Transient tachypnea of the newborn: are there bedside clues for predicting the need of ventilation support?

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Received: 27th November 2014, Revised: 12th December 2014, Accepted: 27th October 2016

SUMMARY: Kahvecioğlu D, Çakır U, Yıldız D, Alan S, Erdeve Ö, Atasay B, Arsan S. Transient tachypnea of the newborn: Are there bedside clues for predicting the need of ventilation support? Turk J Pediatr 2016; 58: 400-405.

Decision making to transfer a late preterm or term neonate with the diagnosis of transient tachypnea of the newborn (TTN) to an intensive care unit for respiratory support is a challenge for caregivers in level one and two NICUs. The aim of this study was to identify "practical bedside clinical clues" that may help to predict the severity of disease and need for respiratory support in patients with the diagnosis of TTN. Newborns having the diagnosis of TTN were classified into two groups according to the intensity of the respiratory support. Infants receiving only supplemental oxygen and infants requiring nasal continuous positive airway pressure or mechanical ventilation constituted group 1 (mild) and group 2 (severe), respectively. Demographic, clinical and laboratory characteristics were compared between the two groups. Patients in group 2 had lower gestational age, higher Silverman and Richardson scores, longer mean duration of oxygen support and hospitalization. A positive correlation was found between subcostal and xiphoid retractions, asynchrony in chest-abdomen movements, arterial pH < 7.30, ratio of PaO_2/ % inspired O_2<1.2 and need of respiratory support ($p< 0.05$). We suggest that simple scores can help physicians to get a good sense of a given baby's likelihood of deterioration.

Key words:* *transient tachypnea of the newborn, silverman score, richardson score.

Transient tachypnea of the newborn (TTN) is a common cause of respiratory morbidity in late preterm and term infants[1-3]. Delayed resorption of lung fluid is the main pathophysiological factor[4-6]. The factors associated with TTN are low gestational age, male gender, low birth weight, cesarean section (CS), low APGAR scores, maternal asthma, maternal sedation and perinatal asphyxia[1,3,5,7-10]. TTN is generally a benign disease and treated with a brief course of oxygen. However, some of the cases need invasive or non-invasive respiratory support[6,7,11,12].

Decision making to transfer a late preterm or term neonate with the diagnosis of TTN to a neonatal intensive care unit (NICU) for respiratory support is a challenge for caregivers in level one and two NICUs. Although TTN is usually a benign and self-limited disease, associated hypoxemia, respiratory failure and pulmonary air leak syndromes may increase the risk of morbidity [6]. The aim of this study was to identify "practical bedside clinical clues" from physical examination and blood gas parameters that may help to predict the severity of disease and need for invasive and non-invasive respiratory support in patients with the diagnosis of TTN.

Material and Methods

Data Collection

Prospective data were collected from patients who were delivered and admitted to the NICU at Ankara University Hospital, Ankara, Turkey between January 2012 and January 2013.

Demographic characteristics; gestational age, birth weight, gender, type of birth, APGAR score and clinical characteristics; initial respiratory rate, peak respiratory rate within 24 and 48 hours, presence of subcostal and xiphoid retractions, asynchrony in chest-abdomen movements on physical examination, the worst arterial pH and ratio of arterial PaO2 to percent inspired O_2 within 24 hours of admission and duration of non-invasive or invasive respiratory support and duration of hospitalization were all recorded. Richardson (gestational age, the worst pH, the worst PaO_2/ FiO_2 ratio, lowest blood pressure) and Silverman (chest movement, intercostal and xiphoid retractions, nasal flaring and grunting) scores were calculated to evaluate the severity of respiratory distress[13,14].

Study Population

Infants who were older than 34th week of gestation with any respiratory symptoms (tachypnea, grunting, retractions, cyanosis) persisting for more than six hours after birth were evaluated for the differential diagnosis of TTN.

The clinical diagnosis of TTN was based on the following criteria[6]:

1. Respiratory distress (tachypnea, grunting, retractions, cyanosis) with onset within 6 hours after birth and persistence for at least 12 hours.

2. Chest X- ray findings that indicate at least one of the following: prominent central vascular markings, widened interlobar fissures of pleural fluid, symmetrical perihilar congestion, hyperaeration as evidenced by flattening and depression of the diaphragmatic domes or increased antero-posterior diameter or both.

3. Exclusion of any competing diagnosis such as surfactant deficiency, pneumonia, meconium aspiration, congenital heart disease or metabolic disorder, to explain respiratory distress.

Infants with respiratory symptoms due to transitional delay, pneumonia, respiratory distress syndrome, air leak syndromes, congenital heart disease, meconium aspiration, metabolic disorders (such as hypoglycemia, polycythemia), asphyxia (umbilical artery pH< 7.10 and/or HCO_3^- >12, BE>-10, APGAR score at 5 min < 3) and congenital lung anomalies were excluded from the study group. Exclusion of respiratory and non-respiratory disorders likely to cause respiratory symptoms were made by radiological and laboratory findings.

Newborns having the diagnosis of TTN were classified into two groups according to the intensity of the respiratory support. Infants receiving only supplemental oxygen and infants requiring nasal continuous positive airway pressure (CPAP) or mechanical ventilation constituted group 1 (mild) and group 2

Table I. Demographic and Clinical Findings of the Patients with Transient Tachypnea of the Neonate (n=35)

Gestational age (weeks) (mean ±SD)	37.1 ±1.6 (34-40)
Birth weight (g) (mean ±SD)	3047 ±701
Gender (male/female)	23/12
Type of birth (CS/NVD)	31/4
5 min APGAR score, median (min-max)	9 (5-10)
Respiratory rate on admission, median (min-max)	69 (52-90)
Peak respiratory rate in first 24 hr, median (min-max)	72 (60-90)
Peak respiratory rate in 24-48 hr, median (min-max)	58 (42-76)
Silverman score, median (min-max)	5 (2-10)
Richardson score, median (min-max)	2 (0-7)
Duration of oxygen support (hours), median (min-max)	30 (12-221)
Respiratory support	
Treatment Oxygen (n, %)	15 (43%)
CPAP (n, %)	18 (52%)
Mechanical ventilation (n,%)	2 (5%)
Duration of hospitalization (days) (mean ±SD)	4.3 ±2.9

CS: cesarean section, NVD: normal vaginal delivery, CPAP: continuous positive airway pressure

Table II. Comparison of Clinical Characteristics in Two Groups.

	Group 1(oxygen/ mild) n=15	Group 2 (CPAP or MV/severe) n=20	p
Gestational age (weeks) (mean ±SD)	37.7±1.6	36.6±1.5	0,048*
Birth weight (g) (mean ±SD)	3272±605	2878±735	0.1
Gender (male/female) (%)	73.3/26.7	60/40	0.41
Type of birth (CS/NVD) (%)	86.7/13.3	90/10	1
APGAR score at 5 min, median (min-max)	9 (7-9)	9 (5-10)	0.47
Respiratory rate on admission, (mean ±SD)	72.3±6.9	67±9.5	0.12
Peak respiratory rate in first 24 hr (mean ±SD)	74.2±6.9	71±7.8	0.22
Peak respiratory rate in 24-48 hr (mean ±SD)	56.5± 6.7	60±7.3	0.17
Silverman score (median)	4 (2-8)	6 (4-10)	<0,01*
Richardson score (median)	2 (0-5)	4 (0-7)	<0,01*
Mean duration oxygen support (hour)	24.7±12.1	72.1±61.1	0.006*
Mean duration of hospitalization (days) (mean ±SD)	2.4±1.1	5.7±3.1	0,001*

* p value < 0.05 was regarded as statistically significant

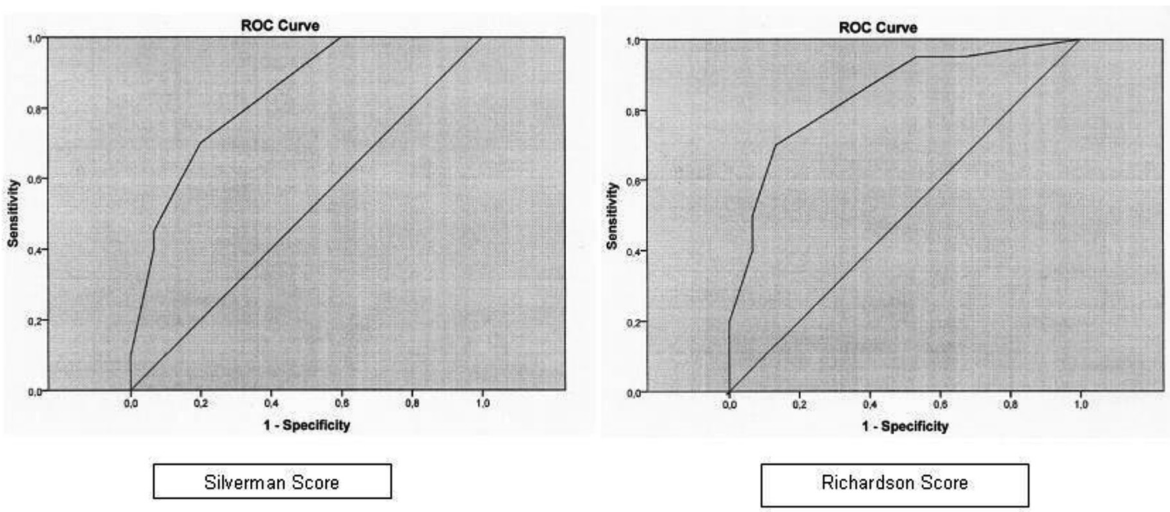

Fig. 1. ROC Curves of Silverman and Richardson Scores

(severe), respectively. Demographic, clinical and laboratory characteristics were compared between two groups.

Indications for CPAP treatment were:

1. $SatO_2$ below 90% with free flow $FiO_2 \geq 60\%$

2. $PaCO_2 > 50$ mmHg and /or $PaO_2 < 50$ mmHg with free flow $FiO_2 \geq 60\%$

Indication for mechanical ventilation treatment were:

1. Presence of severe to moderate respiratory distress under CPAP treatment

2. Sat O2< 90% on 8 cm H_2O nCPAP at $FiO_2 > 60\%$

3. $PaCO_2 > 50$ mmHg and /or $PaO_2 < 50$ mmHg on 8 cm H_2O nCPAP at $FiO_2 > 60\%$

4. Hemodynamic instability (Mean blood pressure < 35mm Hg, capillary refill >3sec)

5. Apneic and/or hypoxic episodes under NCPAP

Nasal CPAP was provided by a neonatal CPAP device (Viasys Healthcare, Infant Flow NCPAP System, UK) with short binasal prongs and invasive mechanical ventilation was provided

Table III. Comparison of Physical Characteristics in Two Groups

	Subcostal retraction		Chest movement			Xiphoid retraction			Grunting		
	Minimal (%)	Marked (%)	Equal (%)	Respiratory Lag (%)	Seesaw respiration (%)	None (%)	Minimal (%)	Marked (%)	None (%)	Stethoscope only (%)	Naked ear (%)
Group 1 (mild) n=15 (%)	12 (57.1)	3 (21.4)	6 (100)	9 (32.1)	0 (0)	5 (83.3)	9 (50)	1 (9.1)	5 (71.4)	4 (40)	6 (33.3)
Group 2 (severe) n=20 (%)	9 (42.9)	11 (78.6)	0 (0)	19 (67.9)	1 (100)	1(16.7)	9 (50)	10 (90.9)	2 (28.6)	6 (60)	12 (66.7)
p	0.036*		0.003*			0.01*			0.29		

* p value < 0.05 was regarded as statistically significant

by a mechanical ventilator (Stephan, Sophie Neonatology Ventilator, Germany) in volume targeted mode. Initial NCPAP parameters were 5 cm-H_2O PEEP and 40% FiO_2.

The initial ventilator parameters were adjusted as to achieve a 5 ml/kg tidal volume, 40% FiO_2, 5cm-H_2O PEEP and ventilator settings were adjusted according to the blood gas parameters.

Statistical analysis

Statistical analysis was done using SPSS version 16.0 (SPSS, Chicago, IL, USA). To compare the proportions among the groups, either χ^2 test or Fisher's exact test was used; to compare the means among the groups the t-test or the Mann–Whitney U-test was used depending on the sample size. P value < 0.05 was regarded as statistically significant. Receiver operating characteristic curve was used to determine the cut-off for Silverman and Richardson scores. Parameters were compared between the groups and statistical significance was assessed by logistic regression to determine the independent predictive value of a specific parameter.

Results

During the study period, 300 newborns ≥ 34 weeks gestation admitted to our NICU. Sixty of these infants had respiratory distress symptoms. Among these 60 infants, 35 infants were diagnosed as TTN, 12 infants as neonatal pneumonia, 11 infants as delay of transition, 1 infant as respiratory distress syndrome and 1 infant as pneumothorax. Demographic and clinical findings of the patients with TTN are presented in Table I.

Comparison of clinical characteristics of both groups demonstrated that patients in group 2 had lower gestational age, higher Silverman and Richardson scores, longer mean duration of oxygen support and hospitalization (Table II). The cut-off for the Silverman score to predict the need of non-invasive or invasive ventilation was 6 with 70% sensitivity and 80% specificity and the cut off for Richardson score was 3 with 70% sensitivity and 86% specificity (Fig. I). A positive correlation was found between subcostal and xiphoid retractions on the first physical examination after admission, asynchrony in chest-abdomen movements, arterial pH < 7.30, ratio of PaO_2/ % inspired

Table IV. Comparison of Laboratory Characteristics in Two Groups

	Arterial pH-pCO2				Arterial pO2/FiO2		
	pH >7.30 (%)	pH 7.25-7.29, p CO2<50 (%)	pH 7.25-7.29, p CO2>50 (%)	pH <7.25 (%)	>2.5 (%)	1.2-2.4 (%)	<1.2 (%)
Group 1 (mild) n=15 (%)	12 (57.1)	3 (21.4)	6 (100)	9 (32.1)	8 (80)	7 (43.8)	0 (0)
Group 2 (severe) n=20 (%)	9 (42.9)	11 (78.6)	0 (0)	19 (67.9)	2 (20)	9 (56.2)	9 (100)
p	0.036*				0.02*		

* p value < 0.05 was regarded as statistically significant

O_2<1.2 and need of respiratory support (p< 0.05) (Table III-IV).

In addition, assessment of the aforementioned significantly different parameters on logistic regression demonstrated that xiphoid retractions independently had an odds ratio of 12.6 (95% C.I 1.06-150.71) for assessing further need for respiratory support.

Discussion

This prospective cohort study demonstrated that higher Silverman and Richardson scores were predictive for further respiratory support in patients with the diagnosis of TTN, and positive correlations were found between subcostal and xiphoid retractions on the first physical examination after admission, asynchrony in chest-abdomen movements, arterial pH < 7.30, ratio of PaO_2/ % inspired O_2<1.2 and further need for invasive and non-invasive respiratory support.

TTN is usually a benign and self-limited disease. However, associated hypoxemia and respiratory failure increase the need of ventilation support and the number of NICU admissions. More than half of our patients (57%) required respiratory support. In the study of Kasap et al.[6], 47 (49.4%) out of 95 TTN patients needed respiratory support. In another study by Weintraub et al.[15], out of 745 neonates with the initial diagnosis of TTN, 336 (45%) infants required CPAP or high flow nasal canula treatment.

Evidence-based approaches for interpreting physiologic data in neonates ≥34 week gestation presenting with respiratory distress including the diagnosis of TTN are not widely used. However, Escobar et al.[13] developed a model to predict death and the need of prolonged assisted ventilation in newborns ≥ 34 weeks with respiratory distress. In his study, 203 (9.3%) infants needed assisted ventilation longer than 3 days or died among 2276 newborns. A simple score based on gestational age, the lowest PaO_2/FiO_2 and the lowest mean arterial blood pressure had a predictive value with a 0.80 validation data set. On the other hand Richardson and Silverman scores were used to determine the severity of respiratory distress of the newborns in few studies[12-14,16]. Silverman scores above 6 and Richardson scores above 3 are usually accepted as to be related to severe respiratory distress[13,14,16]. Our results confirm these findings.

Contrary to the study by Kasap et al.[6] which demonstrated that respiratory rate peak during 36 hours >90/min caused a 7.04-fold risk of prolonged tachypnea, peak respiratory rates at 24 and 48 hours were not different between groups in our study. However, we demonstrated significant difference in Silverman and Richardson scores between the groups. We suggest that subcostal and xiphoid retractions and arterial pH and arterial PaO_2/ % inspired O_2 ratio on admission are significant predictors of subsequent respiratory support. Oztekin et al.[17] assessed respiratory rates and blood gases in the first postnatal hour to predict the duration of respiratory support in patients with TTN. Respiratory rates were not different between their groups but pH<7.22 had a 97.7% sensitivity to predict the need of respiratory support for >5 days[17]. Arterial pH < 7.30 and ratio of arterial PaO_2/ % inspired O_2<1.2 were found to be significant in the group who need invasive and non-invasive respiratory support in our study.

Certain limitations to our analysis must be stressed. First it is a single center study with a limited number of cases. Second, we did not present any data related to maternal complications that may be associated with TTN.

In conclusion, we think that simple scores can help nurses and physicians to get a good sense of a given baby's likelihood of deterioration. Subcostal and xiphoid retractions on the first physical examination, asynchrony in chest-abdomen movements, arterial pH < 7.30 and ratio of PaO_2/ % inspired O_2<1.2 may be helpful for clinicians in decision making for referral of the patients to a secondary or a tertiary level NICU. Despite its limitations, this study can serve as a useful adjunct to clinical evaluation of neonates with the diagnosis of TTN and we hope that it will encourage the use of physiologic data in decision making.

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