Touched by technology: automated tactile stimulation in the treatment of apnoea of prematurity

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PART 2

CHAPTER 1

High variability in nurses' tactile stimulation methods in response to apnoea of prematurity - a neonatal mannikin study

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ABSTRACT

AIM

Neonatal intensive care unit (NICU) nurses provide tactile stimulation to terminate apnoea in preterm infants, but guidelines recommending specific methods are lacking. In this study we evaluated current methods of tactile stimulation performed by NICU nurses.

METHODS

Nurses were asked to demonstrate and explain their methods of tactile stimulation on a manikin, using an apnoea scenario. All nurses demonstrated their methods three times in succession, with the manikin positioned either prone, supine, or lateral. Finally, the nurses were asked how they decided on the methods of tactile stimulation used. The stimulation methods were logged in chronological order by describing both the technique and the location. The nurses' explanations were transcribed and categorized.

RESULTS

In total, 47 nurses demonstrated their methods of stimulation on the manikin. Overall, 57 different combinations of technique and location were identified. While most nurses (40/47, 85%) indicated they learned how to stimulate during their training, 15/40 (38%) of them had adjusted their methods over time. The remaining 7/47 (15%) stated that their stimulation methods were self-developed.

CONCLUSION

Tactile stimulation performed by NICU nurses to terminate apnoea was highly variable in both technique and location, and these methods were either based on prior training or intuition.

INTRODUCTION

Apnoea of prematurity (AOP), defined as a cessation of breathing for 10 to 20 seconds and sometimes accompanied by bradycardia and hypoxia, is one of the most common problems diagnosed in the Neonatal Intensive Care Unit (NICU) [1]. To reduce the occurrence of AOP, breathing is stimulated with methylxanthines and non-invasive respiratory support. Although these methods are effective [2-4], apnoea can persist in a proportion of infants. In order to restore breathing and avoid subsequent intermittent hypoxia and bradycardia, tactile stimulation is applied by the nurse, often combined with supplemental oxygen and, if required, mask ventilation.

NICU nurses are trained to apply manual tactile stimulation in response to AOP, an intervention that has been used worldwide for decades. There are, however, no protocols or guidelines available that define or recommend methods of tactile stimulation, and the optimal stimulation method to end AOP is currently unknown. In this study we aimed to determine the methods of tactile stimulation nurses currently use in response to AOP in our NICU.

METHODS

This prospective observational study was carried out at the NICU of the Leiden University Medical Centre (LUMC) from April to July 2018. Nurses were asked to demonstrate and explain their current procedures for stimulating preterm infants during a simulated scenario of AOP using a manikin. At the end of the demonstrations, all nurses were asked how they had developed their methods of tactile stimulation.

SIMULATION SET-UP

We created a scenario involving an apnoeic preterm infant in an unoccupied patient room at the NICU. The study set-up was equivalent to the clinical set-up; the manikin was placed in a closed and covered incubator, wrapped in a snuggle, and covered with a blanket. Nurses were invited into the room one by one and were asked to demonstrate the tactile stimulation they would usually perform when their patient is apnoeic. During the demonstration the nurses were informed that breathing had not been regained, encouraging them to show all the methods of tactile stimulation they would usually perform before considering mask ventilation. The scenario was repeated three times, with the manikin placed randomly in either prone, lateral or supine position.

DATA COLLECTION

All demonstrations were recorded using a webcam with an integrated microphone at the foot end of the incubator. The webcam was placed so that only the manikin and the hands of the nurse were visible.

ANALYSIS

The recordings were independently reviewed and analysed by two NICU nurses involved in the study (MB and NH). Tactile stimulation methods were logged in chronological order by describing both the technique and the location of stimulation. In situations that were unclear, consensus was achieved with the help of two researchers (SC and HZ). The techniques were subsequently numbered in chronological order; the first technique was assigned the number one, the last 10, and the remaining techniques a proportional value in between one and 10. The nurses' explanations about the development of their tactile stimulation methods were transcribed and categorized.

ETHICS

In concordance with the laws and guidelines, the Ethics Review Committee of Leiden University deemed that formal ethical approval was not required and issued a statement of no objection. The nurses who participated in the study gave consent for us to record the demonstrations and use the data.

RESULTS

In total, 47/59 nurses (80% of the team) participated in the study. The working experience of the 47 nurses varied; 24 (51%) nurses had worked at a NICU for over 10 years, 12 (26%) for 5-10 years, and 11 (23%) for less than five years.

Nurses used 10 different stimulation techniques; press, massage, rub, scratch, shake, squeeze, stroke, tap, tickle and vibrate (Figure 1), in 10 different locations; arms, back, abdomen, buttocks, cheek, feet, hands, head, legs and side. We also observed three tactile interventions that involved an additional component and were related to specific locations: supporting the neck or chin to obtain an open airway, lifting the thorax and turning the infant into either a lateral or prone position. In total, when combining the techniques and locations, we observed 57 different methods of tactile stimulation.

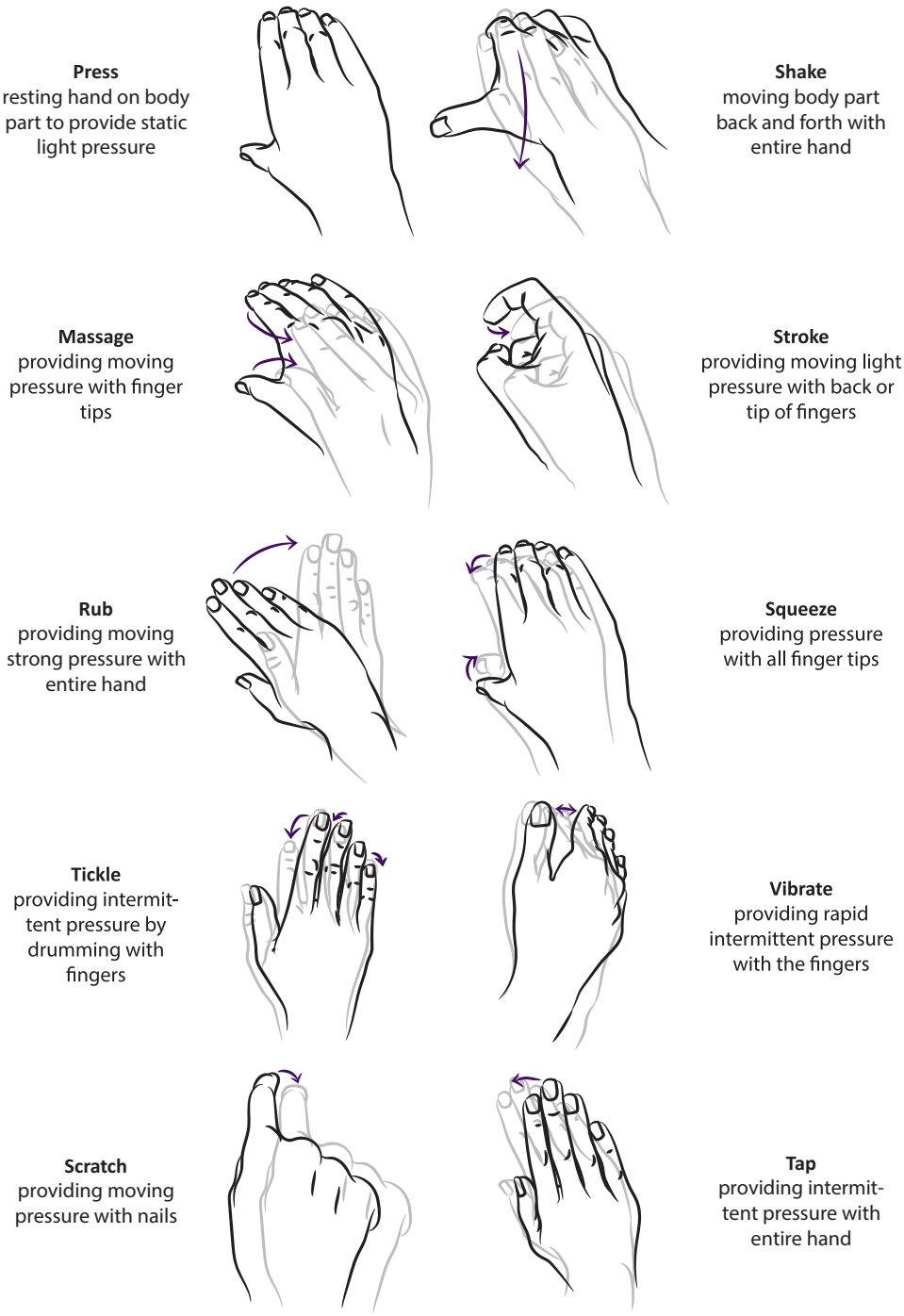

Figure 1. Identified stimulation techniques

STIMULATION TECHNIQUES

The most favoured techniques, demonstrated by more than 70% of the nurses, were pressing, rubbing, and turning the mannikin over when it was in a lateral or prone position (Fig 2). The ranking of the techniques indicates that most nurses performed their stimulation routine in that order.

The least commonly used stimulation techniques, demonstrated by fewer than 10% of the nurses, were scratching, tapping, tickling and vibrating (Fig 2). The median rank of these techniques shows that in most cases a different technique had preceded them.

Little difference was observed in the percentage of use between the different initial positions of the manikin for the stimulation techniques that consisted solely of a tactile component; press, shake, massage, stroke, rub squeeze, tickle, vibrate, scratch and tap (0-13%). The tactile interventions; open airway, turn over and lift, show larger variations in use between the different positions (9-72%).

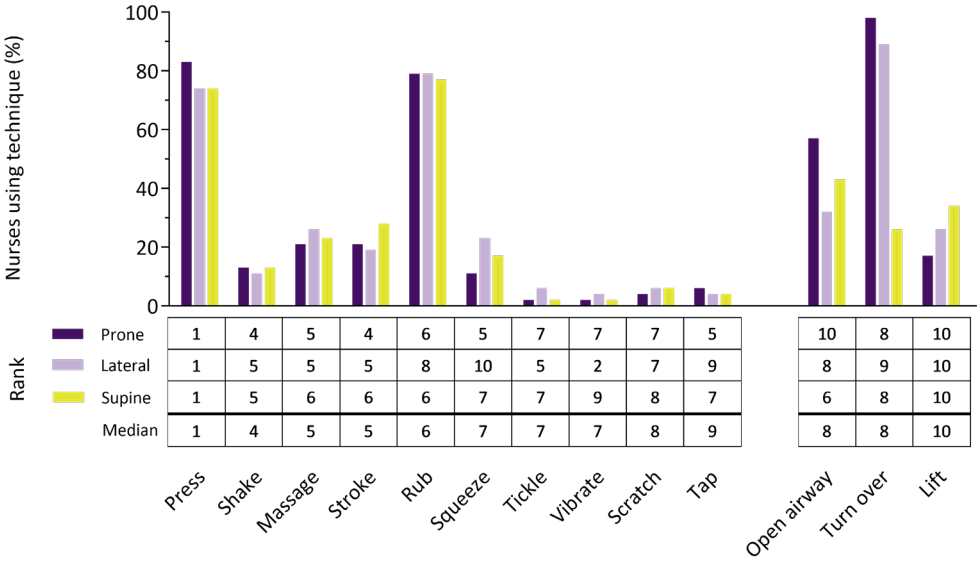

Figure 2. Percentage of nurses using the different identified stimulation techniques (press-tap) and interventions (open airway-lift) for prone, supine and lateral positioning of the manikin and succession rank of different identified tactile stimulation techniques and tactile interventions per position of the manikin.

STIMULATION LOCATIONS

Tactile stimulation was mainly applied on the feet, back, abdomen and head while the arms, cheeks, buttocks and hands were the locations least commonly stimulated areas (Fig 3a).

The feet were a favoured stimulation location in all positions, while the nurses chose to stimulate the torso predominantly on the side facing upwards – the back in prone position, and the abdomen in supine position (Fig 3b). The head was stimulated in all positions but almost solely in order to provide light pressure. The legs were stimulated more frequently, and using a wider range of techniques, when in lateral and supine positions compared to prone position.

Rubbing and massaging, the stimulation techniques that were demonstrated most often, showed the biggest variation in locations (8-9 different locations). The techniques that were least used - tapping, scratching, vibrating and tickling - showed the least diversity in stimulation location (2-4 different locations).

Tactile intervention to obtain an open airway consisted of supporting the chin or neck of the manikin, predominantly the latter. In 75% of the cases when the manikin was turned over it was turned to supine position, and in 25% of cases to lateral position. Finally, the thorax was the only body part that was lifted during the demonstrations.

STIMULATION METHODS

Overall, the most demonstrated stimulation methods to terminate apnoea in preterm infants were rubbing the feet, turning the infant over into a supine position, providing light pressure on the head, opening the airway by supporting the neck, and rubbing the back.

CHOICE OF STIMULATION METHOD

Of all nurses taking part in the study, 40/47 (85%) indicated that their choice of methods of tactile stimulation were based on instructions of supervisors or observations of fellow nurses during their training period. Of these nurses, 15/40 (38%) had adjusted their methods of stimulation over time, based on intuition or experience. The seven remaining nurses (15%) stated that their methods were entirely self-developed.

DISCUSSION

This was the first study to examine the tactile stimulation methods used by NICU nurses to stimulate breathing in response to AOP. The results show that the stimulation techniques and locations used were highly variable.

In general, the most frequently used methods were proving light pressure on the head, rubbing the feet or the torso, supporting the neck, and turning the infant over. However, our study also shows that both the stimulation techniques and locations that nurses use vary depending on the initial position of the mannikin. Furthermore, we observed that nurses used multiple stimulation methods with an increasing intensity if the apnoea persisted. Stimulation usually started with gently resting a hand on the infant to provide light pressure and ended with more vigorous forms of stimulation such as moving the infant into another position.

Our nurses developed their set of different methods of tactile stimulation by observing colleagues and supervisors, their own experience of performing stimulation, or a combination of both.

Unlike tactile stimulation methods to counteract apnoea, tactile stimulation methods to initiate breathing directly after birth have previously been described [5, 6]. These methods include warming, drying, rubbing the back, or flicking the soles of the infant's feet. Although the locations of these methods are similar to the most stimulated locations in this study, the selection of methods described is not scientifically underpinned. Recently, it has been shown that the methods and timing of tactile stimulation to initiate breathing at birth also vary considerably between caregivers and centres [7-12]. It has been suggested that rubbing the thorax region is most effective in providing timely initiation of breathing, but this was based on observations in small cohort studies [9, 11].

Although different forms of manual and mechanical tactile stimulation can prevent or terminate apnoea [13], their effectiveness could well be technique and/or location dependent. Several studies have hypothesized that tactile stimulation exerts its effect on the respiratory centre via activation of cutaneous nerves [14, 15]. Animal studies have shown that electrical stimulation of these nerves facilitates breathing [16] and attenuates inhibitory reflexes by increasing afferent input to the respiratory centre [17]. Alternatively, other studies suggest that tactile stimulation affects the respiratory oscillator by activating proprioceptors in the hands and feet [18] or receptors in the chest wall muscles [19]. Apart from the different neuronal pathways, the effectiveness of tactile stimulation is presumed to be primarily location dependent, as density and sensitivity of receptors varies per skin region [20]. Both the high variability in stimulation methods and the way nurses develop

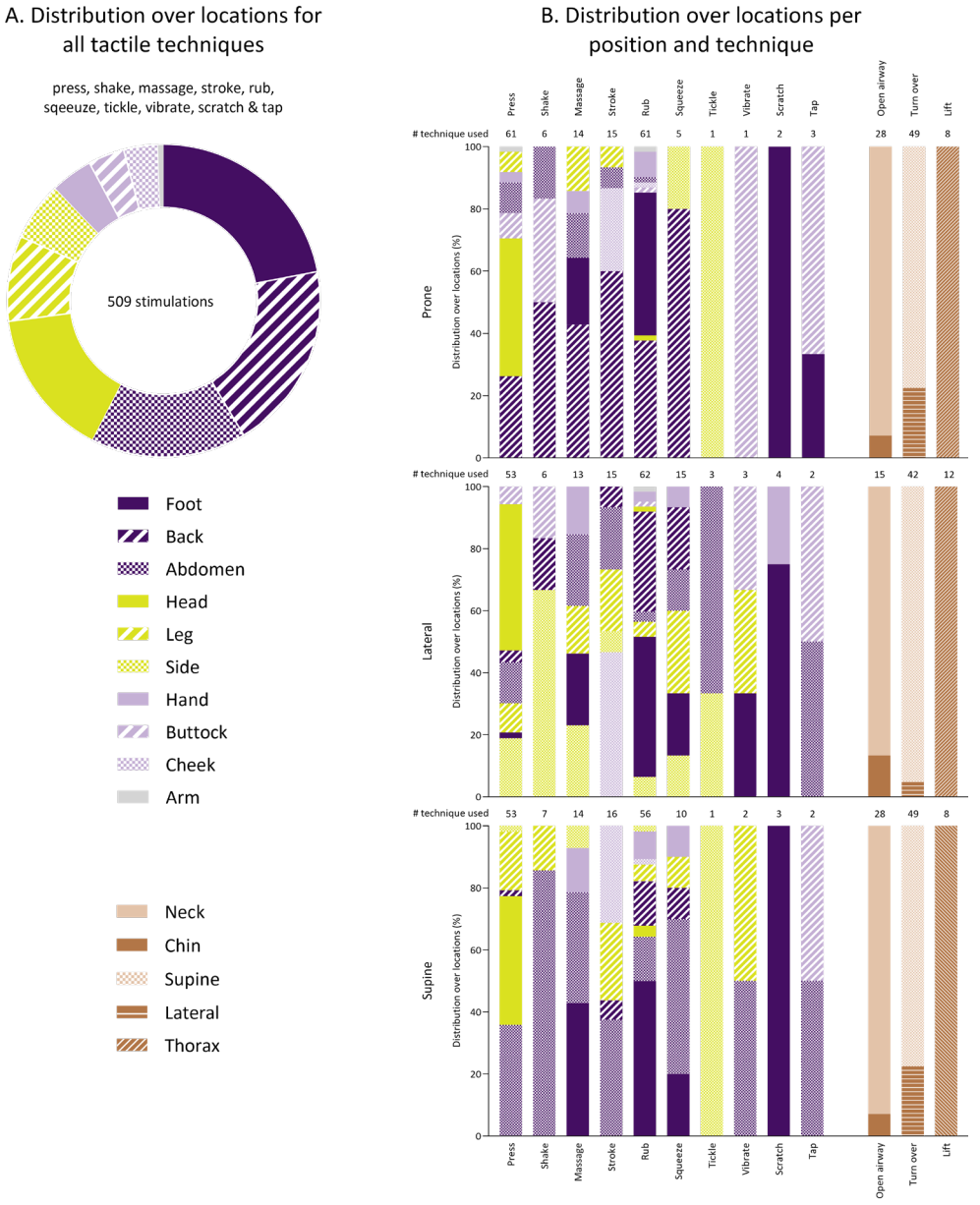

Figure 3. (a) Stimulation locations where tactile stimulation was applied with tactile techniques (press-tap) (b) Stimulation locations that were stimulated per technique and position of the infant.

their methods reflect the lack of detailed protocols, and, in turn, the lack of knowledge about neural activation and pathways to the brain's respiratory centre.

The optimal timing and most effective technique and location of tactile stimulation are currently unknown. In this study, we have provided an inventory of the tactile stimulation methods used by nurses. Although limited by the fact that apnoeic episodes were simulated with the aid of a mannikin, this study has used an objective and pragmatic approach to identify different tactile stimulation methods used by nurses following apnoea in preterm infants. As this study is performed on a small cohort of nurses from a single centre, the results are not commonly generalizable. However, albeit it is conceivable that tactile stimulation methods are more consistent between nurses in other centres, this does not alter the need for evidence instead of intuition or eminence based methods.

CONCLUSION

In conclusion, our study showed that nurses use many different tactile stimulation methods to counteract apnoea in preterm infants. The large variation can be partly explained by the fact that most nurses used multiple methods of stimulation with increasing intensity. However, we hypothesize that the large variations in practice is mainly due to the lack of clear and detailed protocols or guidelines. A prompt, adequate, and effective response is pivotal to minimizing the potentially life-long consequences of frequent or long-lasting apnoeic episodes, but the timing, location and method of stimulation are currently dependent on the discretion of the nurse. In order to improve the management of apnoea in preterm infants, large prospective studies comparing different methods of tactile stimulation should be performed in order to develop evidence-based recommendations.

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