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Original Research Article

Assessment of Changes in Vital Parameters in Relation to Different Feeding Methods in Preterm Newborns

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Abstract

Aim: The aim of the present study was to study changes in vital parameters in relation to different feeding methods in preterm newborns.

Material& Methods: This was a prospective analytical observational study conducted in Department of Pediatrics, AIIMS, New Delhi India from September 2017 to August 2019. Sick preterm newborns are admitted to Neonatal Intensive Care Unit (NICU), and stable preterm newborns weighing more than 1500 gm are admitted to Neonatal Intermediate Care Unit. We collected 350 observations from 100 newborns.

Results: There was rise in RR at 5 min in the majority of groups except the GF (gavage feeding) group. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except the SG (spoon feeding followed by gavage feeding) and BSG (breast feeding followed by spoon feeding followed by gavage feeding) groups. There was rise in PR at 5 min in majority of groups except in the BS (breast feeding followed by spoon feeding) and GF groups. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except in the BF(breastfeeding) and BS groups where it reduced below the baseline. We noticed the trend towards nonsignificant rise in SPO2 immediately after feed in the SF (spoon/paladai feeding), BG (breast feed followed by gavage feeding), and SG groups while in the GF (gavage feeding), BS, and BSG groups there was nonsignificant reduction. There was a sharp reduction at 5 min in the majority of the groups except GF. Mean SPO2 reached towards baseline at 3 hours after feed in the majority of the groups except the SF group where it was below baseline. In the BF group, the mean SPO2 increased significantly immediately after feed.

Conclusion: Vital parameters changed after different types of feeding methods and at different PMA. A further multicentric prospective study is needed to understand the effect of different feeding methods and PMA on vital parameters.

Keywords: Deglutition; Heart rate; Infants; Pulse oximetry; Rehabilitation

Introduction

Appropriate feeding is an important component of essential care for every newborn viz. immediate care at birth including resuscitation, breast milk feeding, temperature control, infection prevention, recognition, and response to danger signs [1, 2]. Breast milk is the basic right of the newborn. Breast feeding of infants has significantly different physiologic effects on their cardiopulmonary activity than does bottle feeding. The methods of feeding are individualized based on gestational age/weight, clinical condition and tolerance of the newborn.

Preterm infants who are breast-fed have fewer episodes of oxygen desaturation (90%) during feeding than do those who are bottle fed. [3,4] Preterm infants are also better able to coordinate sucking and respiration during breast feeding than during bottle feeding. [5,6] Low birth weight newborns who are often premature may not suck effectively and have poor coordination between sucking and swallowing and between swallowing and breathing. Because of this, newborns with gestational age < 32 weeks (<1250 gm) are usually started with gavage feeding followed by spoon/paladai feeding. Newborns between 32 and 34 weeks (1250-1500 gm) usually accept spoon/paladai feeding, and those > 34 weeks (1500-2000 gm) can accept breastfeeding, and some may require spoon/paladai feeding [1,7]. It is important to ensure safe transition from initial methods of feeding to breastfeeding. The coordination of sucking, swallowing, and breathing is dependent on postconceptional age but may vary from infant to infant depending on the clinical condition [8-11]. Continuous cardiorespiratory monitoring is a vital component of care in preterm neonates. Vital parameters like pulse rate (PR), respiratory rate (RR), and oxygen saturation using pulse oximetry (SPO2) are constantly monitored during the hospital stay. They are under complex physiological control, and while patterns of variation often reflect normal physiology, they may also represent the earliest signs of deterioration. [12] Chest indrawing and nasal flaring are also important components of respiratory function assessment. [13]

Additionally, whereas bottle feeding leads to marked reductions in minute ventilation, tidal volume, and breathing frequency, breast feeding is associated with increased breathing frequency, particularly during initial sucking bursts. [14] Finally, bottle feeding has been associated with episodes of bradycardia in preterm infants. There are no reports of similar effects on heart rate during breast feeding. Despite the reported physiologic benefits of breast feeding over bottle feeding in preterm infants, few studies have evaluated the cardiopulmonary effects of breast feeding in full-term neonates and older infants. Reports have varied. Similar to preterm infants, full-term neonates appear to have fewer episodes of oxygen desaturation with breast feeding than with bottle feeding. [15]

During the transition, premature newborns are often given feeds using a combination of these methods. We assume that each method of feeding has different effects on these parameters because of the nature of the feeding method and level of maturity of the cardiorespiratory, central, and peripheral nervous system affecting coordination of sucking, swallowing, and breathing. Some studies have identified changes in heart rate (HR), SPO2, and RR before, during, and after breast feeding, cup-feeding, and bottle feeding in term and late preterm newborns. [16,17] These findings need to be studied further in preterm newborns for the above-mentioned different feeding methods when used alone or in combination.

Hence the aim of the study was to evaluate PR, SPO2, RR, and respiratory effort before and after giving feeds using different methods and to evaluate vital parameters based on PMA in stable preterm newborns.

Material & Methods

This was a prospective analytical observational study conducted in Department of Pediatrics, AIIMS, New Delhi India from September 2017 to August 2019. Sick preterm newborns are admitted to Neonatal Intensive Care Unit (NICU), and stable preterm newborns weighing more than 1500 gm are admitted to

Neonatal Intermediate Care Unit. We collected 350 observations from 100 newborns. Clinicians, during their routine rounds, decide about the feeding methods for the individual newborns based on clinical examination and feedback from nurses and mothers in accordance with the above guidelines. During the transition from gavage feed to spoon/paladai feed and from spoon/paladai feeding to breastfeeding, two or all these three methods are used in succession for feeding the newborns. So at a time, a newborn may be on "gavage feeding"(GF) or "spoon/ paladai feeding" (SF) or "breastfeeding" (BF) or the combination of these feeding methods like "BF followed by SF"(BS) or "BF followed by GF"(BG) or "SF followed by GF"(SG) or "BF followed by SF followed by GF"(BSG). Nurses give GF and SF. They also assist mothers to give SF and BF. All the physiologically stable preterm newborns with PMA less than 37 weeks who were on full enteral feeds at every 3-hour interval were eligible.

Exclusion Criteria.

Infants having feed intolerance, hemodynamic instability, respiratory distress, and bronchopulmonary dysplasia, on invasive/noninvasive ventilatory support or on free flow oxygen were excluded from the study.

Sampling Procedure. The Institutional Ethics Committee of, AIIMS, New Delhi approved the study. After taking an informed written consent from parents, two study authors evaluated PR, RR, SPO2, nasal flaring, and chest indrawing before and after finishing the feeds. Timing of recording of the parameters was dependent on the availability of either author. The infants included were categorized into the GF, SF, and BF groups or combination of these feeding methods, i.e., BF & SF (BS group), BF & GF (BG group), SF & GF (SG group), and BF & SF & GF (BSG group). The vital parameters were recorded before the feed, immediately after the feed, and at 5 min, 10 min, 15 min, 30 min, 1 hour, 2 hours, and 3 hours after the feeding. SPO2 and PR were recorded using a pulse oximeter.

Pulse oximeter probe was attached to the right upper limb for uniformity. To avoid observer bias, respiratory rate was calculated in the calm newborn over a period of one minute. It is important that newborns should be calm while measuring these parameters as physical efforts/cry makes measurement difficult and also affect them because of increased metabolic demand. Young infants usually breathe faster than older infants and young children. The respiratory rate of a newborn is often more than 50/minute. Therefore, 60 breaths per minute or more is the cut-off used to identify fast breathing in a young infant. [18]

During the time of counting respiratory rate, chest indrawing was also looked for. Chest indrawing was considered present if the chest wall went in when he/she breathed in. Nasal flaring was considered present if widening of the nostrils occurred when the newborn breathed in. Routine painful invasive procedure like heel prick was avoided during this 3-hour observation period to avoid stress and effect on viral parameters.

Statistical Analysis

Descriptive analysis was used to define the baseline characteristics of the study participants. Repeated Measure ANOVA was performed using Greenhouse-Geisser Statistics to study change in vital parameters over a period in relation to the feeding method. One-way ANOVA was used to compare baseline vital parameter between PMA groups. P values < 0.05 were considered statistically significant. The analysis was performed using STATA.

Results

Table 1: Baseline characteristics

Characteristic	*N*	Mean	SD
Birth weight (grams)	100	1636.60	340
Gestational age (weeks)	100	32.18	2.07
Weight at the time of assessment (grams)	350	1650.02	262
PMA at the time of assessment (weeks)	3850	36.40	1.55

We collected 350 observations from 100 newborns.

Table 2: RR at different time points for all the feeding methods

	RR	Before	After	5 min	10 min	15 min	30 min	1 h	2 h	3 h
	Mean	48.80	49.05	56.94	57.90	54.06	52.40	52.20	51.40	49.30
BF	SD	8.70	8.16	5.15	4.50	5.520	6.34	6.40	8.50	8.84
	P value		0.20	<0.001	<0.001	<0.001	<0.001	0.003	0.240	0.44
	Mean	45.65	46.55	56	55.42	53.17	52.48	49.51	48.40	46.14
SF	SD	9.30	9.45	7.49	6.60	7.95	8.20	8.32	8.99	8.40
	P value		0.12	<0.001	<0.001	<0.001	<0.001	0.003	0.032	0.52
	Mean	55.60	56.40	56.90	57.20	59.31	58.42	58.40	57.23	56.24
GF	SD	9.32	7.40	8.30	7.22	8.28	8.40	8.10	7.63	7.91
	P value		0.80	0.95	0.420	0.181	0.431	0.120	0.640	0.90
	Mean	54.33	56.34	56.90	56.10	55.45	55.10	55.70	55.19	53.27
BS	SD	9.50	6.80	7.13	8.42	6.84	6.74	7.23	7.33	6.94
	P value		0.002	<0.001	<0.001	0.140	0.060	0.012	0.024	0.540
	Mean	45.55	46.32	55.65	54.76	53.82	53	50.90	49.01	47.23
BG	SD	5.70	7.30	4.80	6.24	6.74	6.56	7.32	6.92	5.720
	P value		0.80	<0.001	<0.001	<0.001	<0.001	<0.001	0.035	0.820
	Mean	48.32	52.38	57.33	55.40	53.10	52.80	52.20	50.24	48.24
SG	SD	12.10	12.60	11.40	13.47	21.49	10.95	12.29	12.65	10.036
	P value		<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.023
	Mean	49.52	55.25	60.50	60	58.42	55.77	55.27	53.33	52
BSG	SD	7.54	9.26	5.56	5.06	5.73	5.79	6.43	6.08	6.43
	P value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.030

There was rise in RR at 5 min in the majority of groups except the GF group. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except the SG and BSG groups.

Table 3: PR at different time points for all the feeding methods

	PR	Before	After	5 min	10 min	15 min	30 min	1 hr	2 hr	3 hr
	Mean	144.90	143	153.45	149.31	145.15	143.27	141.49	138.20	143.37
BF	SD	12.60	9.30	16	14.56	13.66	13.54	13.29	12.40	12.44
	P value		0.014	0.090	0.620	0.710	0.088	0.004	0.001	0.008
	Mean	144.30	142.95	153.69	149.92	147.66	145.36	144.44	143.90	143.70
SF	SD	10.32	12.08	11.07	11.39	10.64	11.43	11.19	12.4	12.70
	P value		0.180	<0.001	<0.001	<0.001	0.016	0.32	0.510	0.316
	Mean	154.33	154.51	153.48	155	153.83	152.82	154.57	151.69	155.08
GF	SD	13.40	13.20	13.13	14.70	15.65	15.80	13.52	13.87	11.5
	P value		0.9	0.620	0.700	0.830	0.200	0.280	0.060	0.829
	Mean	151.92	150.48	152.69	148.75	148.89	147.19	148.20	148.67	146.87
BS	SD	15.10	16.34	16.30	14.35	14.66	15.45	13.56	13.07	12.10
	P value		0.640	0.645	0.440	0.512	0.006	0.055	0.150	0.030
	Mean	145.70	143.40	158	155.58	153.38	152.19	147.32	147.19	146.44
BG	SD	15.75	15.20	12.18	11.60	12.48	12.50	11.09	12.38	14.36
	*P*value		0.210	<0.001	<0.001	<0.001	0.008	0.410	0.464	0.160
	Mean	146.8	146.85	154.14	152.54	151.88	148.25	145.97	144.74	148.34
SG	SD	13	14.05	9.81	9.95	11.77	11.88	8.32	10.12	12.2
	P value		0.525	0.002	0.004	0.025	0.155	0.899	0.267	0.752
	Mean	150.97	153.77	158.77	158.19	155.38	153.97	151.72	151.5	152.22
BSG	SD	10.9	12.23	9.91	9.46	8.68	7.77	9.91	9.31	9.4
	P value		0.313	<0.001	<0.001	0.01	0.264	0.907	0.76	0.876

There was rise in PR at 5 min in majority of groups except in the BS and GF groups. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except in the BF and BS groups where it reduced below the baseline.

Table 4: SPO_2 at different time points for all the feeding methods

	SPO2	Before	After	5 min	10 min	15 min	30 min	1 h	2 h	3 h
	Mean	96.47	97.47	96.52	96.42	98.25	98.04	97.62	97.66	97.62
BF	SD	1.48	1.08	3.68	2.41	2.11	1.91	2.37	1.54	1.36
	P value		<0.001	<0.001	0.009	0.206	0.616	0.084	0.584	0.307
	Mean	98.50	98.60	96.56	96.40	97.10	97.56	97.57	97.73	97.45
SF	SD	1.06	1.01	2.66	2.05	1.93	1.9	1.98	1.30	1.33
	P value		0.357	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.001
	Mean	98.43	97	97.64	97.66	97.54	97.30	97.8	97.40	97.84
GF	SD	2.13	1.96	1.97	2.11	2.38	2.22	1.94	2.5	1.93
	P value		0.53	0.438	0.401	0.707	0.946	0.223	0.708	0.1
	Mean	98.88	98.3	98.18	98.15	98.37	98.64	98.83	98.01	98.26
BS	SD	1.99	2.18	2.29	2.3	2.4	2.55	2.33	1.84	1.63
	P value		0.093	0.043	0.136	0.245	0.485	1	0.274	0.062
	Mean	98.16	98.30	95.20	97.30	97.74	97.84	98.20	98.13	98.22
BG	SD	1.42	0.838	3.02	1.87	1.85	1.85	1.29	1.41	1.2
	*P*value		0.129	<0.001	0.03	0.629	0.542	0.926	0.724	0.455
	Mean	97.77	98.02	97.37	97.57	97.51	97.57	97.46	97.54	97.8
SG	SD	1.73	1.67	2.36	2.23	2.02	1.85	2	1.65	1.65
	P value		0.373	0.009	0.011	0.516	0.56	0.4	0.521	0.922
	Mean	97.30	96.40	95.78	96.50	96.44	96.97	97.40	97.56	97.20
BSG	SD	1.42	1.81	2.30	2.23	1.80	1.69	1.50	1.62	1.21
	P value		0.170	0.004	0.120	0.055	0.405	0.450	0.455	0.910

We noticed the trend towards nonsignificant rise in SPO2 immediately after feed in the SF, BG, and SG groups while in the GF, BS, and BSG groups there was nonsignificant reduction. There was a sharp reduction at 5 min in the majority of the groups except GF. Mean SPO2 reached towards baseline at 3 hours after feed in the majority of the groups except the SF group where it was below baseline. In the BF group, the mean SPO2 increased significantly immediately after feed. No significant change in RR, PR, or SPO2 was observed in the GF group.

Discussion

Breast feeding of infants has significantly different physiologic effects on their cardiopulmonary activity than does bottle feeding. Preterm infants who are breast-fed have fewer episodes of oxygen desaturation (<90%) during feeding than do those who are bottle fed. [3,19] Preterm infants are also better able to coordinate sucking and respiration during breast feeding than during bottle feeding. [5,6] Despite the reported physiologic benefits of breast feeding over bottle feeding in preterm infants, few studies have evaluated the cardiopulmonary effects of breast feeding in full-term neonates and older infants. Reports have varied. Similar to preterm infants, full-term neonates appear to have fewer episodes of oxygen desaturation with breast feeding than with bottle feeding. [20-22] Hammerman and Kaplan21 however, reported that both breast and bottle feeding were associated with significant post feeding declines in oxygen saturation (SpO2).

There was rise in RR at 5 min in the majority of groups except the GF group. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except the SG and BSG groups. There was rise in PR at 5 min in majority of groups except in the BS and GF groups. After 5 min, it reduced gradually towards baseline at 3 hours after feed in the majority of the groups except in the BF and BS groups where it reduced below the baseline. In a study from a tertiary care hospital, Niaz et al. monitored 60 healthy term newborns for HR and SPO2 before, during, and after breastfeeding. SPO2 was lower during breastfeeding than after feeding, and HR was higher during breastfeeding than before feeding. Both were comparable between before and after breastfeeding. [23] In contrast to observations made by the above study, we observed significant rise in SPO2 and drop in PR immediately after feed as compared to before feed in preterm newborns. Thus, PR and SPO2 changed differently in term and preterm neonates. These changes may be because of differences in physical efforts of sucking, maturity of nervous system, cardiovascular system, and lungs between term and preterm newborns. [24] Suiter et al. assessed association between breastfeeding with SPO2 and HR in 22 term newborns at 1 week and 2 months of age. They monitored at every 30 seconds for 5 minutes before oral feeding, during the first 10 minutes of feeding, and the first 10 minutes immediately after feeding. Overall mean SPO2 level was significantly high in 2-month-old infants than 1-week-old infants. SPO2 did not change before, during, and after feeding. The HR increased significantly during breastfeeding as compared to before and after breastfeeding. [24] In our study, we observed that in the breastfeeding group SPO2 significantly increased immediately after feeding and dropped at 5 and 10 min after breastfeeding as compared to before feeding and PR significantly decreased after feeding as compare to before feeding. These findings also suggest that feeding changes the vital parameters differently in term and preterm newborns.

We noticed the trend towards nonsignificant rise in SPO2 immediately after feed in the SF, BG, and SG groups while in the GF, BS, and BSG groups there was nonsignificant reduction. There was a sharp reduction at 5 min in the majority of

the groups except GF. Mean SPO2 reached towards baseline at 3 hours after feed in the majority of the groups except the SF group where it was below baseline. In the BF group, the mean SPO2 increased significantly immediately after feed. Marinelli et al. enrolled 56 late preterm infants in a prospective, randomized crossover study and compared HR, RR, and SPO2 before and during the feeding using 30ml medicine cup and bottle feeding. Significant changes occurred in all these parameters between the two feeding methods. HR and RR increased, and SPO2 decreased during both cup and bottle feedings compared to prefeeding baselines. However, they observed more desaturation below 90% and higher heart rates in bottle feeding group at the time of feeding as compared to no changes during cup feeding. Respiratory rate changes were comparable between the groups. [25]

The current study compared the vital parameters over a period of 3 hours in relation to different feeding methods. The findings of this study should be considered a pilot study and replicated at different sites for generalization. The findings may have implications in deciding the time of monitoring vital parameters in the preterm newborns. Further studies of comparing variations in vital parameters before feed and at different times after feeds should be done to identify the best time of routine monitoring which has fewer variations in vital parameters.

Conclusion

Vital parameters changed periodically at different time points in different feeding methods except gavage feeding. Mean RR and SPO2 varied significantly at different PMA. Chest indrawing and nasal flaring did not occur after feeds in any group. A further prospective study is needed to strengthen the evidence of effect of feeding methods on vital parameters. Local reference charts should be created for vital parameters based on PMA for routine monitoring in preterm newborns.

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