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REVIEW ARTICLE

Sensorial saturation and neonatal pain: a review

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ABSTRACT

Aim: Sensorial saturation (SS) is an analgesic approach to babies' pain that includes three types of stimulations: oral sugar, massage and caregivers' voice. The aim of this review is to assess its efficacy.

Methods: We performed an analysis of scientific literature from 2001 to 2017, retrieving those clinical trials where SS had been compared with other analgesic treatments during procedural pain in babies.

Results: We retrieved 14 studies. Pain sources were heel-prick in nine, eye examination and intramuscular shots in two each, and endotracheal aspiration in one. SS was the most effective treatment in all cases, except in endotracheal suctioning. No drawbacks were reported in any study using SS.

Conclusion: SS is a safe and effective approach to neonatal pain due to heel-prick, more effective than oral sucrose or glucose in both term and preterm babies; it seems also effective in other types of acute procedural pain like eye examination or intramuscular injections, but more studies are needed to confirm these preliminary data. More studies are also needed to test SS efficacy for other procedures, and for older infants.

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Analgesia; newborn; pain; preterm; sensorial saturation

Introduction

Babies undergo many painful stimulations when in hospital, and most are due to procedural treatments. Recent advances in neonatology have shown that this kind of pain can have detrimental effects on the development of their central nervous system [1,2]. Many efforts have been done to find safe and sound analgesic treatments for procedural pain. General analgesics are not an answer because they have drawbacks that seem disproportionate to the risk due to this kind of pain [3]. Topic treatments are a good answer for some of these procedural pains, but not for all. A non-pharmacological approach to neonatal pain with oral sucrose has been proposed and has been found not completely analgesic [4], so combined approaches have been tried, such as breastfeeding [5], a combined use of facilitated tucking and oral sucrose [6], or a particular technique called sensorial saturation (SS) [7].

SS is composed of three stimuli, called "3T": taste (oral sugar), touch (massage of the baby), and talk (attracting the baby's attention with words) [7]. These stimulations should start before the painful intervention and cease only after its end (Table 1).

SS is supposed to work through two mechanisms: a descending inhibition due to the gentle stimuli (massage and oral sugar) that induce the activation of inhibitory pathways and production of endorphins [8]; and an inhibition of the painful stimulus in the spine chord, through intermediate interneurons that act as a gate for pain, called "gate control" [9]. SS has been described with other names beyond the original one, e.g. "multisensory stimulation", "sensory saturation" [10].

The aim of this paper is to review the available evidence on SS and to assess its analgesic effectiveness in term and preterm neonates.

Materials and methods

Using the PRISMA sequence (Table 2), we retrieved papers on the use of SS in term and preterm newborns, published in PubMed database from January 2001 to January 2017. We used as keywords: "Sensorial Saturation", "Multisensory stimulation", "Pain", and "Newborn". Exclusion criteria: reviews, editorials and those trials that used an incomplete form of SS, although based on a multisensory stimulation. Inclusion criteria: clinical trials that compared a

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complete form of SS with other analgesic treatments or with placebo.

Results

We excluded those trials where an incomplete form of SS was used [11–15]. We retrieved 14 papers [16–29] that compared the effect of SS in its complete form (the 3Ts) with other analgesic methods (Table 3). Eight studies included preterm, and six included term babies. Nine studies used the heel-prick as painful stimulus, two the eye examination, and two the intramuscular injection; one used endotracheal suctioning as painful stimulus. SS was compared with 33% oral glucose in four studies on term babies (in one, oral glucose was also associated with non-nutritive suction), with 10% oral glucose in two studies on preterm babies (in one, oral glucose was also associated with non-nutritive suction), with oral 12% sucrose in one study on preterm babies, and with fentanyl in one study on preterm babies. SS was more effective than other analgesic approaches in all trials where heel-prick, intramuscular injections or eye examination were the source of pain, when compared with placebos or with the above analgesic interventions. SS was not analgesic enough if two stimulations only were used (touch and talk, but not oral sugar) [17] and it was ineffective against pain due to endotracheal suctioning [21]. SS was effectively performed by mothers with the same effectiveness than when performed by nurses [20]. No drawbacks were reported in any study using SS.

Table 1. The steps of sensorial saturation

1.	Talk to the baby to grab his/her attention
2.	Massage his/her face while administering some drops of sugar-in-water on the tongue, to obtain a regular sucking
3.	Perform the heel-prick only when the baby focuses on sucking with regular suction
4.	Continue throughout the procedure

Discussion

This review of the literature showed that SS is effective in holding the unpleasant effects of the heel-prick

Table 2. PRISMA 2009 flow diagram.

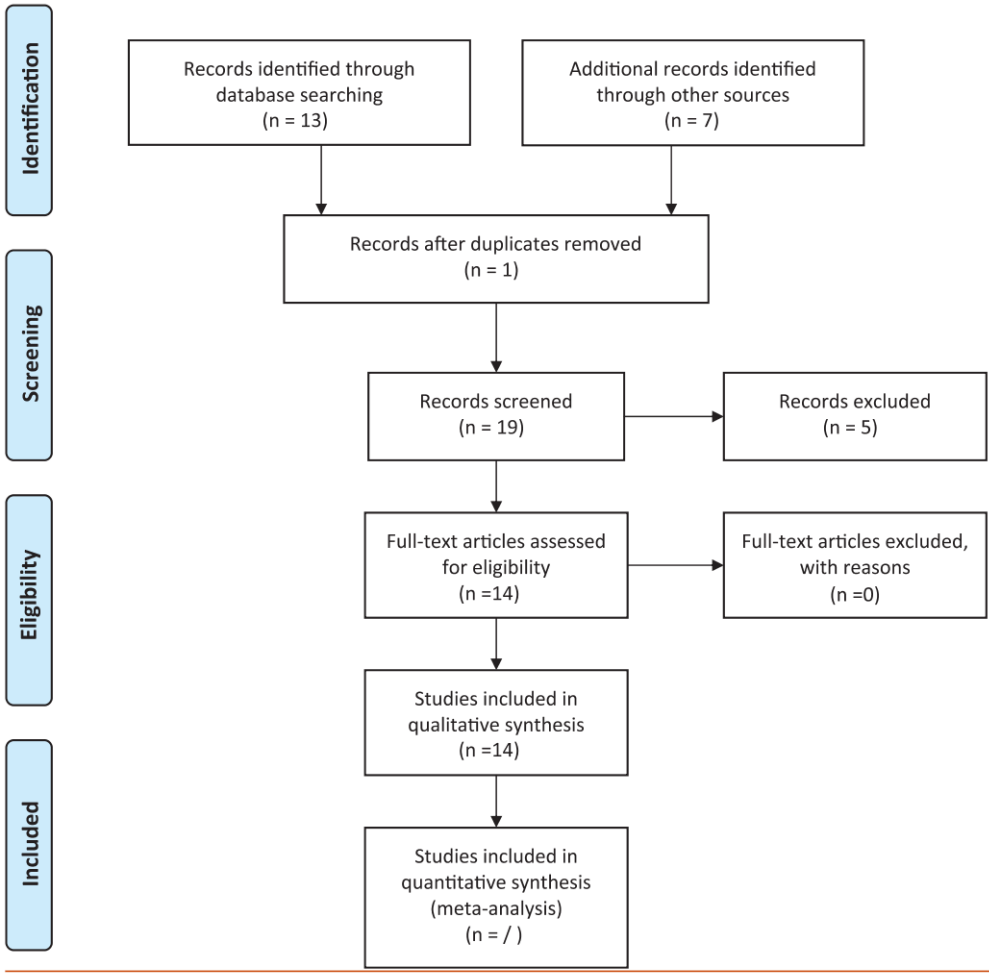

Table 3. Scheme of the 14 trials retrieved for this review.

Ref no.	Procedure	Enrolled infants (*n*)	Term preterm babies	Pain scale	Analgesic treatment	Mean value and SD	Mean value and SD.
Bellieni [16]	Heel-prick	85	Preterm	PIPP	Null	11.1 ± 2.5	
					Oral glucose 10%+suction	6.8 ± 2.2	
					SS	4.1 ± 1.4	
					Oral glucose 10%	8.2 ± 1.9	
					Suction	9.0 ± 2.8	
Bellieni [17]	Heel-prick	120	Term	DAN°	Null	**9 [5–10]**°	25.2 ± 3.1°°
				Crying time (s)°°	Oral glucose 33%	**10 [1–10]**°	22.8 ± 4.5°°
					Suction	**7 [4–10]**°	18.6 ± 3.5°°
					Oral glucose 33%+suction	**4 (0–10)**°	8.1 ± 2.8°°
					SS	**9 [2–10]**°	2.9 ± 1.8°°
					SS without oral glucose	**1 é0-6)**°	21.5 ± 4.6°°
Bellieni [18]	Heel-prick	51	Preterm	ICP (cm H_2O)	Oral glucose 10%	26.22 ± 2.73	
					SS	11.75 ± 7.48	
Bellieni [19]	Heel-prick	17	Preterm	Crying time (sec)	Null	**24 [18.32–27.68]**	
					Oral glucose 10%+suction	**5 [0–8.71]**	
					SS	**0 [0–0.68]**	
Bellieni [20]	Heel-prick	66	Term	ABC	SS (m)	0.6 ± 0.38	
					SS (n)	0.6 ± 0.22	
					Oral glucose 33%	1.7 ± 0.32	
Cignacco [21]	Endotracheal suctioning	30	Preterm	VAS PIPP BPSN	SSRaw data are not available, but the difference between the two groups is reported as "not significant"		
					Holding the baby		
Gitto [22]	Heel-prick	150	Preterm	CRIES	Fentany	l4.71 ± 3.8	
					Facilitated tucking	9.33 ± 5.1	
					SS	4.39 ± 3.6	
Bernardini [23]	Heel-prick	28	Preterm	PIPP	Null versus SS	a) 14.69 versus 6.52 (SD not available; $p < .001$)	
					Null versus oral glucose 33%	b) 16.13 versus 13.80 (SD not available; $p < .05$)	
Rivara Davila [24]	Intramuscular injection	167	Term	DAN	Null	9.02 ± 1.4	
					Breastfeeding	4.15 ± 2.6	
					SS	3.02 ± 2.5	
Bellieni [25]	Intramuscular injection	62	Term	DAN	EMLA topic cream	5.6–6.5	
					Oral glucose 33%	1.4–2.3	
					SS	0.6–1.2	
Di Ventura [26]	Heel-prick	2.720	Term	NIPS	Oral sucrose 12%	4.77 ± 2.1	
					SS	0.7 ± 1.3	
Zeraati [27]	Eye examination	80	Preterm	PIPP	Null	6.4 ± 2.5	
					SS	2.8 ± 2.6	
Zeraati [28]	Eye examination	80	Preterm	SaO_2	Null	90.1 ± 2.0	
					SS	92.6 ± 3.5	
Perrone [29]	Heel-prick	83	Term	AOPP*DAN**	Oral glucose 33%	1.76 ± 1.13*	3.11 ± 1.61**
					SS	1.38 ± 0.87*	0.42 ± 0.85**

Median value and CI are reported in bold font. CI: confidence interval; Null = control group with no analgesia. SD: standard deviation; SS: sensorial saturation; SS(m): sensorial saturation administered by mother; SS(n): sensorial saturation administered by nurse; PIPP: premature infant pain profile; ICP: intracranial pressure; DAN: Douleur Aiguë du Nouveau-né scale; ABC Scale: Acuteness, bursts and continuity of the crying; BPSN: Bernese Pain Scale for Neonates; VAS: Visual Analogue Scale; AOPP: advanced oxidation protein products; NFCS: Neonatal Facial Coding System; NIPS: Neonatal Infant Pain Scale; CRIES: CRIES scale. ° and °° symbols are referred to the two different types of pain assessment employed in that study, as well as * and **.

beneath the pain threshold in term and preterm babies; it is more effective than other procedures, among which oral sucrose or glucose; it also is effective as an analgesic tool for eye examination and for intramuscular injections. In the case of intratracheal suctioning [21], SS was not effective; this can be due to the fact that the endotracheal aspiration in intubated baby should not trespass the end of the endotracheal tube, so it is supposed not to touch the mucosa; thus, it can be distressing but not actually painful. "Incomplete SS" – namely using talk, touch, but not oral sugar – is not effective; this means that oral sugar is fundamental for the SS effect; nonetheless, SS is more effective than oral sugar alone [16,17], and this can mean that touch and talk act amplifying the analgesic effect of sugar.

A limitation of the studies performed on SS is that they can hardly be actually blinded, because the actions required in SS are visible and cannot be masked. The only attempt to mask them was done performing SS with water instead than glucose [17]: this gave a possibility to the scorer of ignoring if a "complete" or "incomplete" version of SS was being performed. Additional studies are necessary to test SS

in other clinical procedures; in particular, studies on vein and artery blood sampling, as those on procedures where SS can actively cooperate with pharmacological analgesia, such as circumcision or rachicentesis. Data show that parents can vicariate nurses in performing SS [20] and this has two main advantages: first, parents are active promoters of their babies' care, and second, this allows nurses – when they are not supported by colleagues – to perform accurately a painless blood sampling; moreover, this actively involves parents in their babies' care.

Modern neonatal care highlights that mother's presence and contact should be implemented and supported [30] and SS is a safe and useful way to do it: "SS, similar to the NIDCAP (Newborn Individualized Developmental Care and Assessment Program) interventions, involves focused human attention and sincere commitment to the infant's comfort. In doing so, it expresses empathy for infants who are undergoing painful experiences during neonatal intensive care" [31]. An improvement of pain assessment [32] and a better treatment of painful events are mandatory, and SS is a promising step in this road.

Disclosure statement

No potential conflict of interest was reported by the authors.

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