Physiological parameters during first three days of life in the healthy late preterm newborns.

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Abstract

Background: Late preterm newborns are born at gestational age between $34^{0/7}$ to $36^{6/7}$ completed week. They are less physiologically and metabolically mature than term newborns, so they suffer more morbidity and mortality. It is important to understand why these newborns are born early as well as the unique problems that this growing population of newborns may experience.

Objective: To study the physiological parameters and derive reference tables and nomograms of late preterm newborns.

Method: The clinical subject consist 500 late preterm newborns in the postnatal ward of a tertiary care hospital in Madhya Pradesh.

Results: Late preterm newborns in the study were enrolled and followed up as per the inclusion and exclusion criteria . Median HRs were 134/minute at Day 1 of life , thereafter 134 to 136 /minute. The 95th percentile was 142 /minute at Day 1 of life ,thereafter 140 to 138 breaths/minute. Median RRs were 44 breaths/minute at Day 1 of life , thereafter 46 to 43 breaths/minute. The 95th percentile was 46 breaths/minute at Day 1 of life ,thereafter 46 to 45 breaths/minute. Median temperature were 97 ^{o}F at Day 1 of life , thereafter 97 ^{o} F to 96 ^{o} F.

Conclusion: Novel centile charts and nomogram tables for HR, RR and temperature were derived based on the study observation from healthy late preterm newborn. These novel centile chart and nomogram tables will add to literature and will act as a cornerstone for further research in the late preterm of Central India.

Keywords: late preterm, physiological, parameters, centiles

Introduction

Gestational age is one of the main factors that influence maturation and the evolution of neonatal development. Newborn with a gestational age between $34^{0/7}$ to $36^{6/7}$ completed weeks are referred to as "late preterm". According to the National Institute of Child Health and Human Development (NICHD) in 2005[1] this designation was made in recognition of the physiological and developmental immaturity of this group of newborns at birth.

Since preterm, term and post term are mutually exclusive categories that have each been defined

precisely according to week and day of gestation (counting the first day as day 1) by the American Academy of Pediatrics, the American College of Obstetricians and Gynecologists, and the World Health Organization [2,3] .

They have higher morbidity and mortality rates than term newborns (gestational age$\geq$37 weeks) due to their relative physiological and metabolic immaturity, though they are the same size and weight of some the term newborns. Although they are not as underdeveloped as their very preterm counterparts, they are not being monitored aggressively in mother units and they can deteriorate quickly due to delay in identifying their problem. This entity has not been studied very often, thus understanding their developmental biology and diseased state is incomplete. Strategies for management are mostly based on the general principles, clinical experience and extrapolation from knowledge regarding the very preterm and term newborns. Early warning signs may help clinician identify early signs of failure to adapt or deterioration but which in turn are dependent on normal vital signs reference ranges for need of improving care and management. Since they have increased incidence of hospital re admission when compared to the full-term counterparts. The aim of this study is to know the changes in physiological parameters in this population.

Methods

This is a prospective observational study in which all healthy newborns born at 34 to 36 completed weeks of gestation whose parents or guardians provide informed consent are included. Institutional ethical committee (IEC) approval was obtained before starting the study. Newborns whose parents or guardians does not provide informed consent, those with major congenital malformation, stillbirth, Sick newborns (admitted in SNCU) were excluded from the study.

The gestational age was calculated from the last menstrual period. In patients where the date of last menstrual period was not known dating of pregnancy was estimated by 1st trimester ultrasound. The newborn was positioned supine in the cot and undressed in a quite environment. The heart rate was counted by pediatric stethoscope (3M Littmann Classic III Stethoscope) average of 3 reading of heart rate at 3 minutes of interval was taken. Respiratory rate was counted clinically by visual observation of respiratory movements without disturbing the newborn over one minute an average of 3 recordings of respiratory rate at 3 minutes of interval was done. Before each assessment, the newborn was in quite state and was not handled for at least 10 minutes before counting the heart rate and respiratory rate, while recording the respiratory rate, the number of breaths was calculated manually for 60 seconds by visual observation. Axillary temperature was recorded by gently placing the tip of the digital thermometer (omron MC -246) in the center of the arm pit and by tucking the newborns arm closely against the body. The temperature was recorded when the thermometer gave an audible signal after ~1 minute. The same thermometer was used for measuring all temperatures in the same infant. The thermometer was rinsed in isopropyl alcohol 70% after each measurement and soaked in sterilization solution for 10 minutes for full disinfection between newborn. The further observations of participants who were transferred to the NICU were not taken and excluded from study. All these parameters were recorded daily by the same observer preferably at the same time daily till discharge of the neonate from hospital.

Result

A total of 500 late preterm newborns of gestational age ranging between $34^{0/7}$ to $36^{6/7}$ completed week were enrolled as per inclusion and exclusion criteria. The length of hospital stays varied from less than 72 hours to 6 days, with longer hospitalizations related to maternal factors, e.g., recovery from caesarean section. Majority of the babies (98.4%) respondents were discharged successfully, 0.6% newborns were lost to follow up and 1% of them were shifted to SNCU. The physiological parameters of late preterm newborns and demographic profile was mentioned in tables and graphs. 80.6% of them were male and 19.4% were female. In the present study male: female ratio was 4.1:1. 90% of them were delivered by normal vaginal delivery whereas 10% of them were through LSCS, only seven babies were born through multifetal gestation rest all were born by singleton pregnancy. In present study only 1.4% newborn were present with history of multiple gestation. All newborns were delivered in tertiary care hospital. 67.4% belonged urban area and 32.6% of them to rural area. 56.2% newborn belonged to middle socioeconomic level, 43.8% belongs to lower socioeconomic level. 98% of newborn mother had undergone complete antenatal checkup whereas 10% of them did not. Demographic profile of studies subjects are shown in table 1.

There was no significant difference in heart rate , respiratory rate and temperature of newborn with gestational age ranging between $34^{0/7}$ to $36^{6/7}$ completed week on 1st three postnatal days of life was (p=0.130, p=0.610, p=0.204), (p=0.695, p=0.452, p=0.615), (p=0.602, p=0.913, p=0.396) respectively as shown in table 2, 3 ,4.

Median HRs were 134/minute at Day 1 of life, thereafter 134 to 136 /minute. The 95th percentile was 142 /minute at Day 1 of life, thereafter 140 to 138

breaths/minute. Median RRs were 44 breaths/minute at Day 1 of life, thereafter 46 to 43 breaths/minute. The 95th percentile was 46 breaths/minute at Day 1 of life, thereafter 46 to 45 breaths/minute. Median temperature were 97 ^{o} F at Day 1 of life, thereafter 97 ^{o} F to 96 ^{o} F as shown in centile charts table 5.

Discussion

The study shows changes in the physiological parameters of late preterm newborns that is heart rate, respiratory rate, temperature after birth who did receive minimal medical intervention. In 1953 Virginia Apgar stated "heart rate was found to be the most important diagnostic and prognostic of the five signs" that now form the basis of the Apgar score [4]. Information on the normal range of HR, RR, Temperature of late preterm newborns immediately after birth and how it changes with time could be vital for those caring for the newborn in hospital. The centile charts invented from the study for respiratory rate, heart rate, temperature in late preterm newborns will provide novel evidence-based reference ranges for these vital signs.

HR is the most important clinical indicator to evaluate status of newborn, criteria for the diagnosis of sepsis [5], emergency department (ED) triage scores [6,7], and Pediatric Advanced Life Support guidelines [8] .In present study, the difference between the heart rate of the newborns born at 34, 35 and 36 weeks of gestational age on first three postnatal days of life was not statistically significant (p=0.130, p=0.610, p=0.204). Almost similar results was found in the study conducted by van Vonderen J et al, which included 24 term newborns whose HR and preductal blood pressure (BP) were measured, the results showed that Mean (SD) HR and BP did not change with time (mean HR: 157 (21) bpm at 2min, 154 (17) bpm at 5min, and 155 (14) bpm at 10min[9]. The Mean (SD) HR in present

study was 134.5(2.25) which was almost similar to the study conducted by Toth et al , who measured HR in 50 newborns born at term not requiring interventions .They did not report HR at 1 min; after 2 min the median (range) HR was 157 (89–199) bpm decreasing after 10 min to 148 (110–191) bpm[10]. Fleming et al in the study, they compared existing reference ranges with those derived from their centile charts which showed that Median heart rate range increases from 127 beats per min at birth, reaching a maximum of 145 beats per min at about 1 month of age[11]. Measurement is unlikely to account for all of the differences at young ages given that Davies et al also used a mix of HR measurement methods.

Respiratory rate is important clinical parameter of health and disease in the newborn. The difference between the respiratory rate of newborns of 34, 35 and 36 weeks of gestational age on 1st three postnatal days of life was not statistically significant(p=0.695, p=0.452,p=0.615) mean being from 43 to 45 breaths/ minute almost similar findings was seen in the study conducted by Tveiten M Lars et al, which included 953 newborns where RRs were slightly higher at 2 hours than later during the first 24 hours of life, but still remarkably consistent in the cross-sectional analyses with a median at 40 to 45 breaths/minute[12]. Cesarean delivery, gender, and being on the mother's chest as opposed to in a cot had no or minimal clinical significance, which was also seen in present study. Taylor WC et al in a study that included 76 healthy term newborns as a control group in which an average RR of 41 to 42 breaths/minute was found during the first 3 days of life[13]. In another study conducted by Valman HB et al which included 54 term newborns, the highest mean (SD) RR during the first 24 hours was 48 (6) breaths/ minute at age 3 hours, when obtained from

a special recording device[14] Respiration has been recorded by visual observation which was also used in study done by Kravitz H et al[15].

In a study conducted by Fleming et al showed that Median respiratory rate decreased by 40% in these 2 years (44 breaths per min at birth to 26 breaths per min at 2 years) and Subgroup analysis of respiratory rate data showed no significant differences on the basis of study setting (p=0·09), economic development of the country in which the study was done (p=0·83), wakefulness of the child (p=0·36) , which was almost similar to our study[16].

Almost similar results were found in the study conducted by Bhandari et al where 100 healthy newborns were studied at 1,2,4,6 and 8 weeks of age. The median RRs ranged between 40 and 44 breaths/min, inter age variability upto 8 weeks of age was very slight and statistically insignificant[17].

There is no statistically significant difference in between temperature of newborns of 34 weeks and 35 weeks on day 1(p=0.606), on day 2 (p=0.385) and on day 3(p=0.702) of 34 weeks and 36 weeks on day 1(p=0.944), on day 2 (p=0.635) and on day 3(p=0.435) and of 35 weeks and 36 weeks on day 1(p=0.569), on day 2 (p=0.481) and on day 3(p=0.098).Similar results were obtained in the study conducted by Fransson AL et al , were no significant differences was found between 16 male and 11 female with regards to gestational age (mean (SD) 40 (1.2) weeks, birth weight (3630(481) g), length (50.7(2.1) cm), mean rectal or skin temperatures[18].

A study conducted by Takayama I John et al showed almost similar results were the mean birth axillary temperature was associated with birth weight (p < 0.0005) and the presence of maternal fever (p<0.0001) but not with type of environment or time of birth[19].

Similar results were also found in the study conducted by Mayfield ST et al , were the final temperature at day 1 was similar to that reported in a study of 99 term newborns at 2 days of age[20].

Conclusion

Nobel centile charts derived from the study, have been developed with data from healthy late preterm newborn. Median HRs were 134/minute at Day 1 of life, thereafter 134 to 136 /minute. The 95th percentile was 142 /minute at Day 1 of life, thereafter 140 to 138 breaths/minute. Median RRs were 44 breaths/minute at Day 1 of life, thereafter 46 to 43 breaths/minute. The 95th percentile was 46 breaths/minute at Day 1 of life, thereafter 46 to 45 breaths/minute. Median temperature were 97 ^{o} F at Day 1 of life, thereafter 97 ^{o} F to 96 ^{o} F. These novel centile chart and nomogram tables will add to literature and will act as a cornerstone for further research in the late preterm of Central India.

Key message

Late preterm newborns are born at gestational age between $34^{0/7}$ to $36^{6/7}$ completed week. They are less physiologically and metabolically mature than term counterparts. To pick up the changes in physiological parameters i.e HR, RR, Temperature and deviation from the nomograms could be the earliest sign to save these late preterms. This study is an novel effort to prepare the centile charts and nomograms for late preterm from Central India.

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Legends tables and graphs

Table 1: Demographic profile of studies subjects

Variables		Number	Percentage
Gestational age	34 weeks	69	13.8
	35 weeks	288	57.6
	36 weeks	143	28.6
	Total	500	100
Gender	Male	403	80.6
	Female	97	19.4
	Total	500	100
Mode of delivery	NVD	450	90
	LSCS	50	10
	Total	500	100
Multi fetal Gestation	Single	493	98.60
	Twin	7	1.40
	Total	500	100
Place of delivery	GH	500	100
	PH	0	0
	Total	500	100
Social background	Urban	163	67.4
	Rural	337	32.6
	Total	500	100
Socioeconomic status	Upper	00	00
	Middle	281	56.2
	Lower	219	43.8
	Total`	500	100
Complete	Yes	490	98

antenatal checkup	No	10	2
	Total	500	100
Final outcome	Discharge	492	98.4
	Lost to follow up	3	0.6
	Shift to SNCU	5	1
	Total	500	100

Table 2: Distribution and correlation between heart rate of various gestational age and postnatal day of life

Heart Rate	Day 1	Day 2	Day 3	
34 weeks Mean	134.8	134.3	134.7	P value = 0.130
(SD)	2.7	1.8	1.9	F = 0.05
35 weeks Mean	134.4	134.6	134.3	P value = 0.610
(SD)	2.1	2.3	2.1	F = 0.495
36weeks Mean	134.8	134.5	134.6	P value = 0.204
(SD)	2.4	2.1	2.3	F = 1.596
P-Value				
34wks vs 35wks	0.183	0.277	0.113	
34wks vs 36wks	0.850	0.568	0.695	
35wks vs 36wks	0.095	0.599	0.192	

Table 3: Distribution and correlation between respiratory rate of various gestational age and postnatal day of life

| RR	Day 1	Day 2	Day 3	
34 weeks Mean	44.4	45.2	44.0	P value = 0.695
(SD)	1.7	1.5	1.5	F = 0.364
35 weeks Mean	44.6	45.0	44.0	P value = 0.452
(SD)	1.9	1.4	1.4	F = 0.796
36 weeks Mean	44.5	45.0	44.1	P value = 0.615
(SD)	1.8	1.4	1.4	F = 0.487
P-Value				
34wk vs 35wk	0.429	0.294	0.956	
34wk vs 36wk	0.719	0.220	0.557	
35wk vs 36wk	0.595	0.707	0.335	

Table 4: Distribution and correlation between temperature of various gestational age and postnatal day of life

Temperature	Day 1	Day 2	Day 3	
34 weeks Mean	97.2	97.4	97.7	P value = 0.602
(SD)	0.62	0.2	0.9	F = 0.508
35 weeks Mean	97.3	97.3	97.8	P value = 0.913
(SD)	0.6	0.2	0.9	F = 0.091
36 weeks Mean	97.2	97.6	97.6	P value = 0.396
(SD)	0.6	0.1	0.8	F = 0.929
P-Value				
34wk	0.606	0.385	0.702	

vs35wk				
34wk vs 36wk	0.944	0.635	0.435	
35wk vs 36wk	0.569	0.481	0.098	

Table 5: Percentile chart for heart rate of late preterm newborns on Day 1

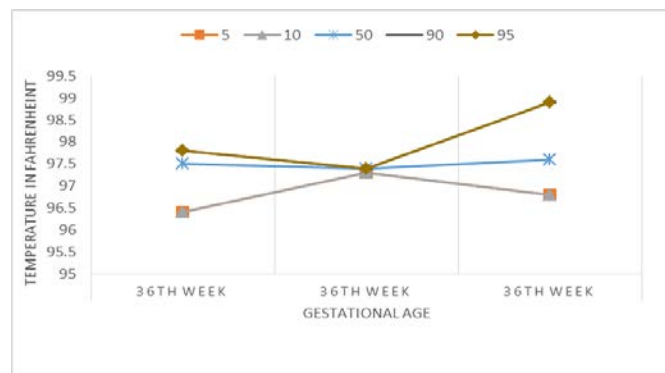|	Day1		
Centiles	34 weeks	35 weeks	36 weeks
3	132	132	132
5	132	132	132
10	132	132	132
25	132	132	132
50	134	134	134
75	1362	136	136
80	136	136	136
85	136.9	136	136
90	140	136	138
95	142	138	140
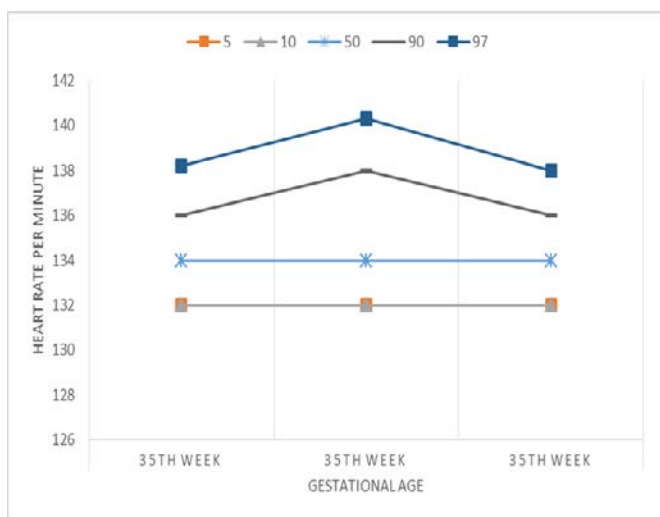
Graph 1 : Estimated percentile curves of Heart rate per minute based on observations at day 1, 2 and 3 of life in healthy late preterm infants at 35 weeks of gestation

Above percentile   curves shows that 90% of late preterm of 35 weeks of gestational age had heart rate

ranging between 138 per minute to 140 per minute in the first three postnatal days of life.
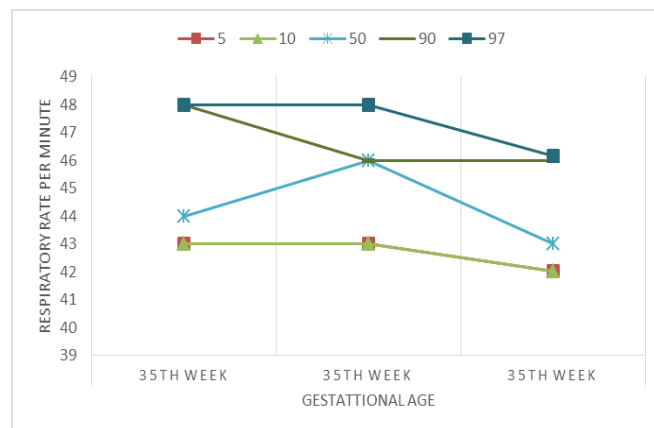
Graph 2: Estimated percentile curves of Respiratory rate per minute based on observations at day 1, 2 and 3 of life in healthy late preterm infants at 35 weeks of gestation

Above percentile curves shows that 90% of late preterm of 35weeks of gestational age had respiratory rate was 48 per minute on day 1 which gradually decreased to 46 per minute on day 3.

Graph 3: Estimated percentile curves of temperature in fahrenheit based on observations at day 1, 2 and 3 of life in healthy late preterm infants at 36 weeks of gestation

Above percentile curves shows that 95% of late preterm of 36 weeks of gestational age had temperture ranged between 98 to 99°F on the 1st three postnadal days of life.