Evaluation of the Degree of Tachypnea for Hospitalizing Children with Pneumonia

CM Nascimento-Carvalho and Y Benguigui*

From the Department of Pediatrics, Faculty of Medicine, Professor Hosannah de Oliveira Pediatric Center, Federal University of Bahia; Alian~ Hospital; Salvador, Bahia, Brazil; and Pan American Health Organization, Washington DC, USA.*

Correspondence to: Dr. Cristiana Nascimento-Carvalho, Department of Pediatrics, Faculty of Medicine, Federal University of Bahia., Rua Prof Aristides Novis, No. 105/120 IB -Salvador, Bahia., Brazil CEP 40210-730. (e-mail: nascimentocarvalho@hotmail.com)

This was a hospital based prospective study to determine the cut-off respiratory rates which can identify children (age £14.5 yr) with severe pneumonia with chest indrawing and to evaluate the validity of the cutoff respiratory rate so obtained in identifying severe pneumonia requiring hospitalization. All children diagnosed with pneumonia (radiologically proven) between September 1997 and October 1999 were enrolled. Of 1,665, cases, 54.7% were males; the median age was 1.8 yr (range 8 days-14.5 yr, mean 2.8 ± 2.7 yr). Frequency of hospitalization, tachypnea and chest indrawing were 29.9%, 58.9% and 42.7%. In hospitalized children, cutoff respiratory rate ³57, ³48 and ³36 were found to identify severe pneumonia requiring hospitalization in the age groups 2-11 mo, 12-59 mo and ³5 yr, respectively.

Key words: *Chest indrawing, Hospitalization, IMCI, Tachypnea, Pneumonia.*

Acute respiratory infections (ARI) are the most frequent illness in childhood[1]. Mortality from ARI is highest in infants and, out of the total ARI-related deaths, pneumonia may account for up to 75.5%[2]. The incidence of pneumonia in the developing countries is up to 10 times higher than that in developed ones[3]. In addition to that, pneumonia is considered the most frequent cause of death in children aged < 5 years, living in the poor areas of the world[4]. Difficult access to health care and delay in receiving health assistance are associated with such a high mortality[5].

In order to reduce mortality due to pneumonia in developing countries, the World Health Organization (WHO) has proposed the Integrated Management of Childhood Illness (IMCI) Strategy[5,6], which is a single and integrated approach to assess, classify and treat children at first level health facilities[7,8]. In the IMCI, pneumonia is diagnosed by the presence of tachypnea defined as: ³60 breaths/ minute among children aged <2 months, ³50 breaths/minute among children aged 2-11 months and ³40 breaths/minute among children aged 12-59 months. Among children with pneumonia, the presence of chest indrawing, somnolence, convulsions, grunting, severe malnutrition or inability to drink indicates need for hospitalization[5,6].

In this investigation, we sought to determine cutoff respiratory rate for different age groups to be associated with hospitalization and to evaluate the validity of these cutoffs and of the presence of chest indrawings for indicating hospitalization.

Subjects and Methods

We attempted to enroll prospectively every child diagnosed with pneumonia from

September 1997 to October 1999, at the Emergency Room (ER) of the Professor Hosannah de Oliveira Pediatric Center (PHOPC) and at the Pediatric ER of the Alianca Hospital (AH) in Salvador, North-east Brazil. The PHOPC serves children predominantly of lower socio-economic status. The AH is a general private hospital, and caters children from middle to middle-upper and high socio-economic status. The duty pediatrician collected demographic and clinical data on a standardised data entry form, read the chest *X*-ray during the consultation and made the assessment for hospitalizing. The diagnosis of pneumonia was based on presence of radiologically confirmed infiltrate. Pediatricians were informed about the WHO Guidelines for ARI before the beginning of this investigation and were reminded of them during the study period. They were also trained to fill out the research form and were blinded to the purposes of this study. Admission to the hospital was verified by cross-reference with the computer file of the respective hospital.

Statistical analysis was performed by using SPSS 9.0. For children aged <5 years, tachypnea was defined according to WHO criteria[5,6] and for children ³5 years, tachypnea was defined as ³30 breaths/minute[9]. Means of continuous variables were compared by Mann-Whitney U or Student t test, as appropriate. 95% confidence interval (95% CI) was reported for each mean and mean difference. The statistical tests were two tailed, with a significance level of 0.05. Sensitivity, specificity, positive and negative predictive values and likelihood ratios were calculated to assess the validity of clinical findings. The study was approved by the institutional review board of each hospital and by the Ethics Committee of the Faculty of Medicine of the Federal University of Bahia.

Results

Of 1,656 eligible cases. 54.7% were males. The median age was 1.8 years (range 8 days to 14.5 years, Mean 2.8 ± 2.7 years) and 29.9% were hospitalized. Overall frequency of tachypnea was 58.9% and stratified frequencies were 63.4%, 65.7%, 64.2% and 31.7% for children aged <2 months, 2-11 months, 12-59 months and 5-14.5 years, respectively. Overall frequency of chest indrawing was 42.7%. *Table I* shows the stratified frequency of chest indrawing by age and the analysis of the respiratory rate according to hospitalization. By analyzing the 95% CI of respiratory rate, (*Table I*) we found the respiratory rate 57, 48 and 36 to be possible lower cutoffs to define severe tachypnea for children with pneumonia aged 2-11 months, 12-59 months and 5-14.5 years, respectively. *Table II* shows the assessment for hospitalization of chest indrawings and severe tachypnea as defined by WHO[8].

Discussion

By comparing the lower limit of the 95% CI of respiratory rate from hospitalized children with the upper limit of the 95% CI of respiratory rate from non-hospitalized children, one can see that they do not intersect in age groups ³2 months. (*Table I*). These findings mean that respiratory rate is statistically different when hospitalized and non-hospitalized children with pneumonia are compared, in each age group. In children < 2-month-old, respiratory rates are very similar in the two groups. However as all such younger patients must always be hospitalized for treatment[8], there may not be much role of defining respiratory rate cut-offs as a marker for hospitalization. In children aged ³2 months, the mean difference 95% CIs are narrow, probably due to sample size.

Table II shows that the assessments of

TABLE I–*Stratified Analysis of Respiratory Rate(RR) from Children with Pneumonia*

Respiratory Rate	Age			
	< 2 mo	2 -11 mo	12-59 mo	³ 5 yr
Hospitalized children N(%)	45 (63.4)	169 (41.7)	236 (26.4)	45 (15.7)
Mean ± SD	65 ± 18	59 ± 14	50 ± 16	40 ± 13
Median	62	60	50	40
Range	35 -140	28 - 100	20 -145	20 -84
95% CI	60-71	57-61	48-52	36-44
Chest indrawing (%)	68.9	58.6	57.2	40.0
Non-hospitalized children N(%)	26 (36.6)	236 (58.3)	657 (73.6)	242 (84.3)
Mean ± SD	64 ± 11	54 ± 14	42 ± 13	32 ± 10
Median	63	52	40	30
Range	47-85	22-100	15-96	10-62
95%CI	59-68	52-55	41-44	31-34
Chest indrawing(%)	65.4	44.1	37.6	23.1
Mean difference in RR(95% CI)	1 (–6,9)	5 (2,8)	8 (6,10)	8 (5, 11)
P value*	0.7	<0.001	<0.001	<0.001
The whole group N	71	405	893	287
Mean ± SD	65 ± 16	56 ± 15	45 ± 15	34 ± 11
Median	62	56	42	32
Range	35-140	22-100	15-145	10-84
95%CI	61-68	54-57	44-46	32-35
Chest indrawing (%)	67.6	50.1	42.8	25.8

Independent samples t test or Mann-Whitney U as appropriate.

severe tachypnea, as defined previously, and of chest indrawing for hospitalization are very similar. That is, severe tachypnea and chest indrawing are associated with hospitalization in children with pneumonia at similar strength, in terms of their sensitivity and specificity. We wonder if training PHC worker to count the respiratory rate for diagnosing pneumonia and classifying pneumonia severity simplifies the IMCI without loss of accurate management of childhood illness.

The importance of tachypnea as a clinical predictor of pneumonia was first established in 1982, when tachypnea was characterized in a qualitative way(10). Afterwards, several studies sought to establish the respiratory rates to be used to define tachypnea as a diagnostic criterion for pneumonia(11-15). In almost all studies regarding tachypnea, only children under 5 years of age were enrolled because mortality from ARI is highest in this age group(2). In addition to that, tachypnea is much less frequent in children with pneumonia aged ³5 years(9). However, two previous studies have proposed respiratory rate cutoff for defining tachypnea in the latter group of children(9,16). That is why this investigation also studied those patients.

TABLE II–*Assessment for Hospitalization of Chest lndrawing and Severe Tachypnea*

Characteristic	Age		
	2-11mo	12-59mo	$\geq$5yrs
Severe Tachypnea*†			
Sensitivity	(99/169) 58.6	(136/236) 57.6	(30/45) 66.7
Specificity	(137/236) 58.0	(431/657) 65.6	(157/242) 64.9
Predictive value positive	(99/198) 50.0	(136/362) 37.6	(30/115) 26.1
Predictive value negative	(137/207)66.2	(431/531)81.2	(157/172)91.3
Likelihood ratio positive	1.40	1.68	1.90
Likelihood ratio negative	0.71	0.64	0.51
Chest indrawing*			
Sensitivity	(99/169) 58.6	(135/236) 57.2	(18/45) 40.0
Specificity	(132/236) 55.9	(410/657) 62.4	(186/242) 76.8
Predictive value positive	(99/ 203) 48.8	(135 / 382) 35.3	(18/ 74) 24.3
Predictive value negative	(132/202)65.3	(410/511)80.2	(186/213)87.3
Likelihood ratio positive	1.33	1.52	1.73
Likelihood ratio negative	0.74	0.68	0.78
Chest indrawing or Severe Tachypnea*			
Sensitivity	(139/169) 82.2	(181/236)76.7	(31/45)68.9
Specificity	(88/236) 37.3	(304/657) 46.3	(129/242) 53.3
Predictive value positive	(139/287) 48.4	(181/534)33.9	(31/144)21.5
Predictive value negative	(88/118) 74.6	(304/359) 84.7	(129/143) 90.2
Likelihood ratio positive	1.31	1.43	1.48
Likelihood ratio negative	0.48	0.5	0.58

* Results in (n/N)% .

† Cutoff respiratory rates $\geq$57, $\geq$48 and $\geq$36 for children aged 2 -11 months, 12-59 months and 5-14.5 years, respectively.

We suggest that, in the absence of the known signs of very severe pneumonia, cut-offs for severe tachypnea as determined in this study may be used as indicators for hospitalization. Further studies are needed to validate this proposal and to evaluate the performance of health worker by using only the respiratory rate or the respiratory rate and recognition of chest indrawing in the evaluation of children with ARI.

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