiratoires inférieures sont une cause fréquente de morbidité et de mortalité chez les enfants des pays peu développés. Compte tenu de la nécessité urgente de protocoles rationnels pour la prise en charge de ces infections chez les enfants et du peu de chose qu'on sait des signes cliniques susceptibles de prédire le besoin d'une antibiothérapie dans le contexte des soins de santé primaires, on a effectué une étude prospective des signes cliniques chez 200 malades atteints de toux fréquentant une consultation de pédiatrie, 100 témoins appariés ne toussant pas et 50 enfants hospitalisés pour pneumonie.

La présence de râles crépitants semble être un bon signe de la gravité de ces infections chez les malades ambulatoires. La fréquence respiratoire (nombre de respirations par minute) chez les enfants ne toussant pas ($37,6 \pm 12,2$, moyenne \pm ET) était semblable à celle qu'on observait chez les enfants avec toux mais sans râles crépitants ($39,5 \pm 10,2$), alors que chez les enfants présentant de la toux et des râles crépitants, la respiration était plus rapide ($57,7 \pm 13,4$). La présence de râles crépitants n'est probablement pas un indicateur approprié pour les agents de soins de santé primaires. En revanche, la fréquence respiratoire pourrait être utilisée pour permettre de décider si un enfant qui tousse a besoin d'une antibiothérapie. Parmi les enfants que nous avons étudiés, si l'on avait administré des antibiotiques à ceux qui toussaient et avaient une fréquence respiratoire de plus de 40 par minute, 10% seulement des enfants présentant des râles

crépitants n'auraient pas été traités, mais 41% des enfants présentant de la toux sans râles crépitants auraient reçu un traitement superflu. Si l'on avait défini comme rapide une fréquence de plus de 50 respirations par minute, il y aurait eu moins d'enfants traités sans nécessité (19%), mais 28% des enfants ayant des râles crépitants seraient restés sans traitement. S'il est peu pratique pour les agents de soins de santé primaires de mesurer la fréquence respiratoire, on pourrait utiliser un autre critère pour déterminer la nécessité d'une antibiothérapie, à savoir la dyspnée: la mère peut signaler que l'enfant est essoufflé ou bien cela peut correspondre à l'impression subjective de l'agent sanitaire lui-même.

La présence de rétraction intercostale avec tirage est un excellent signe indiquant qu'un enfant qui tousse doit être hospitalisé pour recevoir une antibiothérapie intensive. Chez les enfants admis à l'hôpital de Goroka pour pneumonie, la mortalité a été d'environ 5% et tous (50/50) présentaient du tirage; en revanche, la grande majorité des malades ambulatoires qui toussaient ont guéri et 2% seulement (4/200) présentaient du tirage.

De nouvelles études prospectives sont nécessaires pour déterminer si ces signes cliniques (râles crépitants, fréquence de la respiration et rétraction intercostale avec tirage) peuvent indiquer le besoin d'une antibiothérapie dans ces infections chez les enfants.