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Handling during neonatal intensive care

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SUMMARY The handling received by very low birthweight newborns undergoing intensive care in the first few days of life and the effects of this were studied. Infants were handled an average of 4·3 hours (18%) of the total 24 hour observation time and received a mean 234 handling procedures. Parental handling contributed 35% of the total time but was usually benign except in that it could interfere with the infant's rest. Many procedures were associated with undesirable consequences. Endotracheal suctioning was invariably associated with hypoxaemia and was often carried out more frequently, or took longer, than was optimal. Transcutaneous oxygen monitoring, although considered routine for all intensive care infants, was only carried out for 50% of the observation time and often did not accompany periods of likely intensive handling. Increasing technology in neonatal intensive care often results in increased handling of sick infants. Each new innovation, as well as routine procedures, should be viewed in the light of the continuum of neonatal intensive care events, and handling kept to a minimum.

A basic principle of neonatal intensive care is that the sick infant should be handled as little as possible since he is likely to become hypoxaemic and his condition deteriorate with even minimal handling.[1] The development of continuous transcutaneous or arterial oxygen tension monitoring has lent weight to this maxim. A fall in oxygen tension can occur with even minor handling and may be prolonged;[2–5] it may result from procedures specifically designed to improve the infant's oxygenation such as tracheal suctioning[6] and may follow such indirect stimuli as loud noise in the nursery.

The modern neonatal intensive care unit employs an increasing amount of applied technology, most of which is designed to keep the infant's condition optimal and stable with minimal disturbance. Recent studies have suggested that these developments have resulted in improvements in the outcome for very low birthweight infants.[8–10] With increasing technology, however, the number of procedures which have to be carried out regularly but which intrude upon the neonate has also increased. The question now arises whether neonatal intensive care has become too intrusive and too invasive, so that the values of gentle handling and rest have been forgotten.[11]

Few studies have been carried out in this area of iatrogenic hazard and these have generally looked at the effects on the infant of individual events, particularly in terms of oxygenation. The present study was designed to look at the continuum of events which impinge upon the very low birthweight infant undergoing intensive care in the first few days of life, when the infant is most susceptible to hypoxaemia. By recording how much handling a sick preterm infant receives and the effects of this, our aim was to provide information which will aid in a review of our present standard care procedures.

Methods

Christchurch Women's Hospital delivers some 2600 babies annually. While most admissions to the neonatal intensive care unit at the hospital are inborn, the unit provides a regional service for an area with approximately 5800 deliveries, and also receives infant transfers from outside this area. Assisted ventilation of infants has been routine since 1979.

Infants admitted to the neonatal intensive care unit who required assisted ventilation were studied during the first four days of life. Successive infants admitted between December 1983 and February 1984 were studied except that only one infant was studied at any one time. When possible infants studied were of very low birthweight. Informed parental consent was obtained in all cases, permitting observation of the infant. Routine neonatal intensive care was carried out according to the standard practice of the unit. All infants were

nursed in incubators: radiant warmers are not currently in use in our unit.

The infants were observed by one of us (DM) who documented procedures and, where possible, their effects. The nursing staff were not made aware of the true nature of the study but were told that we were observing sleep patterns and conscious levels in very low birthweight infants undergoing standard neonatal intensive care.

Handling procedures were divided into four categories:

(1) Monitoring: placement, adjustment, or removal of continuous monitoring devices, for example transcutaneous oxygen probe.
(2) Investigational or therapeutic: for example umbilical artery catheter placement, chest radiograph, endotracheal tube suction, intramuscular injection.
(3) Nursing: for example alteration of infant's position, nappy change, eye care.
(4) Parental: touching.

In addition to handling, the following were recorded during the observation periods:

(a) Duration of procedures from start to finish of handling.
(b) Transcutaneous oxygen (TCM 2, Radiometer, Copenhagen) at one minute intervals or via continuous printout (TCM 200, Radiometer, Copenhagen) when available.
(c) Heart rate at one minute intervals (Hewlett-Packard Neonatal Monitor, Waltham, USA).
(d) Any apnoeic episodes, their duration and how resolved: (for example spontaneous or ambu bagging).
(e) Continuing procedures: (for example phototherapy, nasal continuous positive airways pressure).
(f) The number of other infants under the nurse's care.

The observation periods were: (a) 0730–0930 hours; (b) 1000–1200 hours; and (c) 1300–1500 hours, for a total of 24 hours within the first four days of life. These periods correspond approximately to: (a) assessment of the infant during the day's 'business round'; (b) action necessary as a result of the morning's assessment; and (c) 'unscheduled time'.

Several parameters were used to determine the effects of handling on the infant in respect of so called 'undesirable incidents'. These were: (a) hypoxaemia: the number and duration of incidents where the transcutaneous oxygen tension was less than 5·2 kPa (40 mm Hg); (b) hyperoxaemia: the number and duration of incidents where the transcutaneous oxygen tension was more than 13·0 kPa (100 mm Hg); (c) the number of times the transcutaneous oxygen tension fell 2·6 kPa (20 mm Hg) or more within one minute; (d) bradycardic episodes: the number and duration of incidents where the heart rate was less than 100 beats per minute; and (e) apnoeic episodes: the number and duration of incidents where there was no breathing for 20 seconds or more.

Results

Five infants ranging in weight from 750 to 1870 g and in gestational age from 27 to 35 weeks, were studied. Details of each infant and their clinical course are given in Table 1.

Table 1 *Details of infants studied and clinical course*

Infant	*Sex*	*Birthweight (g)*	*Gestational age (weeks)*	*Diagnosis*	*Oxygen therapy (days) Total (IPPV/IMV)*	*Outcome*	*Comments*
1	M	1080	27	Severe RDS; PDA; BPD	50 (45)	Discharged well day 81	1st twin; spontaneous labour; caesarean section
2	M	1240	31	Apnoea of prematurity; CPIP	27 (1)	Discharged well day 45	Prolonged ruptured membranes; spontaneous vaginal delivery
3	F	1870	35	Mild RDS; IUGR	8 (6)	Discharged well day 26	Induced for IUGR; moderate birth asphyxia
4	F	1470	29	Mild RDS; PDA; apnoea of prematurity	12 (3)	Discharged well day 35	Caesarean section; APH and placenta praevia
5	F	750	27	Severe RDS; PDA	9 (9)	Died day 9 Pseudomonas septicaemia	1st twin; caesarean section; maternal pre-eclampsia

EGA=estimated gestational age; IPPV=intermittent positive pressure ventilation; IMV=intermittent mandatory ventilation; RDS=respiratory distress syndrome; PDA=patent ductus arteriosus; BPD=bronchopulmonary dysplasia; CPIP=chronic pulmonary insufficiency of prematurity; IUGR=intrauterine growth retardation; APH=antepartum haemorrhage.

Table 2 details the total number of procedures and duration of handling for each infant. On average each infant was handled for 18% of the observation time.

Table 3 shows the total number of procedures and total duration of handling for all infants combined during the three observation periods and the full 24 hour study period. There were no significant differences between duration or number of procedures according to time of day. The contribution to both number and duration by the four categories of procedures is shown. Parental handling contributed on average 35% of the total duration, although the proportion varied considerably between individuals: from 61% of the total handling in the case of infant 3 to only 45 seconds out of the 24 hours' observation for infant 5.

Not all the parameters used to assess 'undesirable incidents' were available throughout the total 7200 minute (120 hours; five infants) study period. Thus transcutaneous oxygen tension monitoring was only undertaken for 3612 minutes (50% of the observation time). A further 117 minutes was discounted because of inaccurately high readings resulting from partial detachments of the electrode from the skin. Because of the inhibiting effect of all but minimal degrees of assisted ventilation apnoea, as defined, was only possible during 2295 minutes.

Table 4 presents a record of the undesirable incidents for all infants, together with the proportion associated with handling procedures and those associated with one specific handling procedure. In most cases it was clear whether handling had been the stimulus in an undesirable incident. If this was not so, an incident was deemed to be associated if some procedure(s) had been performed within the previous minute. Similarly, specific handling procedures that caused a deterioration in the infant's condition were recorded.

Endotracheal suction was the most important specific procedure associated frequently with an undesirable incident. Of the 22 observed tracheal toilets carried out during transcutaneous oxygen tension monitoring, all were followed by hypoxaemia or a significant fall in transcutaneous oxygen tension and on some occasions by bradycardia and apnoea. These 22 instances accounted for 40% of

Table 2 *Number and duration of handling procedures for each infant*

Infant	*Age at start observation (hours)*	*Handling procedures in observation period*		*Mean duration of each procedure (minutes)*
		No	*Duration (minutes) (% total observation)*	
1	15	286	274 (19%)	1·0
2	14	261	311 (22%)	1·2
3	18·5	230	406 (28%)	1·8
4	11	199	156 (11%)	0·8
5	18·5	196	136 (9%)	0·7
Total		1172	1284 (18%)	1·1

Table 3 *Number and duration of handling procedures for all infants by time of day and category of procedure*

	Handling procedures			
	No	*(% total)*	*Duration (% total handling) (minutes)*	*Mean duration for each procedure (minutes)*
Observation period				
0730–0930	443	(38%)	430 (34%)	1·0
1000–1200	374	(32%)	447 (35%)	1·2
1300–1500	355	(30%)	406 (32%)	1·1
Procedure category				
Monitoring	204	(17%)	66 (5%)	0·3
Investigational/ therapeutic	320	(27%)	450 (35%)	1·4
Nursing	565	(48%)	324 (25%)	0·6
Parental	83	(7%)	444 (35%)	5·3
Mean/infant/24 hrs (range)	234 (196–286)		257 (136–406)	1·1 (0·7–1·8)

Table 4 *'Undesirable incidents' and association with handling in the five infants*

	*$TcPo_2$ <5·2 kPa**		*$TcPo_2$ > 13 kPa**		*No of $TcPo_2$ falls ≥2·6 kPa within 1 minute**	*Bradycardia† (heart rate <100)*		*Apnoea‡*	
	Episodes No (%)	*Duration (minutes)*	*Episodes No (%)*	*Duration (minutes)*		*Episodes No (%)*	*Duration (minutes)*	*Episodes No (%)*	*Duration (minutes)*
Total	46	147	14	84	37	15	19	34	6·3
Associated with handling procedures	38 (83%)	124 (84%)	1 (7%)	11 (13%)	30 (81%)	14 (93%)	18 (95%)	13 (38%)	2·4 (38%)
Associated with one specific handling procedure	20 (43%)	87 (59%)	0	0	18 (49%)	12 (80%)	16 (84%)	8 (24%)	1·7 (27%)

$TcPo_2$=transcutaneous oxygen reading.
*Per 3495 minutes; †per 7200 minutes; ‡per 2295 minutes.
Conversion—SI to traditional units: oxygen pressure 1 kPa=7·5 mm Hg.

the total hypoxaemia experienced by the observed infants. In addition there were 36 other occasions when tracheal toilets were carried out *without* transcutaneous oxygen tension monitoring. The mean duration of the total 58 procedures was 83 seconds. Other procedures which were frequently associated with undesirable incidents were peripheral arterial and venous sampling, capillary blood sampling, intubation, chest radiographs, position changes, blood pressure cuff placement, axillary temperature measurement, and nappy changes. There was only one occasion when an undesirable incident (a fall in transcutaneous oxygen tension of 2·6 kPa (20 mm Hg)) occurred with parental handling.

There was no significant difference in the handling experienced by infants, either in the number or the duration of procedures, when there was a one to one nurse to baby ratio (42% of the observation time) compared with a lesser ratio (58% of the observation time).

Discussion

We acknowledge that the present study is limited in that the observation period did not extend through a full day. It could be that handling is rather different at night, especially if there are permanent night nurses who have different routines. In our unit, however, most of the night nurses are normally day staff rostered for a short period to nights. Furthermore, we found little difference between the degrees of handling at different times of the day, perhaps reflecting the lack of variation of nursing routine.

The difficulties of carrying out 24 hour observations are reflected in the few studies which have attempted this. Speidel[2] reported 24 hour observations on three infants but did not document his data in any detail. Korones[12] observed 11 infants for a 24 hour period but at any time in the first 19 days of life. In his study infants were, in fact, handled slightly more during the night than the afternoon and evening, although parental handling was not recorded as it was considered to be insignificant. Adopting an approach more similar to our own, Long *et al*[4] observed 15 infants for four hours a day in the first five days of life but, although comprehensive, the study essentially observed the effects of transcutaneous oxygen monitoring when introduced as a new technical aid rather than an established monitoring procedure. The present study has provided generally unavailable data related to the handling infants requiring intensive care receive on our unit as a result of our present standard procedures.

During the first four days of intensive care infants in our unit are being handled an average 18% of the time. In 24 hours an average of 234 procedures are carried out with the result that, apart from the hypoxaemia and other adverse events which the handling may induce, the infant has little chance to rest or sleep undisturbed. In this context it was noted that parental handling quite frequently interrupted the infant's sleep and more attention could perhaps be paid to this aspect. Despite contributing 35% of the total duration, however, parental handling was in other respects benign, and we see no reason to discourage this contact.

The amount of handling received by an individual infant is, in part, likely to be influenced by how sick that infant is; sicker infants tolerate handling less well but at the same time may require more intensive monitoring and more frequent investigational and therapeutic procedures. To some extent, however, the amount of handling which these infants actually receive may be determined by the medical attendant. Hence, both infants 1 and 5 had severe respiratory distress syndrome, but whereas infant 1 experienced a high degree of handling, a directive was issued to the nursing staff to reduce handling to a minimum in the case of infant 5.

Of specific procedures associated with undesirable incidents the most frequent was endotracheal suction, which during transcutaneous monitoring was invariably associated with a serious fall in transcutaneous oxygen tension. Previous studies have also shown hypoxaemia to be a common sequel to endotracheal suctioning in the newborn,[5 6] and some have shown a consistent association of the procedure with a rise in blood pressure[6 13] and increased cerebral blood flow velocity.[13] It would seem sensible for the schedule of suctioning to be considered for each infant individually and for this schedule to be constantly reviewed. For many infants, three or four hourly suctioning may well be more appropriate than the blanket schedule of two hourly suctioning which was routine in our unit at the time of this study.

A further problem with endotracheal suctioning as observed in this study was that the procedure had a mean duration of 83 seconds, considerably more than the 30 seconds suggested by others.[6] At present the procedure requires the infant to be disconnected from the ventilator and we shall be assessing endotracheal tube connections which allow suctioning without fully disconnecting the infant. Again this procedure and several others such as chest radiographs and blood sampling were undoubtedly complicated by the fact that our infants are nursed in incubators, and apart from the handling involved the infants are exposed to temperature changes

consequent on opening the incubator doors. It seems likely that many procedures could be performed more speedily and with less disturbance in infants nursed under radiant heaters.

It is of interest that there was no evidence of increased handling of the infant when there was a one to one nurse:baby ratio. Not surprisingly, however, there was individual variation in the general awareness of potentially noxious stimuli to the infant. For example, the incubator top was sometimes used to tap blood to the bottom of a sample tube during heelprick sampling. Occasionally medical staff seemed determined to obtain blood samples at all costs even if this meant prolonged handling of the infant.

One way of guarding against such casual handling or attitudes is to display constantly the transcutaneous oxygen measurement. Long *et al*[4] found that handling was decreased appreciably when monitoring was introduced to the nursery. Transcutaneous oxygen monitoring has been available in our unit since 1981 and is viewed as a routine procedure carried out on all intensive care infants. It is perhaps surprising, therefore, that the monitor was only in operation 50% of the observation time. With the exception of arterial blood sampling, the transcutaneous oxygen monitoring electrode was rarely placed before a period of likely frequent or intense handling. The main reasons for removal of the electrode were a belief that the readings were inaccurate (compared with arterial samples) and spontaneous partial detachment, as well as the occasional minor burn and elective resiting.

In the recent history of neonatal intensive care there is no shortage of examples of new techniques being adopted 'wholesale' without adequate controlled trials being carried out and resulting in unforeseen hazards to the neonates. The inference is that all who work in neonatal intensive care have a duty to undertake some form of audit of their practices and the consequences of these. This applies as much to established routine procedures as it does to new technology, and the application of the latter must be seen in the light of the continuum of neonatal intensive care events. The 'hands off' tenet remains a good one; every handling procedure should be viewed in this light and necessary procedures kept as simple and short as possible.

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