Original Article

PREDICTORS OF HYPOXEMIA IN BRONCHIOLITIS IN A SAMPLE OF IRAQI INFANTS

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Summary:

Background: Bronchiolitis is the first episode of wheezing associated with low grade fever, rhinitis, tachypnea, and increasing respiratory effort in a previously healthy infant during the winter months, and it is the most common lower respiratory tract infection in infancy.

Objectives: This study is designed to analyze the clinical signs and symptoms alone or as combinations as possible predictors of severe hypoxemia in infants with bronchiolitis**.**

Patients and methods: This is a prospective study, which was carried out on 96 infants with a mean age of 7.74 ±3.72 months who were admitted to Children Welfare Teaching Hospital in Medical City-Baghdad with bronchiolitis during the period from 1st October 2006 to the 15th March 2007. They are divided into two groups: group one 46 cases (oxygen saturation (SaO_2<90) and group two, 50 cases (SaO_2≥90).Complete history taken from care taker and full examination done for each patient. A portable oximeter was used to measure oxygen saturation.

Results: Forty nine (51%) of patients were males and 47 were females (49%), with male to female ratio of 1.04:1. The mean age was (7.745±3.7) months. The mean oxygen saturation was (90%), with a median of (84.7%) and a range of (76%-89%) in group one (SaO_2<90), while it was (95.32%) with a range of (90%-99%) in group two (SaO2≥90).

Conclusions: Reduced ability to feed, sleep disturbances, hypotonia and clinical signs as suprasternal retractions, continuous nasal flaring, tachypnea, grunting, head nodding and cyanosis appeared to be statistically highly significant in this study as predictors of severe hypoxemia. Combinations of signs and symptoms that showed statistically significant association with severe hypoxemia were: grunting or head nodding, cyanosis or head nodding, tachypnea or sleep disturbance, tachypnea or suprasternal retractions, and tachypnea or head nodding (p.value <0.0001) for all mentioned combinations, So we **recommend** to use these combinations of signs and symptoms as significant predictors of severe hypoxemia especially when pulse oximetry is not available.

Keywords: Bronchiolitis, hypoxemia, predictors, infants.

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Introduction:

Bronchiolitis is the most common disease of the lower respiratory tract in infants. It is defined as the first episode of wheezing associated with low-grade fever, rhinitis,

tachypnea, and increased respiratory effort in a previously healthy infant during the winter months [1,2,3].

Bronchiolitis is predominantly a viral disease. Respiratory syncytial virus (RSV) is responsible for more than 50% of cases. Other agents include parainfluenza virus, adenovirus, influenza virus, mycoplasma pneumonia .There is no evidence of a bacterial cause for Bronchiolitis [2, 3,4] .RSV consists of a single negative strand of non-segmented RNA. Two subtypes of RSV (A and B) are recognized [5,6].

Humans are the only source of infection .In temperate climate, the RSV season begins in late fall and continues until mid-spring, with winter peak [5,7].

Transmission of RSV requires close or direct contact with large droplets, and 40% of hospitalized children may become infected during RSV outbreak [5,7,8].

The average incubation period of RSV-induced respiratory disease is 5 days [5]. Bronchiolitis is characterized by virus induced necrosis of the bronchial epithelium, hyper secretion of mucus and round cell infiltration and edema of the surrounding submucosa. There is small airway obstruction which may be partial, so the child will develop air trapping and hyperinflation; or the obstruction is complete, so the child will develop ateleactasis [1,2,4].

Risk factors for acquiring severe bronchiolitis include: Low birth weight particularly preterm infants , low socioeconomic group , overcrowding ,parental smoking, chronic lung diseases , congenital heart disease ,immunodeficiency [9,10,11,12].

Clinically, the illness is usually preceded by exposure to an older contact with a minor respiratory syndrome within the previous week. The infant first develops a mild upper respiratory tract infection with sneezing and clear rhinorrhea. There may be diminished appetite, fever (38.5-39ċ), followed by relatively sudden onset of tachypnea, moist cough, hypoxia and difficulty with feeding and irritability , apnea may be more prominent than wheezing early in the course of the disease, particularly with very young infants <2 months or former premature infants [1,5,11].

The physical examination is characterized predominantly by wheezing. The degree of tachypnea does not always correlate with the degree of hypoxemia or hypercarbia. So the use of pulse oximetry and noninvasive carbon dioxide determination is essential. Work Auscultation may reveal fine crackles or overt wheezes, with prolongation of expiratory phase of breathing, barely audible breath sounds suggest very severe disease with nearly complete bronchiolar obstruction. Hyperinflation of the lungs may permit palpation of the liver and spleen [1]. The clinical finding that best correlates with hypoxemia is an increasing respiratory rate [7]. None of the clinical signs of respiratory distress had all the attributes of good predictors of hypoxemia. Chest wall indrawing was the most sensitive and inability to feed /drink was the most specific indicator of hypoxemia [13,14].The acute complications of RSV infection in infants include respiratory failure, apnea and rarely secondary bacterial infection[5].

The diagnosis of bronchiolitis is based on clinical criteria with supporting radiographic findings, which should be avoided unless there is underlying illness or deterioration [5,10.15].

Treatment of bronchiolitis remains supportive and consists of oxygen administration, hydration, and diligent monitoring. The use of corticosteroids, bronchodilators, antibiotics and ribavirin is controversial and dependent largely on physician preference [1,10.16]. Hospitalization of some infants with bronchiolitis is prolonged by perceived need for supplemental oxygen therapy based on pulse oximetry reading [17]. Indications for admission to hospital include poor nonresponsive infants, inability to feed ,apnea ,hypoxia unresponsive to low flow oxygen, <3 months old with respiratory rate of > 60/minutes[18].

Children hospitalized for early –life bronchiolitis are susceptible to recurrent wheezing and reduced pulmonary function by seven years compared to age matched non-hospitalized children [19].

In this study, we **aimed** to analyze the clinical signs and symptoms alone or in

combination as predictors of severe hypoxemia in infants with bronchiolitis.

Patients and Methods:

A well matched cross sectional prospective study performed on ninety six infants with bronchiolitis admitted to the emergency department of Children Welfare Teaching Hospital-Medical City –Baghdad in period from 1st October 2006 to 15th march2007. They are divided to two groups: group one 46 cases (SaO_2<90) and group two fifty cases (SaO_2≥90).

Infants less than one year of age with first attack of wheeze were included. Infants with congenital heart disease, hypotonia, cerebral palsy peripheral circulatory failure, severe anemia and dehydration were excluded.

The following points were taken from the history from care taker: age, sex, weight, family history of atopy, family history of smoking, pets at home, history and duration of URTI, history and duration of disease before admission, alteration of sleep and feeding pattern.

Clinical signs recorded were: general condition, tone, conscious level, intercostal, subcostal, suprasternal recessions, tachypnea (defined as respiratory rate of > 60 in babies < 3 months of age and respiratory rate more than 50 per minute for babies <1year) [5], grunting, nasal flaring, head nodding (movement of head synchronous with each breath which is produced by increase use of accessory muscles of respiration and therefore indicate respiratory failure) and cyanosis.

A portable oximeter (Kontron medical B.P:7840, serial number 2000-0306) was used to measure oxygen saturation with appropriately sized sensor on the finger or the toe. The reading taken while the infant breathing room air.

Statistical analysis was performed with software Graph Pad InStat Version 3. The study group was divided into two groups, group one: infant having SaO_2 <90, (cases) and group two: having SaO_2 ≥90, (control). Cases and controls were matched for age, sex, weight and other confounding factors that might play in away or another role in tachypnea in infant

like: feeding pattern, family history of allergy, paternal smoking, and fever.

Baseline characteristic were compared. Frequency of different symptoms and signs in both groups were calculated. Chi square test and fisher's test were used as indicated. Different combinations of signs were studied, p. value of <0.05 was considered statistically significant.

Results:

Ninety six infants with bronchiolitis were evaluated in this study. Forty nine (51%) were males and 47 (49%) were females, with male to female ratio of 1.04:1. The mean age was (7.745±3.7) months, the mean and standard deviation for age in group one (SaO_2<90) was 7.17±3.37 and it was 8.32 ±3.72 in group two (SaO_2≥90).

Family history of allergy was present in 5 cases (10.7%), smoking at home was present in 46 families (49%).SaO_2 was <90% in 46 cases (49%).

The sex was compared between group one (27 males and 19 females) and group two (22 males and 28 females). The mean and SD of weight for both groups was 7.34±2.62 and 7.91±1.92 kg respectively .None of the differences between the two groups were statistically significant. (P. value for age 0.7744, sex 0.271 and weight 0.2219). The characteristic of sample are shown in table **(1).**

The mean oxygen saturation was 90%, with a median of 84.7% and a range of (76 %-89%) in group one, while median oxygen saturation was (95.32%) with a range of (90%-99%) in group two. The characteristic of sample are shown in table **(1).**

Other factors studied, were also comparable in both groups, include family history of allergy (p.value 1.00), paternal smoking (p.value 1.00), fever (p.value 0.82), pattern of crying (p.value 0.26) and tone (p.value 0.099), which were all statistically insignificant as shown in (table **1, 2**).

Regarding the ability of feeding, it was normal in 4 (8%) infants and reduced in 42 (92%) infants in group one. While normal feeding recorded in 22 (44%) and reduced feeding recorded in 28 (56%) in group two. Disturbed feeding was higher in severe hypoxic group and its association with severe hypoxemia was highly significant (p.value < 0.0001), as shown in table **(2).**

Normal sleeping was recorded in 43 (44.7%) of cases, 10 (21%) of them were severe hypoxic. Sleep disturbances were found in 53 (55.2%), 36 (78%) of them were severely hypoxic, and this was statistically highly significant (p.value < 0.0001). The characteristic of sample are showed in table **(2).**

Clinical signs that showed statistically significant association with severe hypoxemia were: suprasternal retractions (p.value < 0.0001), continuous nasal flaring (p.value < 0.0172), tachypnea (p.value < 0.0001), grunting (p.value < 0.0001), head nodding (p.value < 0.0001) and cyanosis (p.value < 0.0001). The characteristic of sample are showed in table **(3).**

Other clinical signs were statistically insignificant include the presence of fever in 13(28%) of group one and 16 (32%) of group two (p value was 0.82), also normal tone found in 35(76%) of group one and 45(90%) of group two, while 11(23%) of group one and 13(26.5%) of group two found to have hypotonia (p value of 1.00). The characteristic of sample are shown in table **(4).**

Crepitations were found in 37(80%) of cases and 39(78%) of control, and this finding was statistically insignificant, while wheezes found in 44(95%) of cases and 39(78%) of control, and this was statistically significant (p value 0.015). table **(4).**

Combinations of signs that showed statistically significant association with severe hypoxemia were: grunting or head nodding (p.value < 0.0001), cyanosis or head nodding (p.value < 0.0001), tachypnea or sleep disturbance (p.value < 0.0001), tachypnea or suprasternal retractions (p.value < 0.0001) and tachypnea or head nodding (p.value < 0.0001). The characteristic of sample are shown in table **(5).**

Table 1: Demographics of the study group of infants with bronchiolitis.

Characteristics		Oxygen Saturation<90 No. =46(%)	Oxygen Saturation≥90 No. =50(%)	P. value
Age (M+SD)		7.17±3.73	8.32±3.72	0.7744
Weight (M+SD)		7.343±2.62	7.91±1.92	0.2219
O_2 saturation (M+SD)		84.76±3.65	95.38±2.47	< 0.0001
Sex	Male	27(58)	22(44)	0.2710
	Female	19(41)	28(56)	
Fever		13(28)	16(32)	0.8244

Table 2: Historical data and hypoxemia in bronchiolitis.

Clinical history		Oxygen Saturation<90 No. =46(%)	Oxygen Saturation≥90 No. =50(%)	P. value
Feeding	Normal	4 (8)	22 (44)	<0.0001
	Decreased	42 (91)	28 (56)	
Sleep	Normal	10 (21)	33 (66)	<0.0001
	Decreased	36 (78)	17 (34)	
Smoking in the family		20 (43)	22 (44)	1.0000
Family history of allergy		2 (4.3)	3 (6)	1.000

Table 3: General signs and symptoms as predictors of hypoxia in infants with bronchiolitis

Signs and symptoms		Oxygen saturation <90 No. =46(%)	Oxygen saturation ≥90 No. =50(%)	P. value
General condition	Well	7(15)	38(76)	<0.0001
	Sick	39(84)	12(24)	
Level of consciousness	Normal	25(54)	42(84)	0.0019
	disturbed	21(45)	8(16)	
Movement	Spontaneous	35(76)	46(92)	0.0476
	Stimulation	11(23)	4(8)	
Tone	Normal	35(76)	45(90)	0.0994
	Hypotonia	11(23)	5(10)	

Table 4: Respiratory signs and symptoms as predictors of hypoxemia in infants with bronchiolitis

Signs and symptoms		Oxygen saturation <90 No. =46(%)	Oxygen saturation ≥90 No. =50(%)	P. value
Continuous nasal flaring		17(37)	7(14)	0.0172
Suprasternal retractions		35(76)	10(20)	<0.0001
Head nodding		27(58)	7(14)	<0.0001
Grunting		32(69)	9(18)	<0.0001
Cyanosis		18(39)	0(0)	<0.0001
Heart rate	(160-179)	15(32)	42(50)	<0.0001
	(180-210)	31(67)	8(16)	
Respiratory rate	(60-79)	18(39)	45(90)	<0.0001
	(80-99)	28(60)	5(10)	
Crepitations		37(80)	39(78)	0.8063
Wheeze		44(95)	39(78)	0.0156

Table 5: Utility of different combinations of signs to predict hypoxemia in infants with bronchiolitis

Combination of signs	Oxygen saturation<90 No.46 (%)	Oxygen saturation ≥90 No.46 (%)	P. value
Cyanosis or head nodding	35 (80.4)	7 (14)	<0.0001
Tachypnea or head nodding	37 (80.4)	8 (16)	<0.0001
Grunting or head nodding	38 (82.6)	10 (20)	<0.0001
Tachypnea or suprasternal recessions	45 (97.8)	11 (22)	<0.0001
Tachypnea or sleep disturbance	41 (89)	17 (34)	<0.0001

Discussion:

In this study, the mean age of all studied infants with bronchiolitis was 7.74 months, (51%) of them were males with a male to female ratio 1.04:1. These results disagree with previously published data which revealed male to female ratio as 1.4:1 .[20]

In this study, a significant association was found between the tachypnea and hypoxemia. Many studies found a high respiratory rate to be useful predictor for hypoxemia. **(7)** This is consistent with that of Adnan et al [21], while others found that tachypnea is a poor predictor sign of hypoxemia in bronchiolitis [22], which might be attributed to short counting time of respiratory rate.

Depletion of oxygen produces abnormal cerebral function which manifests as drowsiness, lassitude, seizure, and even coma which may progress to death . [23] Disturbed consciousness was found to be higher in severely hypoxic group patients and scored as significantly associated with severe hypoxemia, this in agreement with Adnan M.et al [21] and Muhi K. et al. [24]

This study revealed that heart rate was negatively associated with the oxygen saturation, and this agrees with Adnan M.et al. [21].The increased heart rate is a physiological response to hypoxemia**.** [22]

The presence of cyanosis is clinically significant, because it implies severely decreased oxygen content of blood [25]**.** Mai et al [26] concluded that, in respiratory illness all cyanosed babies require supplemental oxygen therapy. On the basis of oximetry, as well as Martin et al [14]**,** stated that cyanosis is one of the best independent predictors of hypoxemia, this was also in agreement with Kim et al [22]**,** who stated that cyanosis is closely related to low oxygen saturation. Many factors may limit the usefulness of this sign in determining the hypoxemia, since it is late, subtle and can be easily missed in darkly pigmented skin infants. In addition it is influenced by hemoglobin concentration, but it is highly significant when present.

Chest retractions are useful predictor of hypoxemia in infant's respiratory infections. [27] Chest retractions showed a significant association with severe hypoxemia especially suprasternal retractions which scored, and is regarded as a major criteria for admission and oxygen supplementation [24], and this is in agreement with all published data. [20-24].

The finding that infants with inability to feed had a significantly lower oxygen saturation than those with normal fed, this is in agreement with previously published data[21,23]**.**it seems that rapid respiration will not permit enough time for suckling or swallowing.

Grunting, head nodding and continuous nasal flaring respectively were found to be highly significant and associated with severe hypoxemia in patients with bronchiolitis, and all in agreement with Mai et al. [26]

In contrast to Martin W.et al [14]**,** this study found that change in the tone is not affected by severe hypoxemia.

In this study, the use of combinations of signs significantly improves the prediction of severe hypoxemia in bronchiolitis. e.g. tachypnea or head nodding, tachypnea or suprasternal retractions, tachypnea or sleep disturbance, cyanosis or head nodding and grunting or head nodding,

Usen S. et al [28] concluded that in children with acute lower respiratory tract infection, simple physical signs that require minimal expertise to recognize combinations of inability to cry, head nodding and respiratory rate of $\geq$ 60 breath per minute, can be used to determine oxygen therapy. Others [23] stated that combination of signs as cyanosis or head nodding, tachypnea or head nodding, grunting or head nodding and tachypnea or suprasternal retractions slightly improves the predictive ability as combination of tachypnea or head nodding and tachypnea or suprasternal retractions.

All mentioned associations of some physical signs with severe hypoxemia make it possible to predict severe hypoxemia in infants with severe bronchiolitis .But still pulse oximetry is best indicator of hypoxemia in

children with severe bronchiolitis and though relatively expensive. Its use might be cost effective in controlling oxygen requirement. [24]

However in the absence of pulse oximetry, a simple model such as a combination of tachypnea or head nodding, tachypnea or suprasternal retractions, tachypnea or sleep disturbance, cyanosis or head nodding and grunting or head nodding can be used for detection of severe hypoxemia in infants with bronchiolitis.

Conclusions

We conclude that: 1. Clinical symptoms that predict severe hypoxemia are: ill looking patients, infants with disturbed level of consciousness, decreased sleeping and reduced feeding. While clinical signs that predict severe hypoxemia includes mainly: grunting, continuous nasal flaring, suprasternal retractions, head nodding, and cyanosis.

2. The combination of signs and symptoms that predicts severe hypoxemia include combinations of cyanosis or head nodding, tachypnea or head nodding, grunting or head nodding and tachypnea or suprasternal retractions.

So we recommend:

1. Anticipation of severe hypoxemia in infants with bronchiolitis in the presence of cyanosis, grunting, head nodding, and suprasternal retractions.
2. Regarding the combinations of signs (as cyanosis or head nodding, tachypnea or head nodding, grunting or head nodding and tachypnea or suprasternal retractions) in infants with bronchiolitis as predictors of severe hypoxemia and dealing with it properly especially when pulse oximetry is not available.

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