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ORIGINAL ARTICLE

A multicentre neonatal manikin study showed a large heterogeneity in tactile stimulation for apnoea of prematurity

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Abstract

Aim: Apnoea of prematurity requires prompt intervention to prevent long-term adverse outcomes, but specific recommendations about the stimulation approach are lacking. Our study investigated the modalities of tactile stimulation for apnoea of prematurity in different settings.

Methods: In this multi-country observational prospective study, nurses and physicians of the neonatal intensive care units were asked to perform a tactile stimulation on a preterm neonatal manikin simulating an apnoea. Features of the stimulation (body location and hand movements) and source of learning (training course or clinical practice) were collected.

Results: Overall, 112 healthcare providers from five hospitals participated in the study. During the stimulation, the most frequent location were feet (72%) and back (61%), while the most frequent techniques were rubbing (64%) and massaging (43%). Stimulation modalities different among participants according to their hospitals and their source of learning of the stimulation procedures.

Conclusion: There was a large heterogeneity in stimulation approaches adopted by healthcare providers to counteract apnoea in a simulated preterm infant. This finding may be partially explained by the lack of specific guidelines and was influenced by the source of learning for tactile stimulation.

KEYWORDS
apnoea of prematurity, preterm infants, simulation, tactile stimulation

1 | INTRODUCTION

Worldwide, around 15 million neonates are born preterm every year, accounting for one of 10 newborns.[1] Prematurity is acknowledged as the first cause of neonatal mortality, as preterm infants often experience severe complications such as pulmonary, neurological, gastrointestinal or immunologic diseases.[2]

Apnoea of prematurity (AOP) is a frequent condition that is inversely associated with gestational age and arises in virtually all extremely low preterm infants (<28 weeks of gestation).[3] In preterm infants, immature and altered development of the respiratory control mechanisms are involved in the pathogenesis of AOP, and prolonged episodes may lead to bradycardia or desaturation.[4] Although the long-term consequences of AOP are still

Abbreviations: AOP, apnoea of prematurity; NICU, neonatal intensive care units.

under debate, the literature suggests that severity, duration and number of episodes of AOP may be associated with adverse neurodevelopmental outcomes.[5]

Methylxanthines (aminophylline and caffeine) and non-invasive respiratory support are the main preventive and therapeutic strategies in neonates with AOP.[3,4] However, this condition may persist in some infants, who are usually cared for with tactile stimulation to reinstate breathing and avoid severe desaturation and bradycardia.[6–9]

Currently, there is no consensus about the procedural aspects of tactile stimulation (such as technique, duration and body location), leading to highly heterogeneous approaches among healthcare givers in neonatal intensive care units (NICUs).[8] A previous study showed such high heterogeneity among NICU nurses of the same medical centre and suggested that prior training and personal intuition may play an important role in the choice of the tactile stimulation technique. Our study aimed to extend such investigation by exploring the modalities of tactile stimulation for AOP in different settings.

Key notes

- Tactile stimulation is recommended among the interventions for treating the apnoea of prematurity, but specific recommendations on the procedure are lacking.
- Our study showed a large heterogeneity in stimulation approaches adopted by healthcare providers to counteract apnoea in a simulated preterm infant.
- Future prospective studies may investigate the most appropriate approach for tactile stimulation in preterm infants to provide evidence-based guidelines.

2 | METHODS

2.1 | Study design

This is a multi-country, observational, prospective study assessing different modalities of tactile stimulation in a simulated preterm infant with apnoea. The study was conducted at the University Hospital of Padova (Italy), the Fondazione Poliambulanza Hospital of Brescia (Italy), the University Hospital of Tengandogo (Burkina Faso), the Saint Camille Hospital of Ouagadougou (Burkina Faso) and the Maputo Central Hospital (Mozambique). The study was approved by the local Ethics Committees and all participants provided written consent.

2.2 | Simulation scenario

Participants were NICU nurses and physicians of the study hospitals. A preterm neonatal manikin (NeoNatalie, Laerdal, Stavanger, Norway) in a supine position was put in an incubator with a blanket under the shoulders to maintain neutral position. Chest movements of the manikin were provided by the researcher using an air pump. The researcher simulated an apnoea and invited each participant to perform tactile stimulation as he/she they would usually do before considering face mask ventilation. Performances were video-recorded and stored in a password-protected computer. Only the manikin and the hands of professionals were visible in the videos. Two researchers reviewed the videos and extracted the relevant data after reaching a consensus. Data collection included demographics (age and sex), NICU experience, healthcare role (nurse or physician), learning source for tactile stimulation (training course or clinical practice) and features of applied stimulation during the simulated scenario (location, technique, duration, and repetitions).

2.3 | Statistical analysis

Data were summarised as frequency and percentage (categorical data) or median and interquartile range (continuous data). Comparisons were performed using Kruskal–Wallis test, chi-squared test and Fisher's exact test, as appropriate. Adjustment for multiple testing was not applied given the exploratory (rather than confirmatory) nature of the study. All tests were two-sided, and a p-value less than 0.05 was considered statistically significant. Statistical analysis was performed using R 4.3 (R Foundation for Statistical Computing, Vienna, Austria).[10]

3 | RESULTS

3.1 | Participants

Overall, 112 healthcare providers (12 males and 100 females; median age 34 years, interquartile range 30–42) participated in the study. Participant characteristics are summarised in Table 1. Forty-two participants learned the techniques for tactile stimulation during a dedicated training course on neonatal resuscitation (Neonatal Resuscitation Program or Helping Babies Breath).[11,12] Seventy participants were instructed on the techniques for tactile stimulation by a colleague during the daily clinical practice. Participants differed among centres in terms of age ($p=0.04$), role ($p=0.01$) and learning source ($p=0.0001$).

3.2 | Modality of the stimulation techniques

Data on stimulation modalities including frequency, duration and number of repetitions are reported in Table 2. The most frequent stimulation modalities were rub back (57%), massage feet (35%) and rub feet (25%). Rubbing and squeezing chest were associated with the longest duration of the stimulation (median 8–10 s). Scratching feet, squeezing chest and rubbing back involved the highest number of repetitions (median 10–16 repetitions).

TABLE 1 Participant characteristics.

	HOSCO ($n=21$)	Tengandogo ($n=11$)	Maputo ($n=22$)	Brescia ($n=28$)	Padova ($n=30$)	p-Value
Males	4 (19%)	2 (18%)	1 (5%)	3 (11%)	2 (7%)	0.43
Age, years	40 (33–45)	39 (32–41)	34 (30–37)	31 (27–41)	31 (29–47)	0.04
Experience in neonatal intensive care unit, years	5 (3–10)	5 (1–10)	5 (4–9)	4 (1–5)	4 (3–21)	0.12
Role						
Nurse	19 (90%)	4 (36%)	15 (68%)	20 (71%)	25 (83%)	0.01
Physician	2 (10%)	7 (64%)	7 (32%)	8 (29%)	5 (17%)	
Learning source[a]						
Training course	3 (14%)	5 (45%)	10 (45%)	19 (68%)	5 (17%)	0.0001
Clinical practice	18 (86%)	6 (55%)	12 (55%)	9 (32%)	25 (83%)	

Note: Data summarised as *n* (%) or median (interquartile range).
[a]How participants learned neonatal tactile stimulation.

TABLE 2 Description of stimulation techniques.

Stimulation modality	Frequency in the sample	Duration, (seconds)	Number of repetitions
Squeeze chest	15 (13%)	8 (6–13)	10 (6–16)
Rub back	64 (57%)	5 (4–8)	10 (7–16)
Rub feet	28 (25%)	5 (4–7)	7 (5–12)
Rub chest	7 (6%)	10 (7–11)	9 (8–21)
Massage chest	10 (9%)	6 (5–7)	6 (4–7)
Massage feet	39 (35%)	4 (3–7)	8 (4–11)
Massage hand	8 (7%)	3 (2–7)	3 (2–5)
Press chest	4 (4%)	4 (3–5)	6 (4–9)
Press hips	2 (2%)	3; 4	4; 10
Stroke feet	6 (5%)	5 (4–5)	8 (7–10)
Scratch feet	4 (3%)	7 (5–10)	16 (9–21)
Tickle feet	5 (4%)	1 (1–2)	3 (3–5)
Tickle chest	2 (2%)	6; 12	9; 24
Rub hand	1 (1%)	3	4
Sting heel	1 (1%)	1	1
Massage ear	2 (2%)	1; 4	2; 6
Massage shoulder	2 (2%)	3; 5	6; 7
Sting neck	1 (1%)	2	2
Shake chest	2 (2%)	2; 4	3; 7
Press feet	3 (3%)	2; 3; 17	2; 3; 17
Tap feet	13 (12%)	2 (2–5)	6 (4–12)
Vibrate back	1 (1%)	6	16
Scratch back	2 (2%)	10; 19	14; 32
Press shoulder	1 (1%)	3	1
Rub head	1 (1%)	5	7
Tap chest	1 (1%)	2	6
Press back	1 (1%)	6	13

Note: Data summarised as *n* (%) or median (interquartile range). When the modality was performed by three or less subjects, the single values were reported.

3.3 | Stimulation location and technique stratified by participating centre

Overall, the most frequent locations were feet (72%) and back (61%), while the most frequent techniques were rub (64%) and massage (43%) (Table 3). Participants from different centres showed significant differences in terms of some stimulation locations (back $p<0.0001$, chest $p<0.0001$, feet $p<0.0001$) and techniques (massage $p=0.0005$, press $p<0.0001$, rub $p<0.0001$) (Table 3).

3.4 | Effect of prior training

Participants who learned during a training course applied the stimulation more frequently to the back ($p=0.01$) and less frequently to the feet ($p=0.03$) (Table 4). In addition, they used more frequently a rubbing movement ($p=0.001$) and less frequently a massaging movement ($p=0.006$), than those who learned during clinical practice (Table 4).

4 | DISCUSSION

This study extends previous observations by Cramer et al.[8] on the modalities of tactile stimulation for AOP in different settings and confirms the high heterogeneity in stimulation location and technique among NICU healthcare providers. The strengths of our study include the multi-country design and the videorecording of the procedures, while the main limitation is the use of a manikin that cannot provide clinical information.

Overall, the most frequent stimulation modality was rubbing the back, followed by massaging or rubbing the feet. Given the lack of specific guidelines on the topic, we believe that the predominance of such modalities may mirror the tactile stimulation approaches that are recommended during neonatal resuscitation at birth.[11] We found heterogeneity in tactile stimulation within each hospital, but

TABLE 3 Comparison of stimulation location and technique by centre.

	HOSCO ($n=21$)	Tengandogo ($n=11$)	Maputo ($n=22$)	Brescia ($n=28$)	Padova ($n=30$)	p-Value
Location						
Back	3 (14%)	0 (0%)	18 (82%)	25 (89%)	22 (73%)	<0.0001
Chest	16 (76%)	11 (100%)	3 (14%)	5 (18%)	1 (3%)	<0.0001
Feet	13 (62%)	2 (18%)	15 (68%)	21 (75%)	30 (100%)	<0.0001
Hand	3 (14%)	1 (9%)	2 (9%)	1 (4%)	2 (7%)	0.70
Head	0 (0%)	0 (0%)	0 (0%)	1 (4%)	2 (7%)	0.72
Shoulder	0 (0%)	0 (0%)	0 (0%)	1 (4%)	3 (10%)	0.39
Technique						
Massage (massage, shake)	12 (57%)	1 (9%)	4 (18%)	11 (39%)	20 (67%)	0.0005
Press (press, squeeze, stroke)	11 (52%)	9 (82%)	4 (18%)	3 (11%)	2 (7%)	<0.0001
Rub	5 (24%)	2 (18%)	19 (86%)	26 (93%)	20 (67%)	<0.0001
Sting	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (7%)	0.39
Tickle (tickle, scratch, ting, tap, vibrate)	4 (19%)	1 (9%)	3 (14%)	9 (32%)	10 (33%)	0.29

Note: Data summarised as *n* (%). Some participants used multiple techniques and stimulated multiple locations; hence, the percentages may exceed 100% in the table.

TABLE 4 Comparison of stimulation location and technique by learning source.

		Training course ($n=42$)	Clinical practice ($n=70$)	p-Value
Location	Back	32 (76%)	36 (51%)	0.01
	Chest	12 (29%)	24 (34%)	0.67
	Feet	25 (60%)	56 (80%)	0.03
	Hand	2 (5%)	7 (10%)	0.48
	Head	0 (0%)	3 (4%)	0.29
	Shoulder	1 (2%)	3 (4%)	0.99
Technique	Massage (massage, shake)	11 (26%)	37 (53%)	0.006
	Press (press, squeeze, stroke)	9 (21%)	20 (29%)	0.51
	Rub	35 (83%)	37 (53%)	0.001
	Sting	0 (0%)	2 (3%)	0.53
	Tickle (tickle, scratch, ting, tap, vibrate)	12 (29%)	15 (21%)	0.49

Note: Data summarised as *n* (%). Some participants used multiple techniques and stimulated multiple locations; hence, the percentages may exceed 100% in the table.

also some differences among the hospitals. For example, stimulating the chest was the preferred approach in two of the five hospitals, despite this procedure may interfere with chest wall movements and respiration.

Of note, the differences among the hospitals may be partially due to the different participant characteristics. In addition, the source of learning for tactile stimulation may contribute to explain both intra- and interhospital heterogeneity. Compared with healthcare providers who learned how to provide tactile stimulation during clinical practice, those who learned during a training course preferred rubbing over massaging, and stimulated more frequently the back than the feet.

While tactile stimulation is currently used to reinstate breathing in apnoeic neonates, the pathophysiology of neural pathways involved in the respiratory centre remains unclear. One hypothesis about the effect of the tactile stimulation involves the triggering of cutaneous nerves that in turn activates the respiratory centre.[13,14] Another hypothesis refers to the activation of proprioceptors located where the tactile stimulation is performed, such as hands, feet or chest wall.[15,16] However, the effect of the tactile stimulation has been suggested to be related to the body location because of different sensitivity and concentration of skin receptors.[17]

5 | CONCLUSIONS

In conclusion, our study supported previous observations on the high variation in stimulation approaches adopted by healthcare providers to counteract apnoea in preterm infants. Large heterogeneity was found both in body location and hand movements during the

stimulation, and differed across the study centres. These findings may be partially explained by the lack of specific guidelines and the source of learning for tactile stimulation, and may be influenced by the approaches recommended in neonatal resuscitation. While AOP is common in NICU and requires prompt intervention to prevent long-term adverse outcomes, the decision about the stimulation approach is left to the healthcare provider. Future prospective studies may investigate the most appropriate approach for tactile stimulation in preterm infants to provide evidence-based guidelines.

AUTHOR CONTRIBUTIONS

Paul Ouedraogo was involved in investigation; methodology; writing—original draft; writing—review and editing. Paolo Ernesto Villani was involved in conceptualisation, supervision, data curation; investigation; methodology; writing—review and editing. Alessia Natalizi, Nicaise Zagre, Paula Alexandra Baltazar Rodrigues and Osara Lamoussa Traore were involved in supervision, data curation; investigation; methodology; writing—review and editing. Daniela Gatto and Emanuela Scalmani were involved in data curation; investigation; methodology; writing—review and editing. Giovanni Putoto was involved in conceptualisation; investigation; methodology; writing—review and editing. Francesco Cavallin was involved in data analysis; investigation; methodology; writing—original draft; writing—review and editing. Daniele Trevisanuto was involved in conceptualisation; investigation; methodology; writing—original draft; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors have no potential conflicts of interest to disclose.

ETHICS STATEMENT

The study was approved by the local Ethics Committtes of participating centers.

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