Clinical Score and Arterial Oxygen Saturation in Children with Wheezing Associated Respiratory Illness (WARI)

SUCHADA SRITIPPAYAWAN, M.D.*,
JITLADDA DEEROJANAWONG, M.D.*,
NUANCHAN PRAPPHAL, M.D.*

Abstract

Objectives : To determine the correlation between clinical score (based on respiratory rate, chest wall retractions, air entry, wheezing, consciousness and audible wheezing) and arterial oxygen saturation (SaO_2 : measured by pulse oximetry) as well as the most appropriate total score for predicting hypoxemia ($SaO_2 \leq 95\%$) in children diagnosed to have wheezing associated respiratory illness (WARI).

Subjects : 70 children (1 month - 5 years old) hospitalized in the Department of Pediatrics, Chulalongkorn Hospital with the diagnosis of WARI from January 1, 1996 to December 31, 1996 were studied. Half of them were diagnosed to have acute lower respiratory tract infection (LRI) with wheezing while the remainder had reactive airway disease (RAD).

Design : Cross sectional, analytical study

Methods : In each group of patients, the clinical score and SaO_2 were assessed by the same pediatrician throughout the study. The correlation between the clinical signs and SaO_2 as well as the cut off point of total score for predicting hypoxemia were analyzed. The sensitivity, specificity and accuracy of that total score in predicting hypoxemia were also calculated.

Result : In both groups of patients (acute LRI with wheezing and RAD group), the clinical signs correlated with SaO_2 were wheezing (r_s = -0.67 and –0.47 respectively) and chest wall retractions (r_s = -0.57 and –0.59 respectively).Total score was also correlated with SaO_2 (r_s = -0.68 and –0.5 respectively). The cut off point of total score in predicting hypoxemia was 4 providing 80 per cent sensitivity in both groups with accuracy 74.3 per cent and 80 per cent respectively.

Conclusion : This clinical score may be used to assess the severity of hypoxemia in WARI patients. Wheezing, chest wall retractions and total score correlated well with SaO_2. The total score > 4 was most appropriate in predicting hypoxemia in both children with RAD and wheezing associated with LRI.

Key word : Clinical Score, Arterial Oxygen Saturation, WARI, Children

SRITIPPAYAWAN S, DEEROJANAWONG J, PRAPPHAL N
J Med Assoc Thai 2000; 83: 1215-1222

* Department of Pediatrics, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

WARI is the major cause of respiratory distress requiring hospitalization in young children. The main functional disturbance is peripheral airway obstruction caused by bronchospasm, edema of bronchial and bronchiolar mucosa and mucus plug in the airways. Ventilation - perfusion mismatch resulting in hypoxemia then develops[1,2].

In children younger than 5 years old, peripheral airways contribute to 50 per cent of the total airway resistance. Obstruction of these airways as found in WARI will lead to a marked increase in airway resistance and work of breathing. Respiratory failure will eventually develop if proper management is not immediately given[3].

The severity of hypoxemia correlates well with the degree of airway obstruction measured by pulmonary function tests[4]. However, in young children, these tests can't be easily performed. Thus, clinical symptoms and signs are important clues in assessing the severity of airway obstructions and hypoxemia.

The objectives of our study were to determine the correlation between arterial oxygen saturation (saO_2) measured by pulse oximetry and clinical signs which can be easily assessed in young children presenting with WARI. We developed the clinical score by deriving it from many clinical scores previously reported to have correlation with SaO_2, PaO_2 or FEV_1 in asthmatic children (aged 0-15 years)[5-11,15,16]. The clinical signs used in the developed score were respiratory rate, chest wall retractions, air entry, wheezing, consciousness and audible wheezing (Table 1). In addition, we assessed the sensitivity, specificity and accuracy of the clinical signs. The cut off point of the total score in predicting hypoxemia was also determined.

MATERIAL AND METHOD

Seventy children with acute WARI, aged between 1 month - 5 years and hospitalized in the Pediatric wards of Chulalongkorn Hospital from January 1, 1996 to December 31, 1996 were studied. Half of them were diagnosed to have either viral pneumonia or acute bronchiolitis (acute lower respiratory tract infection (LRI) with wheezing group) while the remainder were diagnosed to have reactive airway disease or asthma (RAD group). Patients with known history of cardiovascular diseases, chronic lung diseases, foreign body aspiration, external compression of airways and congenital anomalies of airways were excluded.

Demographic data such as age, sex and other clinical data such as duration of oxygen therapy, SaO_2 and clinical score were recorded. While the patients were breathing in room air, clinical scoring and pulse oximetry (measured by portable pulse oximeter : BCI International® 3301) were performed at the same time by the same pediatrician throughout the study.

Unpaired T test (p value < 0.05) was used for determining whether there was a statistical difference between acute LRI with wheezing and the RAD group in view of demographic variables, duration of oxygen therapy, SaO_2 and total scores.

Linear regression analysis and Spearman rank test (p value < 0.05) were used for determining the correlation between clinical signs and SaO_2 in each group of patients. ROC curves were plotted in order to define the appropriate cut off point of the total score for predicting hypoxemia ($SaO_2 \leq 95\%$). Validity of the score was assessed in terms of sensitivity, specificity and accuracy in predicting hypoxemia in each group of patients.

Table 1. Clinical score.

Signs	Score			
	0	1	2	3
tachypnea*	absent	present		
retractions	absent	subcostal	1 + suprasternal	2 + nasal flaring
air entry good	poor			
wheezing	absent	end expired	expired	inspired + expired
consciousness	alert	irritable	drowsiness	unconscious
audible wheezing	absent	present		

* definition of tachypnea

age 0-2 months	respiratory rate ≥ 60/minute
2 months - 1 year	respiratory rate ≥ 50/minute
1-5 years	respiratory rate ≥ 40/minute

Table 2. Demographic and clinical data of the patients.

	Total WARI (n = 70)	Acute LRI with wheezing (n = 35)	RAD (n = 35)
age (months) (X±SD)	16.9 ± 11.4	13.4 ± 8.9	20.3 ± 12.7
(range)	(4 - 48)	(4 - 48)	(4 - 48)
sex (male : female)	47 : 23	22 : 13	25 : 10
duration of oxygen therapy (days) (X±SD)	3.7 ± 3.2	4.4 ± 4.1	3 ± 17
(range)	(0 - 19)	(1 - 19)	(0 - 9)
total score (X±SD)	5 ± 1.6	4.8 ± 1.4	5.3 ± 1.7
(range)	(2 - 9)	(2 - 9)	(3 - 9)
SaO_2(%) (X±SD)	93 ± 3	93 ± 4	94 ± 3
(range)	(83 - 98)	(86 - 98)	(83 - 98)

Table 3. Correlation coefficient value (r_s) between clinical signs and SaO_2.

Clinical signs	Acute LRI with wheezing		RAD	
	r_s*	p value	r_s	p value
tachypnea	0	NS	0.18	NS
retractions	-0.57	< 0.001	-0.59	< 0.001
air entry	-0.27	NS	0.04	0.04
wheezing	-0.67	< 0.001	-0.47	0.004
consciousness	-0.44	0.007	-	-
audible wheezing	-0.01	NS	-0.32	NS
Total score	-0.68	< 0.001	-0.5	< 0.001

*r_s[12] = 0 - ± 0.25 : little or no correlation
± 0.25 - ± 0.5 : fair degree of correlation
± 0.5 - ± 0.75 : moderate to good correlation
> ± 0.75 : very good to excellent correlation

RESULTS

Mean age of the patients was 16.9 ± 11.4 months (4 months - 4 years) and the male/female ratio was 2:1 (47:23). The duration of oxygen therapy was 3.7 ± 3.2 days (0-19 days). SaO_2 was 93 ± 3 per cent and the mean total score was 5 ± 1.6 (2-9). The data of acute LRI with wheezing and RAD groups are presented separately as shown in Table 2. There was no statistical difference between the 2 groups.

According to the individual component of the clinical score, wheezing and retractions mostly correlated with SaO_2 in acute LRI with wheezing and the RAD group respectively (r_s = -0.67 and -0.59 respectively, p value < 0.001). Level of consciousness also had correlation with hypoxemia in the prior group (r_s = -0.44, p value 0.007). None of the patients in the RAD group developed alteration of consciousness. Tachypnea, air entry and audible wheezing had no correlation with SaO_2 while total score had moderate to good correlation with SaO_2 in both groups of patients (r_s = -0.68 and -0.5, p value < 0.001 respectively) (Table 3, Fig. 1 and 2)

Fig. 3, 4 illustrate the ROC curves of total score for predicting hypoxemia ($SaO_2 \leq 95\%$) in acute LRI with wheezing and the RAD group res-

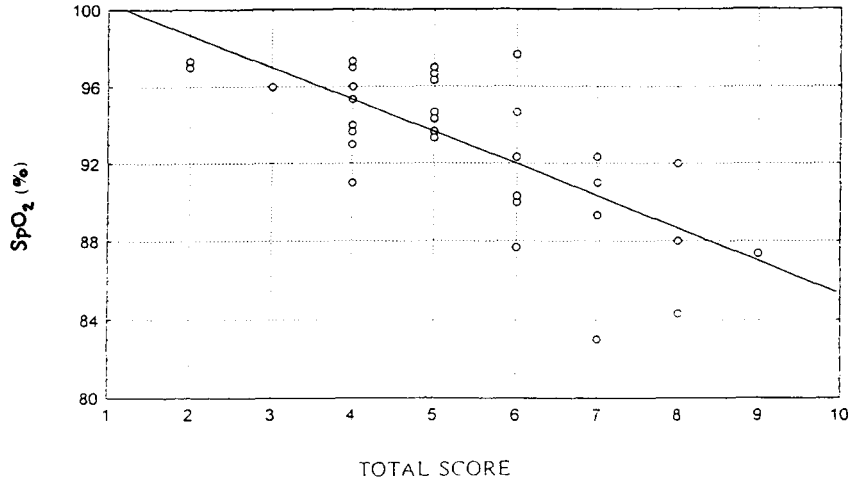

Fig. 1. Linear regression line between total score and SaO_2 in acute LRI with wheezing group (y = 101.94 - 1.65x) (r_s = -0.68, p < 0.001).

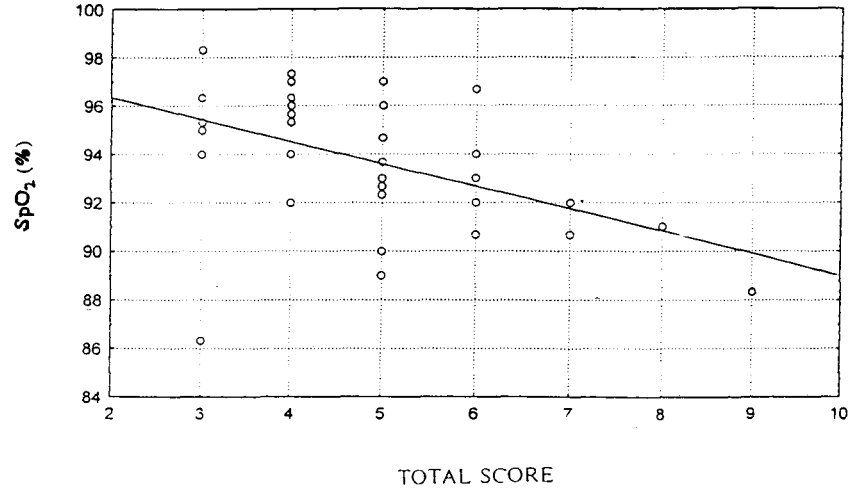

Fig. 2. Linear regression line between total score and SaO_2 in RAD group (y = 98.98 - 0.91x) (r_s = -0.5, p = 0.002).

pectively. We found that total score > 4 was mostly appropriate in predicting hypoxemia in both groups. The sensitivity, specificity and accuracy of this score in predicting hypoxemia were 80.9 per cent, 64.3 per cent and 74.3 per cent respectively in acute LRI with wheezing group and 80.9 per cent, 78.6 per cent and 80 per cent respectively in RAD group. (Table 4)

Sensitivity, specificity and accuracy of each clinical sign in predicting hypoxemia in each group of patients are also presented in Table 4. In predicting hypoxemia in both groups of patients,

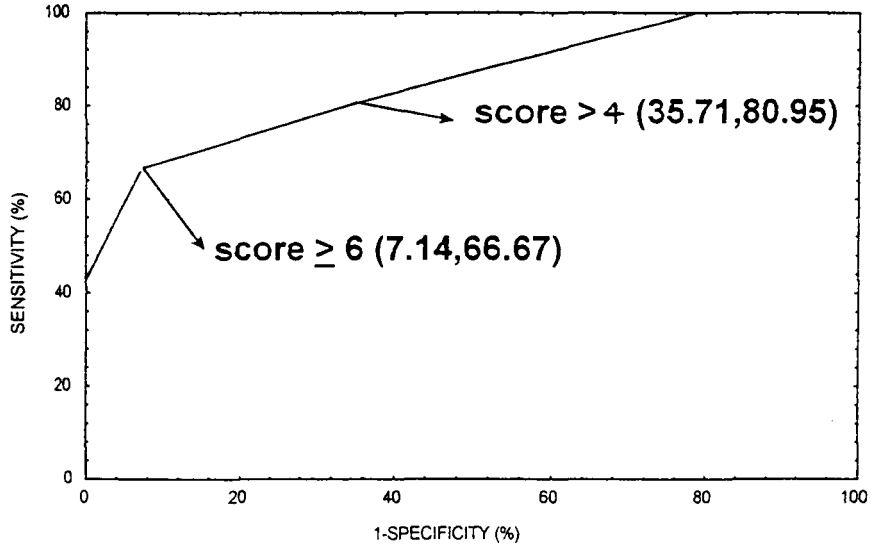

Fig. 3. ROC curve of total score in predicting hypoxemia ($SaO_2 \leq 95\%$) in acute LRI with wheezing group.

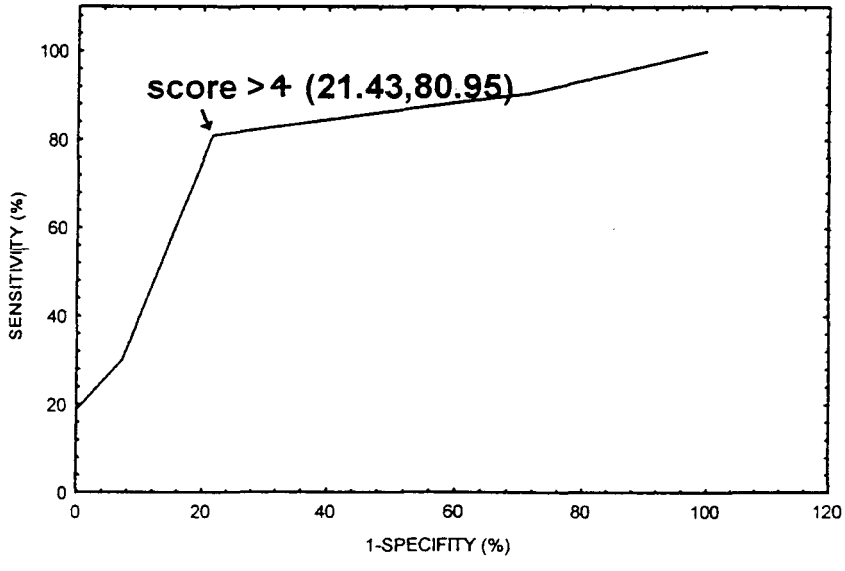

Fig. 4. ROC curve of total score in predicting hypoxemia ($SaO_2 \leq 95\%$) in RAD group.

Table 4. Sensitivity, specificity and accuracy (%) of clinical signs in predicting hypoxemia ($SaO_2 \leq 95\%$.)

Clinical signs	Acute LRI with wheezing			RAD		
	sensitivity	specificity	accuracy	sensitivity	specificity	accuracy
Tachypnea	80.9	21.4	57.1	71.4	21.4	51.4
Nasal flaring + chest wall retractions	57.1	92.9	71.4	33.3	100	60
Poor air entry	19.1	100	51.4	9.5	100	45.7
Inspiratory + expiratory wheezing	38.1	100	62.9	33.3	100	60
Alteration of consciousness	19.1	100	51.4	-	-	-
Audible wheezing	9.5	95.9	42.9	19	92.9	48.6
Total score > 4	80.9	64.3	74.3	80.9	78.6	80

we found that the most sensitive sign was tachypnea, the most specific signs were poor air entry as well as inspiratory with expiratory wheezing and the most accurate sign was nasal flaring with chest wall retractions.

DISCUSSION

There are many prior reported studies about the correlation between degree of airway obstructions (assessed by various clinical scores or pulmonary function tests) and arterial oxygenation (assessed by pulse oximetry or arterial blood gas analysis), but most of them are in older asthmatic children[5-11]. Our study was performed not only in young (1 month - 5 years) asthmatic children (RAD group) but also in young children wheezing from acute lower respiratory tract infections such as viral pneumonia and acute bronchiolitis (acute LRI with wheezing group). Statistical analysis was seperately performed in each group because of the difference in the main mechanism of wheezing which may affect the severity of hypoxemia.

We chose to study young children because it is essential to use clinical signs in assessing the severity of airway obstructions in this group of patients as we mentioned above. Assessing the severity of airway obstruction and hypoxemia is mandatory in young children because of their compromised lung mechanics which may lead to respiratory failure if proper management is not immediately performed[3].

We selected pulse oximetry as the measurement of arterial oxygenation because it is a non invasive, easily performed procedure in young children and provides acceptable accuracy in evaluating arterial oxygenation[13,14].

Clinical signs used in our study can be easily assessed in young children and have been reported in many prior studies to have statistical correlation with SaO_2, PaO_2 or FEV_1[5-11,15,16]. However, we found no correlation between respiratory rate and SaO_2 in both groups of our patients. The reason might be the fact that in young children respiratory rate usually depends on their activities[17]. The patients respiratory rate which was not obtained during asleep might affect the correlation between these two variables. However, tachypnea was most sensitive in predicting hypoxemia in both groups of patients and could be used as a screening sign for hypoxemia in WARI.

We found no correlation between audible wheezing and SaO_2 while Obata did[6]. The reason might be due to the small number of patients who presented with audible wheezing in our study (8 in 70 patients).

In our study, total score had a moderate to good correlation with SaO_2. A score more than 4 had a good sensitivity in predicting hypoxemia in both groups of patients and it also might be used as a screening parameter in detecting hypoxemia.

In conclusion, chest wall retractions, wheezing and total score consisting of parameters in detecting hypoxemia had a moderate to good correlation with SaO_2 in both groups of patients. Consciousness also had a fair correlation with SaO_2 in acute LRI with wheezing. Tachypnea as well as a total score more than 4 were sensitive in predicting hypoxemia and might be used as screening parameters in detecting hypoxemia in young children presenting with WARI.

(Received for publication on November 18, 1998)

REFERENCES

1. Silverman M. Early childhood asthma : What are the questions ? Am J Respir Crit Care Med 1995; 151:S1-S44.
2. Phelan PD, Olinsky A, Robertson CF. Respiratory Illness in Children 4th ed. Oxford : Blackwell Scientific Publications, 1994:94-112.
3. O'Brodovich HM, Haddad GC. The functional basis of respiratory pathology. In : Chernick V, Kendig EL. Kendig's disorders of the respiratory tract in children, 5th ed. Philadelphia : W.B. Saunders, 1990:3-46.
4. McFadden ER. Clinical physiologic correlates in asthma. J Allergy Clin Immunol 1986; 77 (1 pt 1): 1-5.
5. Dawson KP. The asthma clinical score and oxygen saturation. Aust Clin Rev 1991; 11:20-1.
6. Obata T, Kimura Y, Ikwa Y. Relationship between arterial blood gas tensions and a clinical score in asthmatic children. Ann Allergy 1992; 68:530-2.
7. Wennergren G, Engström I, Bjure J. Transcutaneous oxygen and carbondioxide levels and a clinical symptom scale for monitoring the acute asthmatic state in infants and young children. Acta Paediatr Scand 1986; 75:465-9.
8. Kerem E, Canny G, Tibshirani R, et al. Clinical - physiologic correlations in acute asthma of childhood. Pediatrics 1991; 87:481-6.
9. van der Windt DA, Nagelkerke AF, Bouter LM, Dankert - Roelse JE, Veerman AJ. Clinical scores for acute asthma in pre-school children. A review of the literature. J Clin Epidemiol 1994; 47:635-46.
10. Weng TR, Longer HM, Featherby EA, Levison H. Arterial blood gas tensions and acid-base balance in symptomatic and asymptomatic asthma in childhood. Amer Rev Resp Dis 1970; 109:274-82.
11. Wood DW, Downes JJ, Lecks HI. A clinical scoring system for the diagnosis of respiratory failure. Amer J Dis Child 1972; 123:227-8.
12. Colton T. Statistics in Medicine. Boston : Little Brown and Company, 1974: 189-218.
13. Kacmarek RM. Assessment of gas exchange and acid-base balance. In : Pierson DJ, Kacmarek RM. Foundations of respiratory care. New York : Churchill Livingstone Inc, 1992: 492-4.
14. Geelhoed GC, Landau LI, LeSonëf PN. Predictive value of oxygen saturation in emergency evaluation of asthmatic children. BMJ 1988; 297:395-6.
15. Hall CB, Hall WJ, Speers DM. Clinical and physiological manifestations of bronchiolitis and pneumonia. Am J Dis Child 1979; 133:798-802.
16. Reynolds EOR. Recovery from bronchiolitis as judged by arterial blood gas tension measurements. J Pediatr 1963; 63:1182-4.
17. Accurso FJ, Eigen H, Loughlin GM. History and physical examination. In : Loughlin GM, Eigen H. Respiratory disease in children : Diagnosis and management. Baltimore : Williams and Wilkins, 1994:67-76.

ลักษณะทางคลินิกและค่าความอิ่มตัวของออกซิเจนในเลือดแดงของผู้ป่วยเด็กที่มีเสียงหวีดร่วมกับโรคระบบหายใจ

สุชาดา ศรีทิพยวรรณ, พ.บ.,*
จิตลัดดา ดีโรจนวงศ์, พ.บ., นวลจันทร์ ปราบพาล, พ.บ.**

วัตถุประสงค์ : เพื่อศึกษาความสัมพันธ์ระหว่าง clinical score (ประกอบด้วยอัตราการหายใจ, การใช้กล้ามเนื้อช่วยในการหายใจ, เสียงลมเข้าปอด, wheezing, ระดับการรู้สติและการได้ยินเสียง wheezing โดยไม่ใช้ stethoscope) กับค่าความอิ่มตัวของออกซิเจนในเลือดแดง (SaO_2 วัดโดยวิธี pulse oximetry) ในผู้ป่วยเด็กที่ได้รับการวินิจฉัยว่าเป็น wheezing associated respiratory illness (WARI) และหาค่า total score ที่เหมาะสมในการทำนายภาวะการขาดออกซิเจน ($SaO_2 \leq 95\%$) ในผู้ป่วยกลุ่มดังกล่าว

ประชากร : ผู้ป่วยอายุระหว่าง 1 เดือน – 5 ปี จำนวน 70 คน ซึ่งได้รับการวินิจฉัยว่าเป็น WARI และเข้ารับการรักษาแบบผู้ป่วยในที่ภาควิชากุมารเวชศาสตร์ โรงพยาบาลจุฬาลงกรณ์ ในระหว่างวันที่ 1 มกราคม พ.ศ. 2539 – 31 ธันวาคม พ.ศ. 2539 เป็นผู้ป่วย acute lower respiratory tract infection (LRI) with wheezing และ reactive airway disease (RAD) กลุ่มละ 35 คน

รูปแบบการวิจัย : การศึกษาเชิงวิเคราะห์

วิธีการศึกษาและวัดผล : บันทึกเกี่ยวกับอายุ, เพศ, ระยะเวลาในการได้รับการบำบัดรักษาด้วยออกซิเจน, ตรวจร่างกาย และให้คะแนนตาม clinical score ดังกล่าวข้างต้นพร้อมกับวัดค่า SaO_2 ด้วย portable pulse oximeter โดยแพทย์คนเดียวกันตลอด

การศึกษา : หาความสัมพันธ์ระหว่างอาการทางคลินิก, total score กับค่า SaO_2 และหาค่า cut off point ของ total score ตลอดจน sensitivity, specificity และ accuracy ของค่าดังกล่าว ในการทำนายภาวะการขาดออกซิเจนในผู้ป่วยแต่ละกลุ่ม

ผลการศึกษา : ในผู้ป่วยทั้ง 2 กลุ่ม คือกลุ่ม acute LRI with wheezing และกลุ่ม RAD อาการทางคลินิกที่มีความสัมพันธ์กับค่า SaO_2 ได้แก่ wheezing (r_s = –0.67 และ –0.47 ตามลำดับ) และการใช้กล้ามเนื้อช่วยในการหายใจ (r_s = –0.57 และ –0.59 ตามลำดับ), total score มีความสัมพันธ์กับค่า SaO_2 (r_s = –0.68 และ –0.5 ตามลำดับ) และ total score ที่มากกว่า 4 เป็นค่าที่เหมาะสมในการทำนายภาวะการขาดออกซิเจน (sensitivity 80.9% ในผู้ป่วยทั้ง 2 กลุ่ม และ accuracy 74.3% และ 80% ในผู้ป่วย acute LRI with wheezing และ RAD ตามลำดับ)

สรุปและวิจารณ์ : สามารถนำ clinical score ดังกล่าวมาใช้ในการประเมินความรุนแรงของโรคในผู้ป่วยเด็กที่ได้รับการวินิจฉัยว่าเป็น WARI ได้ โดยพบว่า wheezing, การใช้กล้ามเนื้อช่วยในการหายใจ และ total score มีความสัมพันธ์กับค่า SaO_2 และ total score ที่มากกว่า 4 ช่วยในการทำนายภาวะ hypoxemia ในผู้ป่วยทั้ง 2 กลุ่ม

คำสำคัญ : ลักษณะทางคลินิก, ค่าความอิ่มตัวของออกซิเจนในเลือดแดง, เสียงหวีดร่วมกับโรคระบบหายใจ

สุชาดา ศรีทิพยวรรณ, จิตลัดดา ดีโรจนวงศ์, นวลจันทร์ ปราบพาล, พ.บ.*
จดหมายเหตุทางแพทย์ ฯ 2543; 83: 1215–1222

* ภาควิชากุมารเวชศาสตร์, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330