Improving bottle feeding in preterm infants: Investigating the elevated side-lying position

Limited research is available on the optimal feeding position for bottle fed premature infants. A pilot study is described which tests a method for comparing the efficiency of different positions. The commonly used semi-upright position and the elevated side-lying (ESL) position are compared in a small number of infants. Greater physiological stability (measured by heart rate and oxygen saturation) was seen during the mid points of feeds in the ESL position. The results suggest that a larger study is justified.

Liz Clark
MSc, BSc, Clinical Lead in Acute Paediatric Speech and Language Therapy, Barts and the London NHS Trust, liz.clark@bartsandthelondon.nhs.uk

Gillian Kennedy
MSc, BSc, Lead Speech and Language Therapy Clinician for neonates and paediatrics, UCLH NHS Trust

Tim Pring
PhD, BSc, BSocSc, Director of Research, Department of Language and Communication Science, City University

Michael Hird
MBBS, BSc, DCH, MRCPI, FRCPCH, Consultant Neonatal Paediatrician, Royal London Hospital, Barts and the London NHS Trust

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Key points

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1. Semi upright and elevated side-lying (ESL) bottle feeding positions were compared in six preterm infants between 35-38 weeks' gestational age.
2. A trend towards greater physiological stability in the ESL position was found during the middle part of feeds.
3. The results indicate that a larger study is needed to confirm the advantage for ESL feeding.

Improvements in neonatal care and ventilatory support have enhanced the survival rate of low birthweight preterm infants[1]. The care of these infants presents a number of difficulties, however. Prominent among these are early feeding problems. Typically these arise at the transition from non-oral nasogastric feeding to oral feeding. Feeding requires the co-ordination of sucking, swallowing and breathing[2]. Premature infants have had little opportunity to develop these skills and present with disorganised feeding patterns when oral feeding commences[3].

These problems suggest that further research is needed on the optimal methods of feeding preterm infants during the transition to oral feeding. The World Health Organisation/UNICEF Baby Friendly Initiative, launched in 1991, highlights the importance of breastfeeding for all infants. Breastfeeding is the preferred feeding method for preterm infants but may not always be possible.

This study addresses bottle feeding in infants for whom exclusive breastfeeding is not realistic. Different techniques such as breast, cup and bottle feeding have been compared in the past[4] but little is known about the influence of feeding position on feeding ability in bottle fed preterm infants. The 'elevated side-lying' (ESL) method of bottle feeding (similar to a breastfeeding position) is increasingly being used in neonatal units as it is perceived to be therapeutic. The second author developed its use clinically; however, there is no published research on its efficacy as a feeding technique. The primary purpose of this paper is to test and describe a methodology for researching this area. Preliminary data on six infants is presented.

Successful early bottle feeding may be measured in a number of ways. Short and long term measures of its success may be used. Short term success may be evaluated by monitoring individual feeds whereas longer term outcomes such as time to discharge from hospital and appropriate growth can only be assessed by observing outcomes in infants fed in a consistent manner over a period of time. The latter approach would require random assignment of infants to different feeding techniques and would use a between subject design. Although these long term measures are attractive they are rarely dependent on oral feeding success alone and the design might require large numbers of participants to detect differences in feeding techniques.

In this paper an alternative approach that examines the efficiency of individual feeds is explored. Here a within subject design may be used thus controlling for subject variables. Preterm infants were studied during the transition from nasogastric tube feeding to oral bottle feeding. Measures of physiological stability were taken during bottle feeds in two positions, the traditionally used semi-upright position and the ESL position. The assumption was that an infant who is physiologically stable will feed more successfully and a stable system will aid the transition to full oral feeds. The measures of physiological stability used were oxygen saturation and variation in heart rate.

Study

Pulse oximetry is routinely used to measure stability in paediatric populations, particularly within neonatology[5-10]. The pulse oximeter used in this study had a high specification, was not susceptible to a movement artefact and was capable of near continuous sampling of oxygen saturation and heart rate. Recording of the two measures was taken prior to and throughout a feed. Data was extracted from this record for the two-minute period prior to the feed to obtain baseline measures and for two further three-minute periods at the beginning and in the middle of the feed. The baseline provides measures on the infant prior to feeding. It was expected that these measures would deteriorate in the first 3 minutes of the feed regardless of feeding position as the infant adjusted to the physiological demands of feeding, whereas greater stability in the middle period was anticipated. The hypothesis was that, as infants fed in the semi-upright position have less physical support than in the ESL position, they may find feeding increasingly challenging and exhausting and hence the physiological measures would favour the ESL feeds in the middle 3 minutes. Since data from three pairs of feeds on each infant were collected, the design also permitted investigation of whether stability improved over time as the infant became accustomed to bottle feeding and whether such progress was also related to feeding position.

Each feed was video recorded. This was done for two reasons. It was needed to monitor the feed when obtaining the physiological measures. It was also intended to use the videos for a qualitative analysis of feeding practice. Clinical experience suggests that feeder technique varies considerably in both nursing staff and parents. Consequently, additional factors may influence feeding success. These include the feeders' responsiveness to the infant's behavioural and physiological cues. The recordings provide information regarding feeder techniques and infant behavioural responses. Observation of these factors allow them to be related to the measures of physiological stability[10-11] and permit identification of practices that facilitate or interrupt the infants' feeding pattern. Data obtained in this way is not reported in this paper.

Study design

Each infant was fed in both semi-upright and ESL positions. Pairs of feeds, one in each position, were recorded every 3-5 days during the transition to oral feeding (approximately 1-3 weeks). Data on three pairs of feeds were obtained for each infant. The order of the position of feeding was alternated within infants and counterbalanced across infants.

Participants

Six in-patient premature infants on the neonatal unit at the Royal London Hospital were recruited. Parents of eligible infants were asked to give consent adhering to research governance and ethical procedures. Parents also gave consent for the video recording of their children during feeding. Ethical approval for this research was given by East London and the City Research Ethics Committee.

Infants were included if they were born at less than or at 29 weeks' gestational age. At the time of the study they were between 35-38 weeks' gestational age and in transition from non-oral nasogastric feeding to bottle feeding. Infants were excluded if they were being breastfed or if they had significant gastro-enterological sequalae that required a non-standard approach to enteral feeds and/or major congenital malformations likely to affect feeding behaviour. Details of the six infants who participated are given in **TABLE 1**.

- Masimo Radical Oximeter
- Internal hard wired mains distribution block with neon power indicator
- CIU-2 unit (analogue input for saturation and pulse with audio amplifier for sounds signals)
- Laptop computer running Windows with floppy disc and r/w CD
- Winvisi windows software for laptop recording, storage and analysis of saturation and pulse rate
- VHS (12 hour capability) VCR
- 5.6" LCD monitor
- Genlock for overlaying computer signal on video signal
- 240v, 1/3" colour CCD video camera with high sensitivity in low light (0.15lux) with manually adjustable zoom lens
- Very high gain microphone 56dB with 2 mo. battery
- Tripod for camera and microphone mount
- Cables for interconnection of above
- Transportable enclosure case for equipment storage and transportability between rooms and infants

FIGURE 1 Complete system used to monitor an infant's physiological variables during a feed session.

Materials

Portable physiological monitoring and recording equipment was used to capture the infant's physiological stability. The equipment was commissioned for the research and was based upon a well-established technique originally used for paediatric sleep studies[7].

The equipment (**FIGURE 1**) integrates

	Baby 1	Baby 2	Baby 3	Baby 4	Baby 5	Baby 6
Birthweight	630g	1230g	960g	980g	1218g	1318g
Gender	F	M	M	M	M	M
Gestational age at birth	25+1	28+1	28	28	29	29
Gestational age at start of oral feeding	38	35	36	36	35	35
Respiratory involvement on entry to study	Oxygen via nasal cannula	In air	In air	In air	In air	In air
Neurological background	None	Consanguineous parents	None	Bilateral cystic PVL	None	Severe bilateral PVL
Gastric medical history on entry to study	No medication	No medication	No medication	No medication	No medication	No medication

TABLE 1 Details of participants. PVL = periventricular leukomalacia

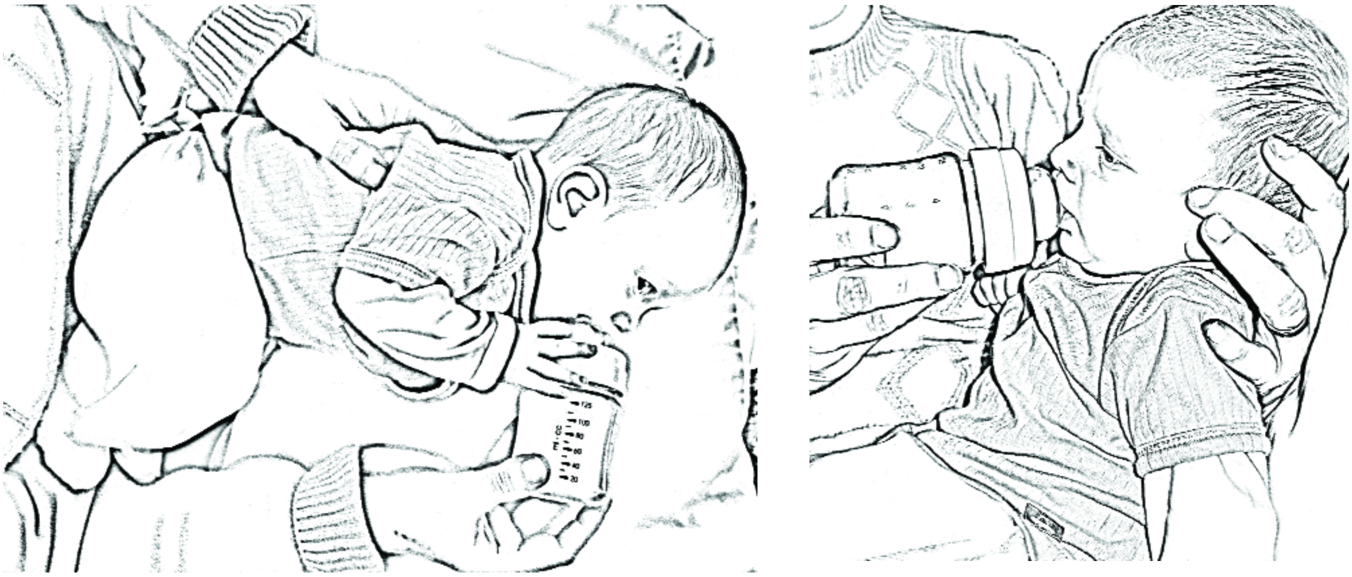

FIGURE 2 Comparison of the bottle feeding positions used, showing a healthy full-term baby.

pulse oximetry with video recording. The pulse oximetry trace and time during the feed is superimposed over the video image and simultaneously recorded onto VHS video tape, allowing later analysis of the readings relating them directly to on-line feeding behaviour. Analysis of the pulse oximetry measures was then conducted through the Winvisi software programme (Stowood Scientific Intruments Visi-Lab Sleep System) for Windows.

Procedure

A corner of the baby unit was identified as the recording centre. A portable trolley and protected case housed the videorecorder, pulse oximeter and the lap top. A camera was then placed on a tripod and a microphone placed near the nurse and infant. The camera selected was specifically designed for low lighting conditions. Both camera and microphone were connected to the portable monitoring system.

The camera was sited so that it focused on the infant's face and torso, taking a side-on/lateral view to capture when the teat was in the infant's mouth and when it was removed. The feed session was then filmed and recorded (including pre-feeding baseline measures).

Physiological stability was recorded for the duration of the feed, which varied considerably from infant to infant and feed to feed. The lead investigator was present for each feed to trouble-shoot and to minimise disruption to nursing staff. However, the investigator did not enter into or comment upon the feeds.

The videos of each feed were watched and times noted when the teat was inserted or removed from the infant's mouth so that data was only collected for periods when the infant was attempting to feed. The WinVisi programme allowed data markers to be entered on the recording to separate this data from the total data. The mid-point of each feed was calculated by removing any time periods of non-feeding from the feed time, summing actual feeding time and then taking the mid-point.

Baseline physiological stability measures were recorded before feeding for 2 minutes. At this time the infant was positioned on the feeder's lap and was non-nutritively sucking on a pacifier. This minimised disruption between baseline collection and the start of feeding and optimised baseline stability.

The two feeding positions are illustrated in **FIGURE 2**. In the ESL position, the feeder should be seated comfortably creating a lap, with the knees higher than the base of the lap (hence providing the elevation). A pillow can be used for extra support if desired. The infant is placed in a side-lying position on the feeder's lap, with head at the top of the lap and bottom against the feeder's stomach. The infant's neck and spine should be in a natural straight alignment and hips should be flexed at 90 degrees, allowing the legs to curve around the feeder's stomach. The infant should be supported by the lap or a pillow on the lap rather than being held by the feeder. The bottle is introduced into the infant's mouth ensuring the bulb of the teat is always filled to prevent inadvertent intake of air during feeding.

In the semi-upright position (traditionally used on neonatal units) the infant sits in a reclining position on the feeder's lap. The feeder supports the infant's head, neck and spine with one hand while handling the bottle with the other. The infant's arms are typically flexed at the beginning of the feed but lose tone and fall to the side as the physiological demands of feeding increase.

Analysis

The primary purpose of this study was to assess whether the methodology outlined above is a practical method of researching feeding efficacy. The data obtained are necessarily preliminary due to the small number of infants tested. Nevertheless they can test whether the methodology is sensitive enough to detect differences between feeds and give an indication of whether a larger study is appropriate. The dependent variables in the analysis were the mean oxygen saturation and the standard deviation of heart rate in the feeding infant. Data on these were collected before each feed and for the first 3 minutes at the beginning and for the 3 minutes at mid-point of each feed. Each child had data from 3 pairs of feeds (one ESL and one semi-upright feed in a 24 hour period) during their transition to bottle feeding. Each variable was analysed with a 3 factor within subjects analysis of variance in which position (semi-upright/ESL), time during feed (before/beginning/middle) and order of feed (first/second/third pair of feeds) were variables.

Results

The analysis of oxygen saturation showed a main effect of the time at which the data was collected ($F(2, 10) = 16.59$, $p < 0.001$). As **TABLE 2** shows this reflects lower oxygen saturation during all feeds compared with the baseline measures. There was also a significant interaction between time and feeding position ($F(2, 10) = 11.42$, $p < 0.01$). In the first 3 minutes oxygen saturation deceased in both positions; however, it moved in opposite directions during the middle three minutes, increasing again in the ESL position while declining further in the semi-upright position. No other main or interaction effects were significant.

A similar analysis was conducted on the variation in heart rate. No significant effects were found in this analysis. **TABLE 3** shows that the variation in heart rate increased during the first 3 minutes of feeds then returned to near baseline level in the middle 3 minutes. It also shows that this trend towards baseline levels was more marked with the ESL feeds.

Discussion

Early difficulty with feeding can place a preterm infant at risk in the short term (through reduced oxygen saturation, bradycardic episodes and risks of aspiration) and impact on feeding abilities in the future[12,13]. Early supportive feeding strategies may allow preterm infants to conserve energy, and develop efficient feeding techniques. In the longer term, this may have a beneficial effect on neuro-developmental outcome[10-11] and long term negative associations with feeding can be avoided[5-6].

Given these benefits it is surprising that little research has occurred on the early feeding of preterm infants. These infants frequently require bottle feeding which can be a challenging and stressful experience. An increasing number of practitioners feel that they benefit from feeding in an ESL position but there is no experimental evidence for this. The present paper is primarily concerned with developing a methodology for such research and with pilot testing equipment to record physiological measures during feeding. Pilot data on six children has been presented to illustrate that the methodology can successfully address the research issue.

Clearly a much larger study is needed to produce robust evidence that the ESL feeding position is beneficial. Nevertheless, the results for the six infants are of interest. In the first three minutes of feeds there is a decline in oxygen saturation and an increase in the variability of heart rate in both feeding positions. By the midpoint of the feed, this situation has changed. Oxygen saturation increases and heart rate variation declines in the ESL position as predicted. For the oxygen saturation, the interaction of feeding position by time in feed is statistically significant. These results indicate that the methodology employed can detect changes in physiological stability that are consistent with expectations. For both measures trends in the data suggest that the ESL position is beneficial. These results, although preliminary, are encouraging and suggest that a larger study may obtain significant results. That oxygen saturation shows a significant effect is surprising given the small number of infants tested and may indicate that it is the more sensitive measure.

During the study, variability between feeders in their implementation of both the semi-upright and ESL position was observed. No attempt was made to regularise their interpretation of the feeding positions. In favour of such an approach is that such variability is likely to exist among potential feeders of preterm infants and that research should aim to demonstrate the superiority of the ESL position as used in clinical practice. An alternative approach might be to demonstrate the feeding positions to participants in future research so that a more consistent approach is used. This might reduce random variation in the data and make a significant outcome more likely.

A larger study using the methodology above is planned. In the first instance, this will seek a more conclusive demonstration that the ESL position is associated with more efficient feeding. As mentioned above, this study will also collect qualitative information on the interaction

	Semi-upright			ESL		
	Baseline	First 3 mins	Mid 3 mins	Baseline	First 3 mins	Mid 3 mins
Infant 1	99.15	98.53	96.12	99.66	97.22	98.87
Infant 2	99.66	96.58	94.74	98.13	94.82	95.24
Infant 3	98.91	96.31	91.17	98.75	93.70	94.48
Infant 4	99.72	94.66	92.84	97.36	91.97	94.32
Infant 5	94.89	91.23	86.47	89.09	86.46	88.42
Infant 6	97.35	86.39	85.53	95.63	87.67	92.67
MEAN	98.28	93.95	91.14	96.44	91.97	94.01
SD	1.83	4.42	4.99	3.84	4.14	3.37

TABLE 2 Oxygen saturation for feeding position and time during feed. Data represents means for the three feeds for each child in each position and at each time during the feed.

	Semi-upright			ESL		
	Baseline	First 3 mins	Mid 3 mins	Baseline	First 3 mins	Mid 3 mins
Infant 1	4.08	2.83	6.52	5.47	4.62	8.44
Infant 2	7.36	9.20	7.11	9.34	7.36	4.08
Infant 3	4.22	11.24	14.65	14.65	13.81	7.39
Infant 4	8.29	9.31	9.59	7.19	12.10	6.46
Infant 5	3.77	10.94	8.32	4.17	13.51	11.72
Infant 6	10.52	15.51	10.80	15.00	17.26	8.65
MEAN	6.38	9.84	9.50	9.30	11.38	7.79
SD	2.74	4.12	3.49	4.61	4.60	2.78

TABLE 3 Heart rate variation for feeding position and time during feed. Data represents means for the three feeds for each child in each position and at each time during the feed.

between feeders and infants during feeding with a view to improving practice in the feeding of preterm infants. If the ESL position is shown to be more efficient, subsequent research will need to examine the longer term benefits to infants who are consistently fed in this way.

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