



## Development of atraumatic heel-stick procedures by combined treatment with non-nutritive sucking, oral sucrose, and facilitated tucking: A randomised, controlled trial



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### ABSTRACT

**Background:** Preterm infants manifest pain and stress by behavioural agitation and state change. Few studies have explored the effects of combining nonpharmacological interventions, i.e. non-nutritive sucking, oral sucrose, and facilitated tucking, on infants' behaviours across painful procedures.

**Objectives:** To explore the effects of combined use of three nonpharmacological interventions (non-nutritive sucking, oral sucrose, and facilitated tucking) on infants' pain- and stress-related behaviours during four assessment phases: baseline, intervention, heel stick, and recovery.

**Design:** Prospective, randomised controlled trial.

**Setting:** Level III neonatal intensive care unit in Taipei.

**Method:** A convenience sample of 110 infants (gestational age 27–37 weeks) needing heel sticks was randomly assigned to five combinations of nonpharmacological treatments: (1) routine care, (2) non-nutritive sucking + facilitated tucking, (3) oral sucrose + facilitated tucking, (4) non-nutritive sucking + oral sucrose, and (5) non-nutritive sucking + oral sucrose + facilitated tucking. Outcomes were infants' withdrawal or stress (*grimace, limb and trunk extension or squirming*) and approach or self-soothing (*sucking, sucking search, or mouthing; hand holding or grasping; and hand to mouth, face*) behaviours.

**Results:** The frequency of infants' withdrawal behaviours decreased significantly when they received combinations of nonpharmacological interventions before heel stick. Specifically, *grimace* frequency decreased by 32.2%, 30.6%, 19.7%, and 13.8% in infants receiving oral sucrose + non-nutritive sucking + facilitated tucking, non-nutritive sucking + oral sucrose, oral sucrose + facilitated tucking, and non-nutritive sucking + facilitated tucking, respectively, compared to those receiving routine care across assessment phases. Furthermore, infants' frequency of *limb and trunk extension or squirming* decreased by 24.0% when they received non-nutritive sucking + oral sucrose + facilitated tucking compared to those receiving routine care. Infants' frequency of approach behaviours did not change significantly across all phases when they received non-nutritive

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sucking + oral sucrose + facilitated tucking, non-nutritive sucking + oral sucrose, and oral sucrose + facilitated tucking compared to those receiving routine care.

**Conclusions:** The combined use of nonpharmacological interventions (non-nutritive sucking + oral sucrose + facilitated tucking) effectively reduced the frequencies of infants' withdrawal behaviours, i.e. *grimace* and *limb and trunk extension or squirming*. Our results provide evidence supporting clinicians' incorporation of the combined use of facilitated tucking, oral sucrose, and non-nutritive sucking into clinical practice during painful procedures. Heel-stick procedures can be atraumatic when conducted while infants are stable and quiet, appropriately positioned, and stabilised and by offering facilitated tucking, oral sucrose, and non-nutritive sucking before gently sticking the heel and squeezing blood.

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## What is already known about the topic?

- Non-nutritive sucking with sucrose is more effective than non-nutritive sucking alone in relieving infant pain during heel-stick procedures as measured by the Premature Infant Pain Profile.
- Facilitated tucking used in combination with oral sucrose has added value in lowering infant pain as measured by the Bernese Pain Scale for Neonates.
- Combinations of supportive interventions (facilitated tucking, non-nutritive sucking, positioning, swaddling, and touch) significantly attenuated pain and hypoxic events during diaper change and stress behaviours during weighing procedures.

## What this paper adds

- Combining non-nutritive sucking, oral sucrose, and facilitated tucking more effectively reduced the frequency of infants' stress-related or withdrawal behaviours (*grimace* and *limb and trunk extension or squirming*) than routine care across heel-stick procedures.
- Frequencies of approach behaviours did not significantly increase or decrease in infants receiving any combination of non-nutritive sucking, oral sucrose, and facilitated tucking, as compared with those receiving routine care.
- The frequency of infants' approach or self-soothing behaviours did not change significantly while receiving any combination of non-nutritive sucking, oral sucrose, and facilitated tucking compared with those receiving routine care.
- Heel-stick procedures were atraumatic when conducted while infants were stable and quiet, comforted, appropriately positioned, and stabilised, and when they received facilitated tucking, oral sucrose, and non-nutritive sucking while gently sticking the heel and squeezing blood.

## 1. Introduction

Fifteen million infants worldwide are born prematurely each year, with nearly half a million born in the United States (March of Dimes, 2013). In Taiwan, nearly 166,000 infants were born prematurely (from 20 to 37 weeks gestation) from 2001 to 2009, with a significant increase in

the premature rate over this period (Wang et al., 2014). Among premature infants born worldwide, more than 1 million died in the first month due to complications (March of Dimes, 2013). Preterm birth is now the single most important cause of neonatal deaths and the second leading cause of death in children under 5 years old (Lawn et al., 2010). These fragile infants need to receive specialised care and treatment to meet the goal of reducing child mortality in the 21st century (United Nations, 2013). While receiving specialised care in a neonatal intensive care unit (NICU), these immature infants are repeatedly exposed to hundreds of painful caregiving procedures (Carbajal et al., 2008; Newnham et al., 2009).

Accumulated pain and stress can harm the premature infant brain by increasing intracranial pressure and oxygen desaturation (Grunau et al., 2006; Hall and Anand, 2005), generating free radicals that can damage fast-growing brain and lung tissues as well as neuronal membranes (Bellieni et al., 2009; Saugstad, 2005). Thus, premature infants are at risk of severe health problems and disabilities such as retinopathy, chronic lung disease, and periventricular leukomalacia (Robertson et al., 2009; Sun et al., 2009). These conditions motivated us to design supportive interventions to provide atraumatic care procedures that promote preterm infant health (Als, 1999; Hockenberry and Wilson, 2011). Atraumatic care refers to therapeutic care or interventions that eliminate or minimise psychological and physical distress experienced by children and their families (Hockenberry and Wilson, 2011). The principles of atraumatic care can be extended to paediatric care by using topical anaesthetics for needle procedures (Ellis et al., 2004) and obstetric care through relaxation and comfort techniques (Jones et al., 2012).

Our framework for understanding preterm infant behaviours was Als' synactive theory of development, which proposes that these infants interact with their environment through five subsystems: physiological, motor, states, attention/interaction and self-regulatory (Als, 1999). Physiological subsystem functions can be observed by skin colour, tremors/startle, and respiratory rate. Motor system functions are seen in infants' muscle tone, movement patterns, and postures. Infant states are categorised by their central nervous system arousal, e.g. sleepy/drowsy, awake/alert and fussy/crying. Attention/interaction functions represent infants' interactive availability and level of alertness. Self-regulatory functions

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