Chest Physiotherapy in the Neonate: A Controlled Study

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ABSTRACT. The effect of postural drainage alone was compared to postural drainage with chest percussions on the arterial blood gases of 20 neonates with respiratory distress. There was no significant alteration in the arterial Po_2 following postural drainage alone, with a significant increase (14.5 mm Hg) following postural drainage with chest percussions. The Po_2 midway through postural drainage with percussions showed a small (5 mm Hg) but nonsignificant rise in the Po_2, suggesting a gradual improvement throughout the use of this form of therapy. There was no significant change in the pH or Pco_2 with either procedure. Appropriately performed chest percussions will result in an improvement in oxygenation in neonates with respiratory distress. *Pediatrics* 61:282-285, 1978, *chest physiotherapy, respiratory distress, oxygenation, neonate.*

There has been little attempt to objectively document the effects of chest physiotherapy in pulmonary disorders, especially in neonates.[1,2] In a previous study[3] a complete chest physiotherapy treatment consisting of postural drainage, vibrations, and percussions in neonates with respiratory distress was followed by a mean rise in the arterial Po_2 of 20 mm Hg, with no significant alteration in the Po_2 following suctioning of the infant's airway. Because of these findings, a controlled study was undertaken to determine which aspects of chest physiotherapy were responsible for the improvement in oxygenation.

MATERIALS AND METHODS

Twenty newborn infants admitted to the Neonatal Intensive Care Unit of the Royal Alexandra Hospital comprised the study group. All patients had respiratory distress and required greater than 21% oxygen. The mean birth weight was 2,072 gm with a mean gestation of 34 weeks, with a range of birth weights from 900 to 3,890 gm and a gestation ranging from 29 to 40 weeks; the infants were studied at a mean age of 99 hours (range, 7 to 873 hours). All infants were seen within 12 hours of admission by one of the authors who confirmed the diagnosis using previously established clinical and roentgenographic criteria.[4] Fourteen infants had hyaline membrane disease, two had transient tachypnea, three had pneumonia, and one was being ventilated for apnea. Gestational age was determined from the last normal menstrual period of the mother and the Dubowitz examination[5] was performed within 12 hours of birth. All infants had arterial catheters placed in the descending aorta for continuous measurement of blood pressure and arterial blood gas determinations. They were nursed in a neutral thermal environment consisting of a servocontrolled incubator or a servocontrolled radiant warmer. In all circumstances, an attempt was made to maintain the arterial Po_2 between 50 and 75 mm Hg by alteration of the inspired oxygen concentrations. Continuous distending pressure by mask[6] or nasal prongs[7] was administered if greater than 40% oxygen was required to maintain the arterial Po_2 at greater than 50 mm Hg; if there was a positive response, this form of therapy was continued. Mechanical ventilation utilizing a Baby Bird ventilator was instituted for intractable hypoxia unresponsive to distending pressure, apnea, or a progressive respiratory acidosis. The mean inspired oxygen concentration at the time of the study was 50% with a range from 24% to 75%. Eight infants were

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receiving distending pressure by nasal prongs (seven) or face mask (one), and seven were nasally intubated and mechanically ventilated.

The infants were studied only after their condition was clinically stable with acceptable arterial blood gases for three hours before being enrolled in the study. The study protocol required that each infant have arterial blood gas determinations performed five minutes before and 15 minutes after either postural drainage with chest percussions or postural drainage alone, each procedure being followed by suctioning of the airway. The order in which the infant received these two forms of therapy was determined randomly by drawing from a group of sealed and shuffled envelopes. The two procedures were performed during the same eight-hour shift with the average interval between the two procedures being 3.1 hours. The inspired oxygen concentrations and all modes of assisted ventilation were kept constant from before to after each pair of blood gas determinations. In addition, ten infants had an arterial blood gas determination after ten minutes of chest percussions in the 45° head-down prone position, midway through their complete therapy. All blood gas analyses were performed by the respiratory therapist in the Intensive Care Unit using a pH blood gas analyzer (Instrument Laboratories 213) with calibration and balancing done before each blood gas determination.

Postural drainage was performed for the posterior and anterior basal segments with each position being maintained for ten minutes. Postural drainage with contact-heel chest percussions was performed utilizing the same two positions with ten minutes spent in each position. The chest percussions were performed constantly throughout the 20-minute period at a frequency of 40 per minute. The technique involved applying pressure using the thenar-hypothenar eminence of the hand continuously applied at right angles to the infant's chest wall (Figs. 1 and 2). The degree of pressure varied with the size of the infant with an attempt to achieve a thoracic displacement of 1 to 2 cm. After completion of either form of therapy, the infant's airway was suctioned. All physiotherapy was performed by a single physiotherapist (J.B.).

Statistical analysis was performed using Student's t test.

RESULTS

Ten infants received postural drainage with percussions initially and ten infants received postural drainage alone initially. All infants studied had an increase in their arterial Po_2 following postural drainage with percussions, with a mean rise of 14.5 mm Hg from 60.4 ± 1.3 mm Hg to 74.9 ± 2.5 mm Hg (± SEM, $P < .001$). In contrast, there was no significant change between the predrainage and postdrainage Po_2 (63.8 ± 2.2 mm Hg vs. 62.2 ± 2.4 mm Hg, $P > .5$). The predrainage Po_2 was slightly higher than the prepercussion Po_2 (63.8 mm Hg vs. 60.4 mm Hg), but this difference was not significant ($P > .1$). However, a comparison of the postpercussion Po_2 with the postdrainage Po_2

FIG. 1. Areas of hand used to apply contact-heel percussions.

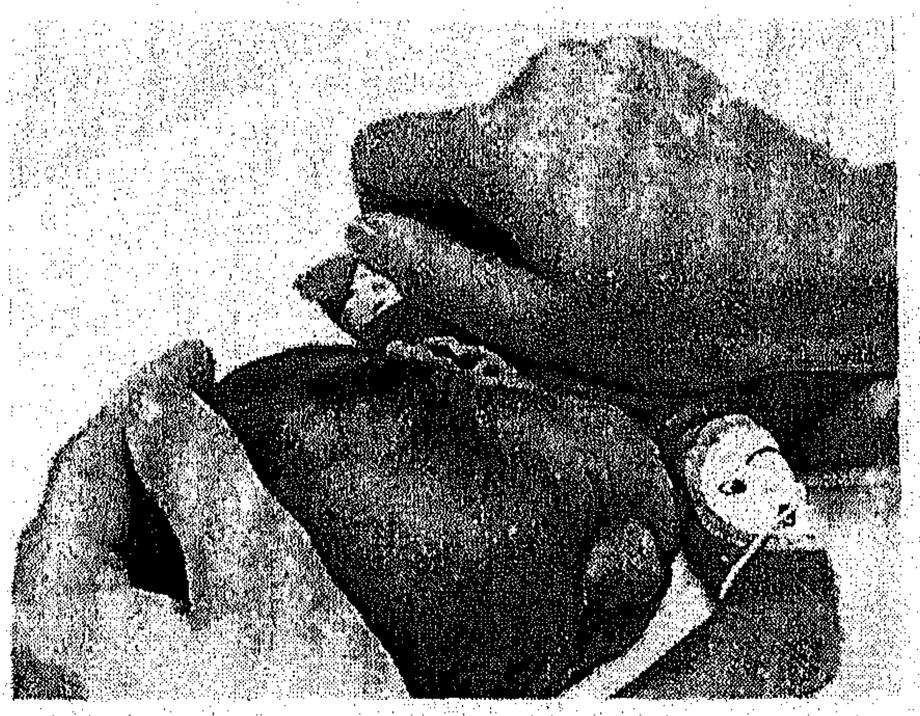

FIG. 2. Infant receiving contact-heel percussions over left apicoposterior segment.

Arterial Blood Gases Before and After Therapy

	Drainage & Percussions		*Drainage Alone*	
	Before	*After*	*Before*	*After*
pH	7.36	7.36	7.36	7.36
Pco_2 (mm Hg), mean ± SEM	38.9 ± 1.7	38.1 ± 1.7	37.9 ± 1.9	39.6 ± 1.9
Po_2 (mm Hg), mean ± SEM	60.4 ± 1.3*	74.9 ± 2.5*	63.8 ± 2.2	62.6 ± 2.4

*$P < .001$.

revealed a highly significant increase with the postpercussion value of 74.9 mm Hg compared to 62.6 mm Hg ($P < .001$) (Table).

There was no significant change in the pH or Pco_2 with postural drainage with percussions or with postural drainage alone (Table). In ten infants, an arterial Po_2 was obtained in the middle of their postural drainage with chest percussions. Comparison of the pre- and mid-physiotherapy values revealed a slight rise in the arterial Po_2 from a mean of 60.4 mm Hg to a mean of 65 mm Hg. This increase was not significant ($P > .1$).

DISCUSSION

This study documents the improvement in arterial oxygenation that is associated with postural drainage with chest percussions using a contact-heel technique devised by one of the authors (J.B.). Postural drainage alone did not lead to any significant change in the arterial Po_2. Arterial blood gas values determined midway through percussions with drainage showed a slight increase in the arterial Po_2, suggesting that this form of therapy was associated with a gradual rise in the arterial Po_2 as opposed to a drop during therapy with a later rise.

Holloway et al.[8] examined the effects of chest physiotherapy in arterialized capillary blood gases in 22 neonates being treated for tetanus neonatorum by intermittent positive pressure ventilation; a drop in the Po_2 occurred following physiotherapy. Hyperinflation resulted in a more rapid return to the prephysiotherapy value. Fox et al.[9] examined the alterations in respiratory function following chest physiotherapy in neonates and demonstrated a drop in the Po_2 following suctioning, with an increase in the Po_2 toward the presuction value following hyperventilation similar to that noted by Holloway et al.[8]

A 20-minute period of postural drainage alone did not lead to any significant alteration in the arterial Po_2 following this procedure. This period of drainage may be too short to lead to significant improvements in ventilation–perfusion ratios with resultant increases in the arterial Po_2. A study of five adults with acute respiratory distress syndrome using the CircOlectric bed demonstrated a significant increase in the Po_2 (47 mm Hg) following 30 to 120 minutes of postural drainage.[10] In addition, the narrow airways of premature infants may not allow secretions to drain without mechanical assistance in the form of percussion or vibrations.

Further studies are necessary to examine the effects of repeated chest physiotherapy to determine whether there is a continual rise in the Po_2 with each subsequent treatment, and to clarify the role of chest vibrations. The improvement in oxygenation observed in our initial study[5] and in the present one is no doubt related to the development and use of an effective chest percussion technique uniformly administered by a single individual. Before the appointment of a chest physiotherapist to our unit, the intensive care nurses performed all physiotherapy, using face masks (Bennett) for percussions. There was a reluctance to place infants who were receiving any form of assisted ventilation in the prone position and the chest percussions, although not quantitatively measured, were less vigorous than those used in our present technique. Our nurses are now being taught this technique and are continuously supervised by trained physiotherapists. The previous studies[6,11] did not give details of the method of physiotherapy used, and, therefore, a direct comparison with our methods is not possible.

SUMMARY

Appropriately performed postural drainage and chest percussions in neonates with various forms of respiratory distress are followed by a significant increase in the arterial Po_2. This

increase is a gradual one with a small rise being observed midway through the therapy. No significant alteration in the Po_2 occurs following postural drainage alone. Further studies are needed to determine the role of chest physiotherapy in respiratory disorders of newborns.

The ritualistic application of unproven techniques of chest physiotherapy, including the use of chest percussions by face masks, should be subjected to critical evaluation before being accepted as standard procedure for the neonate with respiratory distress.

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A BLACK HOLE

. . .I [do] not infer . . . that the choice is between a humane caring for the chronically ill and disabled on the one hand and public-health interventions on the other. Neither are doing well at present (in the United States 18 million children are not protected from poliomyelitis) and there is no need to worsen their case by implying that they are competitive. The voracious competitor to them both is high-cost technology, centered on the doctor-hospital complex. Even in developed countries, it is losing touch with the real biology of need. By reason of its intramural psychology, its control on education, and its autonomous costing, it curbs the invention and development of the medium and low cost technology services which are required to support the well-being of communities and the personal care of their large, needy minorities, whether they be rural villagers or urban elderly. Given infinite time and money, the doctor-hospital complex will never of its own extend outwards towards them. For it is a kind of black hole in the medicosocial sky: more resources only make it denser.

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Submitted by Student

From Lawson IR: Health—A demonstration of technology. *Lancet* 1:481, 1976.