



# The respiratory physiotherapy causes pain in newborns? A systematic review

*A fisioterapia respiratória causa dor em neonatos? Uma revisão sistemática*

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## Abstract

**Introduction:** Neonatal respiratory physicaltherapy plays an important role in prevention and treatment of respiratory pathologies. In preterm neonates, immaturity of respiratory system can let development of various respiratory diseases. Meanwhile, it is discussed if respiratory physiotherapy can cause pain. **Objective:** Investigate presence of pain in neonates undergone to respiratory physiotherapy by a systematic review. **Methods:** Scientific search in electronic databases: Medline, Lilacs, Bireme, PEDro, Pubmed, Scielo and Capes thesis and dissertations base. Portuguese, English and Spanish, publication year from 2000 to 2012. **Results:** Thirteen studies were included, but one of them was excluded due to fulltext unavaiable. Therefore, twelve articles were included, nine (81,8%) confirm pain in newborn (NB), from these, in eight (72,7%) intervention was suction and in only one vibrocompression. Four articles studied term and premature newborns. Mechanical ventilatory assistance was used in seven of the studies analyzed. **Conclusion:** Results suggest that suction and vibrocompression were pain causers in NB. However, evidenced the necessity of well delineated methods to evaluate if physicaltherapy techniques can cause pain in neonates.

**Keywords:** Physical Therapy Modalities. Pain. Pain Measurement. Newborn. Neonatal Intensive Care.

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## Resumo

**Introdução:** A fisioterapia respiratória neonatal representa um papel importante na prevenção e tratamento das patologias de origem respiratória. Em neonatos pré-termos, a imaturidade do sistema respiratório pode levar ao desenvolvimento de várias doenças respiratórias. Porém, é discutido se a fisioterapia respiratória possa causar dor. **Objetivo:** Investigar a presença de dor em neonatos submetidos à fisioterapia respiratória por meio de uma revisão sistemática. **Métodos:** Busca científica nas bases eletrônicas de dados: Medline, Lilacs, Bireme, PEDro, Scielo e base de teses e dissertações da Capes, nas línguas portuguesa, inglesa e espanhola, ano de publicação de 2000 a 2012. **Resultados:** Treze estudos foram considerados elegíveis, porém um dos estudos foi excluído devido a indisponibilidade do texto na íntegra. Dos 12 trabalhos incluídos, nove (81,8%) comprovaram presença de dor em recém-nascidos (RN), destes, em oito (72,7%) a intervenção realizada foi a aspiração e, em apenas um, a vibrocompressão. Quatro artigos estudaram neonatos a termo e pretermo. A assistência ventilatória mecânica foi utilizada em sete dos estudos analisados. **Conclusão:** Os resultados sugerem que a aspiração e a vibrocompressão são causas de dor em RN. Entretanto, evidenciou a necessidade de métodos bem delineados para avaliar se as técnicas de fisioterapia podem causar dor em neonatos.

**Palavras-chave:** Modalidades de Fisioterapia. Dor. Medição da Dor. Recém-Nascido. Terapia Intensiva neonatal.

## Introduction

World Health Organization reveals that in every year about 15 million babies were born prematurely in the world. The increase in premature births in developing countries is related to the number of pregnant women with more advanced age and higher frequency of fertility medicines. Meanwhile in under developing countries, main cause include higher adolescent pregnancy rates, malaria, HIV and infections (1).

Brazil appears in 10th position in absolute numbers, with 279.3 thousand of premature births per year. The information system of living births (SISNAC) showed that the percentage of premature living births in 2010 was 7.1%, which corresponds to 204.299 living births (1). In preterm neonates, there is immaturity of respiratory system which can favour development of various respiratory pathologies, resulting in increased occupied beds in neonatal intensive care and multidisciplinary treatment, including physiotherapy (2).

Physiotherapeutic approach in face of these diseases represents an important role in prevention and treatment, acting in ambulatory, hospital and intensive care. The aims reached by physiotherapeutic procedures prioritizes pulmonary volumes and capacities normalized, increment in oxygenation and

gas changes, mobilization and elimination of pulmonary secretions, respiratory work reduction, increase of respiratory muscle endurance and strength and then, promote function respiratory independency, beyond preventing complications and motivate patient recovery (3, 4).

Among most used techniques in respiratory physiotherapy we can quote thoracic vibration, vibrocompression, forced expiratory flow technique (FEF), bag-squeezing, postural drainage (PD), suction, diaphragmatic stimulation, Rhinopharyngeal Retrograde Clearance (RRC), prolonged slow expiratory (PSE) and tapping (4, 5, 6, 7, 8, 9, 10, 11, 12, 13).

It is discussed if these techniques can or cannot cause pain, considering that neonatal pain deserves differential attention, thus these patients do not verbally express and its manifestations are distinct in other age bands. Until 60th decade suspected that newborns were not able to experience pain, because of lack of central nervous system myelination. Actually it is known that premature newborns present nociceptive neurophysiological paths (14). In pain stimulus presence despite chemical, thermal or mechanical occurred algogenic substances releases such as bradycinins, acetylcholine, serotonin, histamine and prostaglandins. Such substances unleash process that results in reduction of action potential limit of nociceptors (15, 16).

International association for pain study defines painful sensation as a sensorial emotional disgusting experience, associated to potential and or real tecidual lesion, being always subjective (5, 17). It is important to analyze if chest physiotherapy causes pain in neonates, once pain influences directly in stabilization and clinical evolution, having long term repercussions in family interactions, cognition and learning (5). Because of this subjective and newborn preverbal characteristics, specific methods to evaluate were created.

Among utilized methods showed up pain scales: behavioral pain scale, Neonatal Infant Pain Scale – NIPS, Neonatal Facial Coding System – NFCS, Premature Infant Pain Profile – PIPP, among others (13). These for this time, evaluate behavioral parameters (NIPS and NFCS), and its association to physiological parameters as heart rate and oxygen saturation (PIPP) (5, 10, 13, 18, 19, 20, 21, 22).

The practical dearth of this type of evaluation for physiotherapy team, added to reduced number of studies that evaluated pain in neonates during physiotherapeutic procedures justifying the aim to investigate if respiratory physiotherapy causes pain in neonates by a systematic review.

## Methods

Scientific articles search strategy includes: (a) electronic data base: *Medline*, *Lilacs*, *Bireme*, *Pubmed*, *PEDro*, *SciELO* and *Capes* thesis and dissertations base; (b) selection of key words utilized in review process through health science descriptors BIREME (DeCS) in Spanish, English and Portuguese languages: physical therapy modalities, pain, pain measurement, suction, neonate/newborn, neonatal intensive care; (c) publication year from 2000 to 2014; (d) types of study: clinical trial, randomized clinical trial, controlled clinical trial and meta-analysis.

Initial search was made by four of the researchers (CFZ, FRR, GML, JRF), then, it was realized again by three researchers (FRR, GML, LG), in independently and blinded way (23). After title and abstract reading, only those that evaluated any kind of relation between respiratory physiotherapy and pain in neonates were selected.

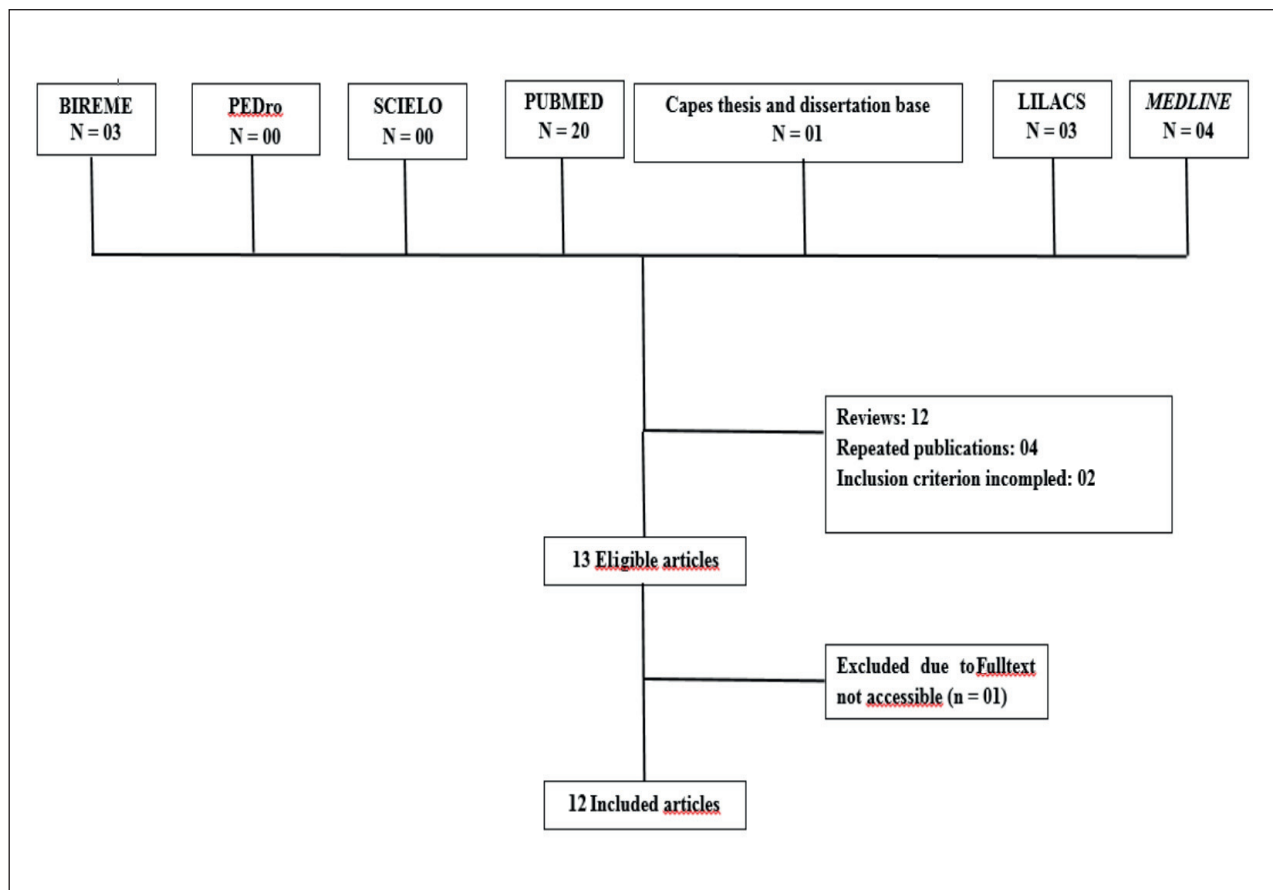
To evaluate studies methodological quality PEDro scale that is based in Delphi list was used. Delphi list originated from Delphi system that consisted in 206 items associated to studies quality. These items were reduced to nine by Delphi consensus technique. PEDro scale is composed by 11 criterion, only 2 criterions more than Delphi list (criterions 8 and 10) and final score is generated by the sum of ten of eleven criterions (24, 25, 26, 27). This score is realized for two independent evaluators, and in case of disagreement in any of the criterion, a third evaluator analyzed and decide the final score. Quality score range from 0 to 10 points. This scale is appropriated to physiotherapy studies (26, 27).

The following aspects are evaluated: 1) inclusion criterion specification; 2) study groups randomization; 3) true randomization; 4) groups homogeneity; 5) double blind; 6) independent evaluator for results; 7) measurement of at least a key result in more than 85% of subjects initially distributed among groups; 8) intention to treat analysis; 9) results description of comparison between groups; 10) presentation of variability measurements and point estimative for primary variable (25, 26, 27). Were considered of lower methodological expressivity articles that scored four or less (Category 1) and those that scored five or more, higher methodological expressiveness (Category 2) (28).

Kappa analysis was used to calculate inter examiner agreement, comparing results of evaluations that used PEDro scale (28). The concordance measured by Kappa is interpreted in this way: Kappa values < 0,10 - absence concordance; from 0,11 to 0,40 low; from 0,41 to 0,60 discreet; from 0,61 to 0,80 moderate; 0,81 to 0,99 substantial and 1,00 perfect concordance (29). Mann Whitney test was used for medians of evaluators scores comparison, considered as significance level  $p < 0,05$ . Statistical package *Social Package for Social Science* (SPSS) version 8.0 and the program of Statistics and Epidemiology laboratory were used (30, 31).

## Results

After analysis of scientific articles, thirteen studies were eligible, but one of the studies was unavailable and was excluded. Figure 1 presents selection of included studies fluxograma.



**Figure 1** - Flowchart of selected studies.

From twelve selected articles, nine observed pain unleashed by procedures in neonates, in eight the intervention was suction (10, 11, 12, 19, 20, 21, 32). Thoracic vibrocompression technique was described as potentially painful in another study (13), while techniques as vibration, diaphragmatic stimulation, postural drainage associated to others techniques, passive respiratory exercises associated to neonate positioning, bag-squeezing, forced expiratory flow and thoracic physiotherapy do not resulted in pain in six analyzed studies (5, 13, 18, 20, 22).

Pain measurements included behavioral and or physiological evaluation scales. Behavioral scales used were Neonatal infant pain scale (NIPS), neonatal facial coding system (NFCS), premature infant pain profile (PIPP). Six articles used some of these scales and physiological parameters, four utilized NIPS scale (19, 20, 32) and two NFCS (21, 22).

Another study applied PIPP scale and two only NIPS (5, 10, 18). Beyond this, two pain scales were used together, NIPS and NFCS, as described in one article (13).

In two articles only the following physiological parameters were evaluated: heart rate (HR), respiratory rate (r), oxygen peripheral saturation (SpO<sub>2</sub>) and pulse frequency (P) (11, 12). Two articles investigated only HR and SpO<sub>2</sub> (21, 22), four articles beyond these parameters observed respiratory rate (18, 19, 31). While two articles, beyond HR, r and SpO<sub>2</sub> evaluated P (11, 12).

Investigation of HR and P is considered equal parameters, but according to literature, there is difference among their values.

The main data of these studies are summarized in Table 1.

(To be continued)

**Table 1** - Main data from selected studies

AUTHOR/ YEAR	PEDro MEDIA/ TYPE OF STUDY	SAMPLE	ANALYZED VARIABLES (EVALUATION INSTRUMENTS)	INTERVENTION	MAIN OUTCOMES
Falcão LFM 2007 (14)	Transversal and prospective	60 NB	Pain (NIPS and NFCS)	Diaphragmatic stimulation oral or manual vibrocompression TA: 3 times of 5 s each	Primary: - Pain (NIPS > 3): 53% (p = 0,0199) during thoracic vibrocompression
Falcão FRC 2008 (21)	7/ Randomized clinical trial	13 NB	Pain (NFCS) HR and SpO2	Tracheal suction with or without contention TA: 10 s	Primary: - 23% contentend patients felt pain; - 92% non contented patients felt pain (p = 0,0015).
Nicolau CM 2008 (5)	Longitudinal prospective of case series	30 NBPT	Pain (NIPS)	Vibration; postural drainage; passive respiratory exercise; SAW and ETT suction.	Primary: - Pain before physiotherapy: 19,1%; - Pain after suction: 71,6% (p < 0,001).
Nicolau CM 2008 (32)	Longitudinal prospective of case series	50 NBPT	Pain (NIPS); r (chronometer), HR and SpO2 (pulse oximetry)	Endotracheal suction	Primary: - Pain at T1: 52%; - Pain at T5: 40% (p < 0,05) Secondary: - SpO2 < 90%: 20% NB.
Moran CA 2009 (18)	4/ Double blind clinical trial	06 NBPT	Pain (NIPS)	- Vibration; FEF; - ETT and SAW suction; -Tatil stimulation;	Primary: - T and T1 without pain (p = 0,312).
Castro ACL 2010 (19)	Observational quantitative and transversal cohort	09 NBPT	Pain (NIPS); r; HR, SpO2 (monitor)	Endotracheal suction	Primary: - Pain: 25% (p = 0,00) Secondary: - ↑ HR (p = 0,01); ↑ r (p = 0,32); ↓ SpO2 (p = 0,83);
Lanza FC 2010 (22)	Transversal	NBPT	Pain (NFCS), HR, SpO2, r	Vibration TA: 20 min	Vibration: no pain neither physiological parameters changes (p < 0,05).
Araújo MC 2010 (10)	Exploratory field research, observational and non- participative	10 NBPT	Pain (PIPP)	Tracheal cannula suction	Primary: - Pain during suction: 70% NBPT
Leal SS 2010 (20)	Analytical, observational transversal cohort	60 NBPT	Pain (NIPS); HR, SpO2 (monitor) and r .	Vibrocompression; - Bag-squeezing; - FEF; - OTT suction. TA: 3 min each technique	Primary: Pain: - Before: 9 NBPT; - During: 38 NBPT; - After: 14 NBPT (p = 0,05); Secondary: ↑ HR (p < 0,05).

**Table 1** - Main data from selected studies

Brazil TB 2010 (11)	Quantitative, transversal e descriptive exploratory	56 NB	HR (neonatal stethoscope), r (direct observation), SpO2 (pulse oximetry monitor).	OTT suction	Secondary: - During At: SpO2: ↓ 9 NB (17,3%) - Immediately after At: HR ↑ 20 NB (35,7%); r ↑ 13 NB (23,2%); Pulse ↑ 18 NB (32,1%).
Barbosa AL 2011(12)	Longitudinal, quantitative	104 NB	HR (chronometer), r (observation), SpO2 and P (pulse oximetry monitor)	OTT suction	Secondary: Oxi-Hood (Oxygen hood): - T0, T1 and T5 ↓ r (p = 0,002); T1: ↑ HR (p = 0,006); T5: ↓ HR (p = 0,006). CPAP: - T5 ↓ r (p = 0,009); T1 ↑ HR (p = 0,017). Oxi-Hood (p < 0,0001), CPAP (p = 0,04) and MV (p = 0,002)
Martins R 2013 (17)	7/ Blinded randomized clinical trial	60 NBPT	Pain (NIPS, NFCS e PIPP) HR, SpO2, f (cardio respiratory parameters)	G1 – Rest G2 – mechanical vibration and manual compression AT: 10 minutes each G3 – Four modalities method TAR TA: 5 min each	Primary: - Pain: NIPS at G2 group just after intervention. PIPP at G2 group following conventional physiotherapy.

Note: NB: Newborn; NBPT: newborn preterm; NIPS: Neonatal Infant Pain Score; NFCS: Neonatal Facial Coding System; PIPP: Premature Infant Pain Profile; OTT: or tracheal tube; SAW: superior airways; HR: heart rate; r: respiratory rate; SpO2: oxygen peripheral saturation; P: pulse frequency; T: before procedure; T0: during procedure; T1: immediately after procedure; T5: five minutes after procedure; At: tracheal suction; MV: mechanical ventilation; FEF: forced expiratory flow; G1: control group; G2: conventional physiotherapy; G3: thoracoabdominal rebalance (TRA); TA: application time.

Studied population constitute of premature newborns interned in NICU in seven articles (5, 10, 18, 19, 20, 22, 32). Four articles studied term and preterm newborns (11, 12, 21). Mechanical assisted ventilation (MAV) was used in seven studies, in three of them they do not specified the MVA type (5, 13, 32). Two forms of mechanical ventilation (invasive and non-invasive) were described in two studies (11, 12).

Articles media score that were analyzed for two evaluators by PEDro scale is included in box I. Articles score was divided in two categories. Based in this division, it was possible classified four articles in category 1 and seven articles in category 2, with agreement inter both examiners.

Concordance analysis inter examiners showed perfect concordance (Kappa = 1,0; p = 0,001) according to

Table 2. Medians distribution of examiners scores do not differed significantly (p = 0,972).

**Table 2** - Concordance analysis inter examiners

Kappa value	1.0
p value	0,0010
95% Confidence interval	1.0 - 0,49

## Discussion

This literature systematic review points to presence of pain during procedures of suction, vibrocompression and manual vibration. Suction is used to bronchial

hygiene, indicated when physiological response for secretion removal do not act adequately. It is potentially painful because it is an aggressive procedure that causes discomfort and anxiety (21). Beyond, suction can promote reduction of volume, pulmonary ventilation and oxygen saturation by hemoglobin in children submitted to mechanical ventilation, due to suction catheter introduction, interruption in oxygen supply and gas removal due to negative pressure application, Nicolau et al. verified that suction adverse effects can overcome benefits effects (33, 34).

Vibrocompression is a technique that imposes higher thoracic pressure added to a vibration stimulus, providing a higher stress stimulus to neonates, which could explain the higher presence of pain during and after this procedure according to Falcão et al. (13).

Others techniques such as vibration, diaphragmatic pressure, postural drainage associated to others techniques, passive respiratory exercises associated to neonate positioning, bag-squeezing and FEF do not resulted in pain in the analyzed studies. These findings are suitable to Selestrin et al.'s results, that verified neonatal respiratory physiotherapy do not cause physiological repercussions in the population studied. Emphasized that bronchial hygiene maneuvers are contraindicate in preterm neonates with weight lower than 1.500g in the first three days of life due to higher instability and intracranial hemorrhage possibility. In this population, it is viable positioning with the aim to improve thoracoabdominal biomechanics and respiratory function without risks of hemorrhages (34).

Painful stimulus or distress presence instable the neonate considering cardiovascular, respiratory and metabolic components (20, 34). This fact can be observed in mechanical ventilated NBE which is also a stress and pain factor unchained. Independently of others invasive procedures, mechanical ventilation unleashes stress hormone discharge. Among them features: adrenaline, noradrenaline, cortisol, aldosterone, glucagon, growth hormone and insulin production suppression, with substrate mobilization as protein, lipid and carbohydrates. Hormone biochemical dose can be a method used to pain evaluation in this population (35). In the present work, premature neonates constitute the frequently studied population among analyzed articles. This fact can be explained due to an extensive internment period in which the referred population is submitted, constantly exposed to potentially painful procedures and its hurtful effects (5).

Actually it is known that nociception neurophysiological ways (A-delta and C fibers) are present in premature, but until third gestational trimesters, fibers C synaptic connections are immature. Therefore, central nervous system uses temporally A-beta fibers to painful stimulus transmission (5, 14, 16, 36, 37). Receptors low activity and inhibitory synaptic neurotransmissions reduced levels turn pain perception in neonates more intense than older children and adults, resulted of pain control inhibitory immature mechanisms (38).

Pain expression in neonates is a nonverbal language, turning necessary interpretation. Cry is a neonatal communication when there is distress. Nevertheless, it is only useful for pain measurement when associated to others parameters. Facial mimic is an important parameter, in pain presence, occur more expressive facial movements. These two behavioral parameters are considered the main parameters during pain analysis (39, 40).

Based on this, emerge the need of multidimensional scales implementation as a routine procedure in neonate pain evaluation. Falcão et al. verified the importance of multidimensional method described and validated for pain characterization. NIPS is useful for term and preterm pain evaluation, distinguishing painful and non-painful by six pain indicators, five behavioral and one physiological. In this review, the method frequently used for pain evaluation was NIPS in 54.5% of the studies. It was used as a single measurement method or associated to others scales and physiological parameters (39, 40, 41).

Painful stimulus modify behavioral parameters and a series of physiological parameters in neonates such as HR, SpO<sub>2</sub> and r. There are controversy in the literature about changes in these parameters after respiratory physiotherapy techniques application, whereas variation in these parameters can occur due to hungry, cry, distress, anxiety and installed pathology, besides pain (39). Antunes et al. compared effects of conventional respiratory physiotherapy versus forced expiratory flow, observing increases in HR, SpO<sub>2</sub> and r remains unchangeable (6). Counterpart, Selestrin et al. evaluated physiological parameters in mechanical ventilated preterm neonates after neonatal physiotherapy procedures, they found HR and f reduction (2).

This systematic review points to HR increase and SpO<sub>2</sub> reduction after neonatal physiotherapy. The findings related to f behavior were controversial in evaluated articles. Among physiotherapy techniques studied, suction was the main cause of physiological changes.

This research had some limitations: lack of studies that related respiratory physiotherapy and pain, difficulty in study this population due to ethical reasons and pain subjectivity. Other limitations were the lack of reports about airway clearance such as RRC, PSE and tapping, but are largely used in clinical practice. It shows need of scientific evidence correlating these techniques with neonatal pain. Besides, PEDro scale allow evaluate randomized clinical trials. In this review, from twelve analyzed studies, only three (17, 18, 21) were classified as randomized clinical trial reinforcing lack of studies about this topic. PEDro scale evaluation pointed to exiguity of scores in criterions 2, 3, 6 and 7, respectively related to group randomization, blind of subjects, therapist and examiners. This fact corroborate to ethics limitations and peculiarities in studying neonates showing the need of higher methodological studies.

## Conclusion

In front of the exposed, we conclude that suction and vibrocompression were the techniques pain causers in the studied population, evidencing necessity of other studies, with well delineated methods that evaluate relation of these techniques and pain aiming establish neonatal physiotherapy risk benefit in premature due to fragility of this population.

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