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Cardiorespiratory and Transcutaneous Oxygen Monitoring of High-Risk Preterms Receiving Systematic Stroking

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Abstract: This paper reports on a study which examined the immediate physiological effects of systematic stroking on a sample of high-risk ventilated preterms. The aim was to determine whether physiological changes, positive or negative were induced by systematic stroking of these at-risk infants. Heart rate, respiration rate and $TcPO_2$ (transcutaneous arterial oxygen tension) were collected simultaneously before, during and after the systematic stroking intervention using computerised data recordings. The results found suggested that the stroking intervention appears to have had no harmful effects as reflected in the absence of a significant heart rate increase or a $TcPO_2$ drop, patterns which would have been indicative of infant distress, and thus safe to be applied to a sample with the same characteristics as the one recruited for this study.

Resumo: *Monitorização cardiorespiratória e do oxigenio transcutâneo de pretermos de alto risco recebendo toque (stroking) sistemático.* Este artigo relata um estudo examinando os efeitos fisiológicos imediatos do toque (stroking) sistemático em pretermos de alto risco recebendo oxigenio artificialmente. O objetivo foi determinar se as mudanças fisiológicas, positivas ou negativas, foram provocadas pelo toque aplicado nesses bebês de alto risco. Frequências cardíaca e respiratória e tensão transcutânea do oxigênio ($TcPO_2$) arterial foram registrados no computador, antes, durante e depois do toque sistemático (stroking) ou intervenção. Os resultados mostraram uma ausência de aumento significativo da frequência cardíaca e de uma queda significativa no oxigênio, simultâneamente; isto sugere que o estresse dos bebês não aumentou e portanto a intervenção pode ser considerada benéfica para ser usada com bebês com as características apresentadas neste estudo.

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Introduction

Over recent years, significant developments in obstetrics and neonatal care have contributed to the birth and survival of babies born as young as 23 weeks ges-

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tation and greater than 500 grams in birthweight. These enhanced survival rates now mean that more premature newborns are being cared for who require longer hospitalization and more resources than ever before (Wolke 1991). It is these younger preterms in particular who tend to have the greatest number of medical problems early on and display a greater incidence of developmental delay and significantly more problems later on in childhood (Creasey, Jarvis, Myers, Markowitz and Kerkering 1993).

Developmental delay, cerebral palsy, epilepsy and mental retardation are sequelae associated with prematurity (Caputo and Mandel 1970; Cohen 1986; Holmes, Reich and Rieff 1988) as are sensory and motor deficits, disturbed parent-infant interaction, poor school performance and delayed language development (Dunn 1986; Greenberg and Crnic 1988; Largo, Graf, Kundu, Hunziker and Molinari 1990). Subtle and specific cognitive and behavioural deficits in attention-span, task-orientation and activity have also been consistently found across the preterm infant population (Field, Dempsey and Shuman 1981; Meisels, Cross and Plunkett 1987; Minde, Goldberg, Perrota, Washington et al. 1989).

In trying to prevent such problems from arising, the care of premature infants while being hospitalised in the special or intensive care baby unit (SCBU/ICU) has become a focus of research interest. Features of such hospitalization include infrequent positive tactile contact and position change and a lack of co-ordinated sensory experiences (Gottfried, Wallace-Lande, Sherman-Brown et al. 1981; Korner 1981).

In response to this, a variety of sensory intervention programmes, particularly tactile, have been developed and carried-out with preterms. These have been found to be particularly effective in enhancing preterm growth and development (Adamson-Macedo and Werner 1994; de Róiste and Bushnell 1993, 1996; Field, Vega-Lahr, Goldstein and Scafidi 1987; Field 1990). Some programmes are seen to work not through arousing the infant but through pacifying him/her and by providing a predictable pattern of stimulation (Mann, Haddow, Stokes et al. 1986) whilst others contend that there is a psycho-immunological (Adamson-Macedo 1991, 1997), metabolic (Scafidi et al. 1986, 1990), endocrine (Acolet, Modi et al. 1993), parent-infant interaction (Watt 1986, 1990) or gastric mediating mechanism involved (de Róiste and Bushnell 1993).

Virtually all such programmes however have worked with healthy preterms and not those who are in greatest need for such intervention, i.e. ventilated and high-risk preterms, whilst they are in the intensive care baby unit. This, in part, being due to the mistaken equation of stroking with general handling and the associated fear that such an intervention, like excess handling, may compromise the health of the high-risk neonate (Long et al. 1980; Speidel 1978).

In addition, such programmes have commonly not taken place in the early postnatal period, i.e. the first 28 days of life, when infant health may be more vulnerable, nor have they examined several physiological measures immediately and simultaneously.

As health prognosis is determined on the basis of physiological indicators, and given that the physiological effects of tactile sensory stimulation with high-risk ventilated preterms are unknown, particularly in the early neonatal period, this study set out to discover simultaneous physiological effects of a form of systematic

stroking, a shortened version of TAC-TIC therapy (Macedo 1984), on a sample of ventilated preterms. A shortened version was used as recommended by the hospital ethics committee.

Method

Design

An interrupted time series design was employed whereby measures of preterm heart rate, respiration rate and $TcPO_2$ (transcutaneous arterial oxygen tension) were collected before, during and after the systematic stroking intervention.

Equipment

All of the infants were attached to the Mary (McIntosh, Ducker and Bass 1989) computer monitors (similar to that used by Gorski et al. 1990) which was used for 24 hour monitoring. The data sampling rate was 1 value per second, averaged over successive 60 second intervals. Heart rate was measured within a range of 0–250 beats per minute, respiration rate within a range of 0–200 breaths per minute and $TcPO_2$ within a range of 0–20 kPA.

Heart and respiration rates were collected by electrode sensors monitoring beats and breaths per minute while $TcPO_2$ was collected by electrode sensors monitoring oxygen diffusion from the arterialized capillary bed through the epidermis to the skin surface. These electrodes were attached to the skin surface by self-adhesive rings thereby minimising pressure against the skin and compression of blood vessels underneath.

Heart rate, respiration rate and $TcPO_2$ levels were printed as ordinates with markers demarcating 'before', 'during' and 'after' tactile intervention phases at 1 minute intervals on the abscissa of a printed output. One of the investigators and an independent examiner interpreted the data 'blindly' so that the reliability of the data could be checked.

Sample

The 13 preterms (9 female, 4 male) in this study were all recruited from the intensive care unit of a major London hospital. All were receiving ventilation and attached to the computer system due to their critical health status.

Table 1. Sample Characteristics

Variables	Mean	S.D.	Min.-Max.	N
Gestation	29.23	4.51	24–36	13
Birthweight kg	1.36	0.66	0.71–2.6	13
Apgar 1 min	5.42	2.64	1–9	12*
Apgar 5 min	8.33	1.87	4–10	12*
Maternal age	25.23	6.98	17–42	13

* missing data for 1 infant due to a lack of recording of Apgar scores

Eleven infants had jaundice, 8 had respiratory distress syndrome, 4 had patent duct arteriosus, 3 had necrotizing enterocolitis, 2 had hypotension, 2 hypoglycaemia, 1 had sepsis and 1 had rhesus disease. Missing values arose for some of the sample due to the relevant measure not being selected by the hospital unit for recording during that particular occasion.

Sensory Stimulation

A modified, 3–4 minutes (as compared to 20 minute) version of TAC-TIC therapy, which consists of systematic, sequenced stroking all over the preterm's body was used encompassing only those strokes that did not require the infant to be moved from his/her position. TAC-TIC therapy is currently in use in Britain, Brazil and Chile and it revolves around the principles of G.R.E.C., Gentleness, Rhythm (of stroking movements), Equilibrium (balance between alerting and soothing movements) and Continuity of stroking (Adamson-Macedo and Alves-Attree 1994). The stroking is initiated on the crown of the baby's head and continues in a cephalocaudal direction with stroking of the baby's temples, face, nape of the neck, chest/stomach, arms and hands, legs and feet and finally the baby's back with a repetition of the arm and leg movements.

All of the sample received a daily version of TAC-TIC therapy, referred to as the stroking intervention in this paper, from the day on which medical permission was given with informed parental consent. The onset was when each infant averaged 3 days of age (mean = 3; S.D.= 1.6; Min.= 2; Max.= 8) up until the day on which the infant was detached from computerised monitoring. The mean number of recordings were 9 per infant (min. = 5, max. = 14).

The stroking intervention was administered by the investigators who had received a training in this programme. The investigator hands and arms were always scrubbed, warmed and disinfected immediately before and after carrying-out the procedure.

Procedure

Four minutes before the stroking intervention was administered, the investigator coded in the '*before phase*' into the computer, which was immediately logged onto the physiological recordings. Immediately prior to beginning the stroking intervention, the investigator coded in the '*during phase*' and immediately after the stroking intervention was completed the investigator coded in the '*after phase*'. After another four minutes had passed 'end' was coded in which demarcated the after phase of the physiological recordings.

Data Analysis

Using SPSS, the physiological recordings were compared between the before, during and after the stroking intervention phases using 1-tailed analyses.

Results

Heart Rate

T-tests revealed a significant drop in heart rate from the 'during to after' stroking intervention phases ($t = 1.86$, $df = 12$, $p \leq 0.04$) but no significant changes arose from the 'before to during' ($t = 0.7$, $df = 12$, $p \leq 0.24$) or over the sessions as a whole from the 'before to after' phases ($t = 0.64$, $df = 12$, $p \leq 0.26$) where it can be seen to return to the baseline level.

Respiration Rate

While respiration rate was found to increase significantly from the 'during to after' phases ($t = 2.31$, $df = 10$, $p < 0.02$), no significant differences were found across the 'before to during' ($t = 0.46$, $df = 10$, $p \leq 0.32$) and the 'before to after' phases ($t = 1.67$, $df = 10$, $p \leq 0.06$).

$TcPO_2$

No significant changes were found in this measure from the 'before to during' ($t = 0.67$, $df = 10$, $p \leq 0.26$), 'during to after' ($t = 1.24$, $df = 10$, $p \leq 0.12$) or 'before to after' phases ($t = 0.73$, $df = 10$, $p \leq 0.12$).

Table 2. Physiological Data

Phases	Heart rate			Respiration rate			$TcPO_2$		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Before	13	160.5	13.44	11	57.31	7.46	11	9.09	2.33
During	13	161.0	14.50	11	57.66	7.31	11	9.02	2.15
After	13	160.1	13.76	11	59.02	8.10	11	9.26	2.37

Inter-Rater Reliability

Inter-rater Cronbach alpha reliabilities from a sample of 3 sets of raw data printout recordings from 9 infants and 1 set from the remaining infants were found to be greater than 0.90 indicating a significant reliability between the two scorers.

Discussion

Overall, the major conclusion from this study is that the stroking intervention appears to have had no harmful effects upon high-risk ventilated preterms, at least in the measures monitored, as reflected by the absence of a significant heart rate increase or a $TcPO_2$ drop during the stroking, patterns which would have been indicative of infant distress (Gandy and Roberton 1987). The post-stroking intervention respiration rate rise suggest distress however as it was accompanied by a significant drop in heart rate (which is indicative of an absence of distress or positive relaxation) no clear conclusion can be drawn. This somewhat paradoxical

combination of a heart rate drop combined with a rise in respiration rate is understandable given the extreme immaturity, disorganization and lack of physiological regulation displayed by high-risk preterms (Hutchinson 1975).

Future research is warranted to explicitly support the deployment of sensory stimulation programmes, such as TAC-TIC therapy with high-risk preterms in the NICU. Alternative physiological measures such as temperature, blood pressure and gastric activity, all of which are examined by medical staff in the determination of infant prognoses, should also be employed in such research to establish an overall picture of the physiological effects of tactile sensory intervention programmes.

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