



## ORIGINAL ARTICLE

# Clinicians guide for cue-based transition to oral feeding in preterm infants: An easy-to-use clinical guide

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**Abstract**

**Rationale, aims and objectives** This article aims to provide evidence to guide multidisciplinary clinical practitioners towards successful initiation and long-term maintenance of oral feeding in preterm infants, directed by the individual infant maturity.

**Method** A comprehensive review of primary research, explorative work, existing guidelines, and evidence-based opinions regarding the transition to oral feeding in preterm infants was studied to compile this document.

**Results** Current clinical hospital practices are described and challenged and the principles of cue-based feeding are explored. "Traditional" feeding regimes use criteria, such as the infant's weight, gestational age and being free of illness, and even caregiver intuition to initiate or delay oral feeding. However, these criteria could compromise the infant and increase anxiety levels and frustration for parents and caregivers. Cue-based feeding, opposed to volume-driven feeding, lead to improved feeding success, including increased weight gain, shorter hospital stay, fewer adverse events, without increasing staff workload while simultaneously improving parents' skills regarding infant feeding. Although research is available on cue-based feeding, an easy-to-use clinical guide for practitioners could not be found. A cue-based infant feeding regime, for clinical decision making on providing opportunities to support feeding success in preterm infants, is provided in this article as a framework for clinical reasoning.

**Conclusions** Cue-based feeding of preterm infants requires care providers who are trained in and sensitive to infant cues, to ensure optimal feeding success. An easy-to-use clinical guideline is presented for implementation by multidisciplinary team members. This evidence-based guideline aims to improve feeding outcomes for the newborn infant and to facilitate the tasks of nurses and caregivers.

**KEYWORDS**

clinical guidelines, evidence-based medicine, patient-centered care, practical reasoning

## 1 | INTRODUCTION

The aim of this paper is to discuss the evidence underlying the initiation and successful maintenance of oral feeding in preterm infants based on infant feeding cues. This includes physiological and developmental factors to be considered in the management of infant feeding, as well as practical (clinical) aspects of feeding advancement towards full oral feeding, while considering nutritional needs, without elaborating on

nutritional requirements. The latter falls beyond the scope of this article, since it focuses on the "how and when" of oral feeding.

Attaining full oral feeding is an important milestone for preterm infants, since it is a major discharge criterion indicating maturity<sup>1-4</sup> and health of the preterm infant.<sup>5</sup> However, the acquisition of safe and efficient nipple feeding skills is a complex task and 1 of the most challenging milestones for most preterm or high-risk infants to achieve.<sup>1,6</sup> Preterm infants are especially at risk of feeding failure.

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When compared to full term infants, preterm infants' transition to full oral feeds are complicated by innate differences in muscle tone, state regulation, endurance, and independent or interdependent suck-swallow-breathe coordination.<sup>7,8</sup> Prematurity can further disrupt brain development, leading to decreased myelination and white matter disturbances<sup>9</sup> as well as disrupting the development of a specialized neural circuit known as the suck central pattern generator (sCPG), often resulting in poor feeding skills.<sup>10</sup> In addition, preterm infants have higher nutritional requirements per kilogram than term infants and are less tolerant of high fluid volumes.<sup>11</sup>

Feeding challenges place these vulnerable infants at risk for prolonged hospitalization and readmissions after discharge.<sup>12</sup> Poor feeding is a common reason for readmission to hospital within 2 weeks after neonatal intensive care unit (NICU) discharge, especially in infants born between 34 and 37 weeks postconceptual age. These late preterm infants are more prone to poor oral feeding because of medical issues, such as respiratory distress, jaundice, hypoglycaemia, and temperature instability.<sup>13</sup> Respiratory distress can be highlighted as a challenging condition influencing feeding, as preterm infants often experience physiological instability and need assistance from caregivers to maintain adequate oxygenation during the time when their oral feeding skills are developing. This assistance towards optimal oxygenation during oral feeding requires an understanding of how the infant expresses and aims to self-regulate his or her oxygen status.<sup>14</sup> Therefore a skilled and observant caregiver is essential to assist the infant in a pleasurable feeding experience that maximizes intake and minimizes stress.<sup>7,14</sup>

Apart from acquiring physical skills towards oral feeding, nutritional status needs to be considered as a parallel rather than an isolated process. Nutritional status is important to prevent growth restriction which in turn impacts on the physiological development influencing behavioural maturation that is important for oral feeding success. According to Hay,<sup>15</sup> numerous studies have shown that a deficiency in protein at critical stages of the development process produces long-term short stature, organ growth failure, and neuronal deficits. It furthermore influences later behavioural and cognitive outcomes.<sup>15</sup> When striving to ensure good nutritional status by means of volume-driven regimes, the risk emerges to overfeed the infant.

Overfeeding also has a definite potential towards later complications, since it has the potential to produce adipose tissue, or obesity, which then leads to insulin resistance, glucose intolerance, and diabetes.<sup>15</sup> Optimal nutrition is therefore important for successful oral feeding to prevent challenges associated with feeding failure. It is clear that quantitative and subjective approaches towards the initiation of oral feeding in preterm infants do not incorporate infant skill, maturity, and abilities. Therefore, a need was identified to explore the evidence to support a good clinical regime to guide the transition to the oral feeding process on the basis of the infant's maturity and abilities, while providing the caregiver with measurable milestones to progress through the transition process.

## 2 | METHOD

This narrative review was developed from primary research, explorative work, existing guidelines, and evidence-based opinion. Publications were searched using electronic databases and websites, hand

searching relevant journals, and contacting experts. The databases searched included Embase, Medline and PubMed databases, and Google-indexed scientific literature. Combinations of the following keywords were used: cue-based, feeding, newborn, neonate, infant, preterm, ad-libitum, demand-feeding, semi-demand, volume-driven, oral, gavage, and transition. Only human studies addressing the keywords and providing evidence to guide cue-based feeding in preterm infants were considered, including both original studies and reviews published between 2000 and 2016. Official and national documents were included for review on the basis of their relevance to the review question. Documents published prior to 2000 were excluded, as well as documents in languages other than English and Afrikaans, which did not address cue-based feeding or preterm infant feeding transition.

Data were extracted from the selected documents and analysed using a thematic analysis approach of the recommendations made in the selected documents.

### 2.1 | Discussion on current feeding regimes

Feeding regimes for the advancement from tube to oral feeds that are followed and described in the literature are often inconsistent and contradictory among clinicians and even NICUs and are based on custom rather than evidence.<sup>8,16</sup> These regimes can be explained as either quantitative or subjective approaches towards feeding. Within the quantitative regimes, gestational age and weight is the criteria relied upon for the initiation of oral feedings,<sup>8</sup> and weight gain is the main indicator of infant feeding success, and as a result volume-driven regimes, which allow for the measurement of nutritional intake, are often standard practice for preterm infant feeding.<sup>17</sup>

Volume-driven regimes implicate strictly scheduled interval feeds.<sup>15,18</sup> In addition, quantitative regimes include formal criteria to initiate feedings on the basis of criteria such as infant weight and/or post conceptual age,<sup>1,8,13,19</sup> being free of illness,<sup>19</sup> and emptying the bottle; all opposed to considering infant development.<sup>20</sup> For this reason, bottle or cup feeding was introduced as precursor for breastfeeding, since the volume taken could be measured, resulting in measurable nutritional intakes judged to be sufficient to achieve a postnatal growth rate approximating that of the normal fetus of the same gestational age.<sup>15</sup> These criteria have, however, shown to compromise the infant and increase levels of anxiety and frustration for parents and caregivers.<sup>19,21</sup>

Subjective approaches, on the other hand, include caregiver intuition,<sup>8</sup> physician orders, or a "light-bulb phenomena" where the infant all of a sudden "figures out" how to feed successfully.<sup>18</sup> The approaches described above do not consider the energy expenditure associated with the physical actions involved in bottle-feeding and scheduled processes, leading to energy needs that are higher than the fetal growth rate. Research indicates that bottle-fed preterm infants experience a significantly higher level of physical distress (based on the stress cues observed during feeding) than breastfed preterm infants,<sup>22</sup> indicating that bottle feeding actually uses more energy and present more physiological challenges.<sup>4</sup>

Cup feeding is another mode often recommended for preterm infants to precede breastfeeding and to align with baby-friendly practices aiming to prevent the introduction of artificial nipples. During cup feeding, premature infants are physiologically more stable, with

lower heart rates, higher oxygen saturation levels, and fewer desaturations, than during bottle feeding. However, according to a study by Marinelli et al,<sup>23</sup> cup fed infants take less volume over a longer time, than bottle-fed infants for these initial feedings. On the basis of the better physiologic stability and no difference in untoward effects, cup feeding is regarded as safe, if not safer, than bottle feeding. This study supports the use of cup feeding as a safe alternative feeding method for premature infants learning to breastfeed.<sup>23</sup> On the other hand, Dowling et al<sup>24</sup> found that although infants remain physiologically stable, cup feeding has questionable efficacy and efficiency, since differentiating between actual intake and spillage of milk merits attention.<sup>24</sup> Alternative feeding measures such as bottle and cup feeding can easily lead to infants being force-fed with negative impacts on physiological stability if feedings are not administered by a skilled person, or if the infant's level of maturity to handle this burden of feeding skills is not considered.

Because of the short-term volume success, many medical insurance companies regard these "force-fed" infants as able to oral feed sooner on bottles but do not consider the sustainability and inability to keep up the successful feeding when the infant is not yet mature enough. In addition, these approaches did not consider longer-term outcomes, such as feeding success after NICU discharge and the development of neurological maturity. These findings support the importance of enhancing care provider sensitivity with regard to behavioural-cue observation.<sup>22</sup>

## 2.2 | Results (Literature review supporting cue-based feeding)

Maturity at the first oral feed and experience in feeding seem to be important factors influencing oral feeding success. Pickler et al<sup>25</sup> found that the duration of the infant's hospitalisation from the start of oral feedings until discharge was predicted by maturity at the first oral feeding and that positive feeding experiences contributed towards a more rapid transition to oral feeding regardless of the severity of illness.<sup>25</sup> Furthermore, cue-based feeding, opposed to volume-driven feeding, lead to increased weight gain, shorter hospitalisation, fewer adverse events, and contrary to opinions, does not increase staff workload while improving parenting skills with regard to feeding.<sup>19</sup>

The ability of a preterm infant to transition from gavage to oral feeds depends on a variety of "neurodevelopment" factors. These factors include the infant's behavioural organization, a rhythmic, coordinated suck-swallow-breathe pattern and cardiorespiratory regulation.<sup>1,4,21</sup> Gorski et al classified preterm infant development in 3 developmental stages: turning-in, coming-out, and reciprocity,<sup>26</sup> and only once the infant reached reciprocity will he or she be able to show signs (cues) of neurological maturity to support successful oral feeding.

## 2.3 | Cue-based feeding

"Cue-based feeding is a method that combines the use of non-nutritive sucking (NNS) to promote awake behaviour for feeding, use of behavioural assessment to identify readiness for feeding, and systematic

observation of and response to infant behaviour cues to regulate frequency, duration, and volume of oral feedings."<sup>27</sup> Thoyre et al (2013) defines cue-based feeding as "maintain[ing] the goal to optimize the feeding through assessment of infant cues."<sup>28</sup> Cue-based feeding includes a variety of benefits for the preterm infant:

### 2.3.1 | Earlier transition to oral feeding

Kirk et al<sup>29</sup> and McCain et al<sup>30</sup> found that cue-based and semidemand fed infants reached full oral feedings 6 and 5 days earlier, respectively, than infants transitioning to full oral feeds based on physicians' orders.

### 2.3.2 | Length of stay

A significantly shorter hospital stay is evident in infants who received cue-based feeding. Kirk et al showed a 4.5 day decrease, while other authors reported a shorter duration of hospitalisation,<sup>13,17</sup>

### 2.3.3 | Fewer adverse events

Kirk et al<sup>29</sup> showed a decrease of 9 adverse events when infants received cue-based feeding opposed to feeding on the basis of physicians' orders and this decrease in adverse events was also reported by Puckett et al.<sup>19</sup>

### 2.3.4 | Behavioural maturity

On a neuro-behavioural level, the infant who receives cue-based feeding elicit 2.8 more cues per feed<sup>29</sup> and demand-fed infants exhibited more hunger cues and had improved behaviour state organization, indicating a higher level of neurological maturity.<sup>13</sup> Furthermore, this infant-led approach towards feeding allowed the infant to develop more efficient sucking patterns by discharge from hospital,<sup>31</sup> since experience with earlier oral feeding led to enhanced maturation and improved oral feeding success.<sup>8</sup>

### 2.3.5 | Improved physiological outcome

In support of the neurological improvement observed in cue-based feeding, these infants also benefited on a physiological level, since they demonstrated a statistical and clinically significant decrease in bradycardiac incidences during feeding and pacing in NICU care practices which appeared to be beneficial for preterm infants with respiratory disease.<sup>31</sup>

### 2.3.6 | Increased nutrient intake

McCormick et al<sup>17</sup> stated that cue-based feeding improved infants' nutrient intake and some researchers reported an increase in weight gain during cue-based feeding<sup>13</sup> or at least at the same rate as infants fed with quantitative approaches.<sup>13,17,29-31</sup>

### 2.3.7 | No additional workload

An important factor to consider when motivating for the implementation of cue-based feeding is that it does not affect the workload.<sup>29</sup>

The literature provides sufficient evidence to support a cue-based approach towards the transition of preterm infants from oral to tube feeding, and Table 1 provides a summary of this evidence.

**TABLE 1** Summary of evidence to support nonnutritive sucking and cue-based feeding

Benefits of NNS	Evidence
Physiological stability	Pinelli & Symington, 2005 <sup>41</sup>
Protects against aspiration	Ludwig, 2007 <sup>7</sup>
Increased absorption of feeds	Barlow et al, 2008 <sup>10</sup> Foster et al, 2016 <sup>44</sup>
Facilitates development of sucking behaviour	Foster et al, 2016 <sup>44</sup>
Faster transition from tube to oral feeds	Pinelli & Symington, 2005 <sup>41</sup> Bingham et al, 2010 <sup>45</sup> Greene et al, 2013 <sup>34</sup> Bache et al, 2014 <sup>43</sup> Engebretson & Wardell, 1997 <sup>48</sup>
Greater weight gain (lead to earlier discharge)	Bingham et al, 2010 <sup>45</sup> Greene et al, 2013 <sup>34</sup> Foster et al, 2016 <sup>44</sup> Engebretson & Wardell, 1997 <sup>48</sup>
Soothing and self-consolation	Pinelli & Symington, 2005 <sup>41</sup> Jenik & Vain, 2009 <sup>46</sup>
Improve muscle tone and coordination	Ludwig, 2007 <sup>7</sup>
Promote awake behaviour before oral feeding	McCain et al, 2001 <sup>30</sup> Engebretson & Wardell, 1997 <sup>48</sup>
Benefits of cue-based feeding	Evidence
Earlier transition to oral feeding (up to 5 days)	Kirk et al, 2007 <sup>52</sup> McCain et al, 2001 <sup>30</sup> Pickler et al, 2015 <sup>4</sup>
Shorter length of stay	Crosson & Pickler, 2004 <sup>13</sup> McCormick et al, 2010 <sup>17</sup> Puckett et al, 2008 <sup>19</sup> Pickler et al, 2015 <sup>4</sup>
Fewer adverse events	Puckett et al, 2008 <sup>19</sup> Kirk et al, 2007 <sup>52</sup>
Behavioural maturity	Crosson & Pickler, 2004 <sup>13</sup> Kirk et al, 2007 <sup>52</sup> Law-Morstatt et al, 2003 <sup>31</sup> Thoyre et al, 2016 <sup>53</sup>
Improved physiological outcome	Law-Morstatt et al, 2003 <sup>31</sup> Thoyre et al, 2016 <sup>53</sup>
Increased nutrient intake	Crosson & Pickler, 2004 <sup>13</sup> McCormick et al, 2010 McCain et al, 2001 <sup>30</sup> Kirk et al, 2007 <sup>52</sup> Law-Morstatt et al, 2003 <sup>31</sup>
Increased weight gain	Puckett et al, 2008 <sup>19</sup>
Fewer adverse events	Puckett et al, 2008 <sup>19</sup>
No additional workload	McCormick et al, 2010 <sup>17</sup> Kirk et al, 2007 <sup>52</sup> Puckett et al, 2008 <sup>19</sup>

The conclusion can be drawn that feeding of preterm infants in response to their cues (hunger, satiation, and stress) rather than feeding at scheduled intervals might help to establish successful oral feeding.<sup>17,32</sup>

## 2.4 | Interventions to ensure successful feeding transition and maintenance

Transition towards full oral feeding requires a structured process of activities following on each other: as preparing the gut, providing

positive oral stimulation, including nonnutritive sucking, determining readiness to transition, the actual transition regime and sustaining successful feeding after discharge.

## 2.5 | Preparing the gut

Trophic feedings (small volume of feeds given at the same rate for at least 5 days) during parenteral nutrition provide a strategy to enhance the feeding tolerance and decrease the side effects of parenteral nutrition and decrease the time required to achieve full feeding.<sup>33</sup> At the same time, positive oral stimulation should be provided.

## 2.6 | Positive oral stimulation

Oral stimulation can have either a negative or positive influence on feeding success.<sup>32</sup> The use of oral stimulation shows promise to improve nutritive sucking,<sup>2</sup> however, more research is required to direct the multidisciplinary team in this regard.<sup>34</sup> Preterm infants are exposed to noxious stimuli in the NICU and especially negative olfactory stimulation is provided by strong alcohol hand rub, perfumes, and other cleaning detergents. These negative stimuli may contribute to feeding problems such as feeding aversion.<sup>35,36</sup>

Positive oral stimulation can however be provided by providing positive smells and taste to the preterm infant. The best way to provide positive stimulation is by allowing mothers (and fathers) to keep the infant in skin-to-skin contact as often and as long as possible.<sup>37,32</sup>

Skin-to-skin care should begin as soon as the baby is stable and has improved hemodynamic stability without increasing energy expenditure.<sup>11</sup> Skin-to-skin care furthermore contributes to shaping the sleep-wake cycle, as well as maturation of the autonomic nervous system, and improves maternal-infant bonding and pain response.<sup>38</sup>

In the instance of parent-infant separation, positive smells should be provided by putting a cotton wool or cloth with a few drops of mother's milk next to the infant in the incubator,<sup>39</sup> providing a bonding blanket, which can be a baby blanket with which the mother had slept and is placed next to the infant in her incubator or crib.<sup>40</sup> A drop of breast milk could in addition be placed in the infants mouth.<sup>37</sup>

If preterm infants are not exposed to sucking opportunities, they run the risk of losing the sucking reflex.<sup>4</sup> Sucking opportunities should be provided by means of the infant's hands, thumb, or preferably the mother's expressed breast or a suitable pacifier.<sup>37,41</sup> Sucking on the expressed maternal breast allows the infant to get used to the feeling, taste, and smell of the breast under conditions where the infant is not hungry. The baby should be placed in the skin-to-skin position between the mother's breasts and not necessarily positioned over the nipple.<sup>37,42</sup> When ready, the infant will then lick and suck on the nipple and be comforted without the need to learn the skill of feeding while being hungry.<sup>42</sup> Sometimes, a mother is not available and then a pacifier can be used, however Bache et al (2014) found that prefeeding oral stimulation contributes to improved breastfeeding rates in preterm infants and should therefore be provided.<sup>43</sup>

## 2.7 | Nonnutritive sucking

Nonnutritive sucking (NNS) is used during gavage feeding and in the transition from gavage to oral feeding in preterm infants. The

rationale for this intervention is that nonnutritive sucking facilitates the development and maturation<sup>43</sup> of sucking behaviour and improves digestion of enteral feedings.<sup>44</sup> Nonnutritive sucking on the expressed breast (mother pumps first and then places the baby to the breast) can be attempted as soon as the baby is extubated and stable with success noted as early as at 28 weeks corrected gestational age.<sup>11</sup>

Nonnutritive sucking precedes nutritive sucking and is characterised by shorter sucking bursts. Nonnutritive sucking is beneficial to the newborn infant as it contributes to physiological stability, including higher levels of oxygenation and a decreased heart rate. It protects against aspiration, since sucking inhibits swallowing and improves glucose usage because of an increase in insulin secretion. Nonnutritive sucking increases absorption of feeds due to an increase in gastrin secretion, decreased somatostatin secretion, and enhanced functioning of the gastro-intestinal track. Nonnutritive sucking during gavage feedings contributes to the faster transition from tube to oral feeds and better bottle feeding outcomes,<sup>43,34</sup> due to an acceleration in maturation and greater weight gain result in earlier discharge from hospital<sup>45,34</sup> Nonnutritive sucking is beneficial for pain relief, soothing, and self-consolation,<sup>46,41</sup> since it increases self-regulatory state modulation with increased levels of alertness and increased duration of sleeping and finally improving muscle tone and coordination. According to a study by Bingham et al,<sup>45</sup> higher nonnutritive sucking organization scores predicted a shorter transition to full oral feeds ( $P < .05$ ) or 3 days earlier than infants with more chaotic patterns of suck bursts. The use of pulse training and pacifier-activated lullaby systems were found to significantly increase oral feeding ability with infants at 34 weeks' gestation.<sup>2</sup> Opposed to traditional believe, pacifiers do not affect breastfeeding in preterm infants.<sup>47</sup>

## 2.8 | Choose a pacifier to support sucking development

For a pacifier to support preterm infant development, it is important that it should be as close as possible to what the fetus would have been using in utero. In infants who are unable to coordinate their suck-swallow and breathing reflex, a pacifier with an upward angle, similar to the infant's thumb in utero should be used.<sup>48</sup> When suck-swallow and breathing is coordinated, the pacifier should be similar to the mother's nipple in size and shape, since this infant should be starting to feed on the breast.

Choose a 1-piece<sup>48</sup> pacifier made of a tasteless and odourless medical grade plastic.<sup>48</sup> The nipple of the pacifier should be cylindrical to support tongue cupping—similar to fetal thumb size in infants less than 32 weeks or the mother's nipple size in infants older than 32 weeks or who are able to coordinate sucking, swallowing, and breathing. It should have a small bolus at the end of the nipple, and the optimal nipple length should reach the ridge between the soft and hard palate to stimulate the limbic system of the brain.<sup>48</sup> Finally, the mouth shield should be big and soft to stimulate nerve endings around the mouth and prevent aspiration<sup>48</sup> and have a "handle" on the shield to provide for hand-to-mouth positioning, grasping, self-soothing, and midline positioning.

## 2.9 | Determine readiness for transition from tube to oral feeds

A limited number of instruments indicating individual infant readiness to commence either breast or bottle feeding have been developed.<sup>6</sup> There is currently no evidence to inform clinical practice, with no studies meeting the inclusion criteria for this review. Research is required in this area to establish an evidence base for the clinical utility of implementing the use of an instrument to assess feeding readiness in the preterm infant population.<sup>6</sup>

In determining when a preterm infant is ready for oral feeds different areas of maturity should be assessed. Feeding maturity is dependent on neurological maturity which can be accelerated by starting with human milk feeds immediately after birth and allowing skin-to-skin care even for the ventilated infant. These 2 interventions contribute to the myelination process of the nervous system resulting in neurological maturity.<sup>35</sup> Some indicators for feeding readiness include sucking well on a finger, fist, pacifier or expressed breast, showing mouthing activity and the handling of the infant's own secretions,<sup>1,42,32</sup> The infant should be medically stable,<sup>42</sup> although it might still be receiving oxygen supplementation. The infant should have comfortable, stable breathing with no rib retraction or grunting, the resting breathing rate should be less than 60-70 breaths per minute,<sup>32,29</sup> and the infant should need less than 40% oxygen. The heart rate should be stable between 120 and 160 beats per minute during caregiving and holding.<sup>1</sup> Sufficient bowel sounds should be audible, and the infant should be tolerating 2-3 hourly tube feeds well,<sup>40,32</sup> With regards to growth, the infant should gain 15 g/kg/day on oral feeds.<sup>42</sup>

On the neurological level, the infant's gestational age should be more than 28-32 weeks to be able to coordinate sucking, swallowing and breathing.<sup>37</sup> Furthermore, the infant must be able to maintain its own body temperature outside the incubator or when in skin-to-skin care.<sup>1,42</sup> The infant is ready for the initiation of oral feeds when it can maintain a quiet alert state,<sup>1,32</sup> is able to relax, and has a bright, healthy look.<sup>42</sup> The infant should also shows cues for engagement, such as making a mouthing "ooh" configuration, making eye contact, and moving hands to mouth while mouthing. The preterm infant must show sufficient mouthing, rooting and sucking reflexes, and hunger cues together with waking up for feeds and finally be able to focus on the food source (Table 2).

## 2.10 | Transition from tube to oral

Assistance from an experienced nurse or lactation consultant to guide the transition is invaluable. When transitioning from tube to oral feeds, the following approach is suggested. Correct positioning is the first step when initiating feeding. The infant should be positioned in a way to support a flexed orientation around the midline,<sup>49,37</sup> and the cross-cradle and football holds seems to be the most suitable for the initiation.<sup>50,32</sup>

Select the time of day that the infant is more awake,<sup>51,4</sup> and provide NNS for 10 minutes before the planned oral feeding, and if the infant enters a wakeful state,<sup>30</sup> then only try to breastfeed once. If it is unsuccessful, try again the following day until the infant can manage the feed. Then continue with 2 oral feeds per day in a sequence of 1

**TABLE 2** Readiness to initiate transition from tube to oral feeding

Readiness to transition from tube to oral feeds	Evidence
Neurological maturity	Bingham et al, 2010 <sup>45</sup> Dodril et al, 2004 <sup>35</sup> McCain et al, 2001 <sup>30</sup> White & Parnell, 2013 <sup>32</sup>
Nonnutritive sucking and handling own secretions	Pinelli & Symington, 2005 <sup>41</sup> Holloway, 2014 <sup>1</sup> Cape MPIGW, 2007
Medically stable with or without oxygen supplementation of less than 40%	Pinelli & Symington, 2005 <sup>41</sup>
Comfortable, stable breathing	Pinelli & Symington, 2005 <sup>41</sup> White & Parnell, 2013 <sup>32</sup>
Resting breath rate less than 60-70 bpm	Kirk et al, 2007 <sup>52</sup> White & Parnell, 2013 <sup>32</sup>
Stable heart rate between 120 bpm and 160 bpm	Holloway, 2014 <sup>1</sup>
Sufficient bowel sounds	Kirk et al, 2007 <sup>52</sup>
Tolerate 2-3 hourly tube feeds well	Raimbault et al, 2007 <sup>39</sup> White & Parnell, 2013 <sup>32</sup>
Gain an average of 10-15 g/kg/day once on a normal caloric intake of about 120 kcal/kg/day enterally.	Kirk et al, 2007 <sup>52</sup>
Gestational age older than 28-32 weeks	Ben, 2008 <sup>33</sup>
Coordinate suck, swallow and breathing	Ben, 2008 <sup>33</sup>
Maintain body temperature outside incubator/in skin-to-skin	Cape MPIGW, 2007 <sup>42</sup> Pinelli & Symington 2005 <sup>41</sup>
Rooting and sucking reflexes	Cape MPIGW, 2007 <sup>42</sup> Pinelli & Symington, 2005 <sup>41</sup> White & Parnell, 2013 <sup>32</sup>
Grow 15 g/kg/day on oral feeds	Cape MPIGW, 2007 <sup>42</sup> Pinelli & Symington, 2005 <sup>41</sup>
Transition to and maintain quiet alert state	Cape MPIGW, 2007 <sup>42</sup> Pinelli & Symington, 2005 <sup>41</sup> Kirk et al, 2007 <sup>52</sup> White & Parnell, 2013 <sup>32</sup>

oral feed followed by 2 tube feeds to allow the infant time to rest in between. When the infant is able to manage this, continue to alternate breast and tube feeds and when this is well established the infant may take the breast with every feed.<sup>40</sup> Most premature infants can begin nutritive sucking at about 32 weeks' gestation,<sup>30</sup> and there is no evidence that oral feeding started earlier than 34 weeks contribute to sooner full oral feeds, however maximum oral feeding experience does.<sup>4</sup> Early use of nipple shields increases milk intake and duration of breastfeeding<sup>11</sup> and can be used to aid initial latching. Infants should be observed and assessed during, as well as, after every feed to determine how they are coping with the activity.

Semidemand feeding is more suitable for preterm infants than demand feeding. With semidemand feeding, the infant is assessed every 3 hours for behavioural signs of hunger. If the infant is sleeping, reassess 30 minutes later, and if the infant is still sleepy give a tube feed.<sup>30,32</sup> If the infant wakes up and demonstrates hunger signs before the 3 hours are over, the feeding can be provided earlier. These infants reach full oral feeding 5 days earlier than infants on scheduled feed.

## 2.11 | Assessment during the feed

Thoyre et al (2013) states that assessment during the feed includes the infant's ability to (1) sustain attention and energy for the duration of feeding, (2) control and organize oral-motor functioning, (3) coordinate swallowing, and (4) maintain physiologic stability.<sup>28</sup>

Reliance on preterm infant behavioural cues will be insufficient for detection of oxygen desaturation during oral feeding, but absence apnoeic incidents is a good indication of infant success, therefore oxygenation levels should be observed during the feed. Attention to changes in breathing sounds and to the pattern of sucking are potentially important intervention strategies for the prevention of and appropriate response to oxygen declines during feeding. Sucking pauses may indicate periods when preterm infants aim to regulate their breathing patterns and thereby increase oxygenation. Interventions that focus on detection and minimization of apnoea during feeding, and which aim to protect infant sucking pauses, may reduce the number and severity of desaturation events preterm infants might experience during bottle feeding.<sup>14</sup> Nurses should observe changes in respiratory control and fatigue during feeding to determine the length of a feeding. Feedings should be stopped when the infant fall asleep, do not resume sucking after pausing or is clinical instable (apnea and bradycardia).<sup>30</sup> An increase in eye flutter is a precursor for apnoeic spells observed immediately prior to a desaturation event.<sup>14</sup> During a desaturation event, infants typically relax their arms and hands and stop sucking.<sup>14</sup>

## 2.12 | Assessment of the feed

It is important to be able to rate the effectiveness of the feed as being good, fair, or poor. A good feed can be identified when the infant latches well, has good positioning, and sucks continuously (>15 minutes)<sup>29</sup> with or without stimulation and where no additional feed needs to be given via the naso-gastric tube.<sup>32</sup> The first let down can produce almost half of the total volume of milk in the breast, therefore the following management decisions are acceptable.<sup>50</sup>

A fair feed is identified when the infant latches and starts to suckle nonrhythmically,<sup>32</sup> but loses grip and "fights" on the breast. Active sucking for 5-15 minutes is considered half the intended volume of the feed was taken and half should be given via the naso-gastric tube.<sup>29</sup>

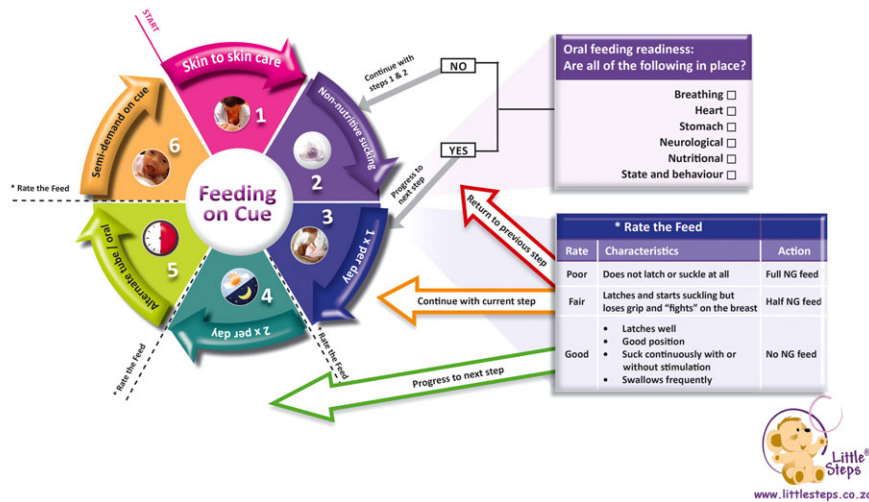
A poor feed is identified when the infant remains sleepy, does not latch, or has a few sucks (less than 5 minutes) and then releases. The full feed should be given via the naso-gastric tube.<sup>29,32</sup>

Feeding should be a pleasant experience for all involved in the process, and if the previously stated information is followed, this aim can be achieved. Figure 1: Transition protocol for feeding initiation, aims to provide a visual guide for the clinician to make decisions on the transition regimes for each individual infant. The author are proposing this transition protocol based on all the evidence already presented in this article.

## 2.13 | Safety measures

According to Crosson and Pickler,<sup>13</sup> 1 or all of the following safety measures should be included with cue-based feeding: (1) There

## Switching from tube to oral – regime



**FIGURE 1** Transition protocol for feeding initiation (with permission from Little Steps® 2016)

should be a limit on the interval between feedings (such as 4 hours maximum), (2) daily fluid minimum should be calculated to ensure reaching the caloric intake goals, (3) routine assessment of growth should be done, and (4) assessment of blood glucose levels with any clinical suspicion, or at the extended time limits of demand feeding should be done.

### 2.14 | Guidelines on preterm infant feeding after discharge

It is important to teach mothers to read their infants' cues with regard to feeding instead of letting them rely on monitors, such as scales to indicate feeding success, since this engages parents and enhance their nurturing and caregiving skills.<sup>1</sup> The most important guideline is that a mother should hear her baby swallow. The infant should gain weight on any type of feed at a rate of 15 g/kg/day,<sup>42</sup> whether it is formula or breast feeding. The infant might receive supplemental feeds if necessary, provided that an experienced lactation consultant assists the mother to ensure lactation and breast feeding establishment. The infant must be physiologically stable and parents must be confident in handling him or her.<sup>42</sup>

Semidemand feeding should be continued after discharge, since hunger cues may be unreliable in preterm infants, therefore the feeding schedule that was used in the NICU should be continued. Eight feeds per 24 hours is required, which does not necessarily have to in 3-hourly intervals. Infants feeding every 2 to 2.5 hours during the day may stretch night feed intervals to four hours, allowing more rest for the mother-infant dyad. However, infants less than 2.5 kg should be woke every 3 hours during the day for feeds and should not sleep for more than four hours consecutively without a feed. After 2.5 kg these intervals may stretch to five hours to allow more rest for the dyad.

Although scheduled feeding will ensure sufficient caloric intake, feeding preterm infants in response to their hunger and satiation cues (ad libitum or demand/semidemand) might help in the establishment of independent oral feeding,<sup>4</sup> increase and ensure sufficient nutrient intake and growth rates, and ensure NG feeding success.

Demand-fed infants will take fewer feeds per day, can be discharged from hospital 5-6.2 days sooner than infants on scheduled feeds,<sup>13,17,30</sup> exhibit more hunger cues, and may consume fewer calories in 24 hours. However, there is no difference in their weight gains compared to infants on scheduled feeds, contributed to longer sleep periods.

A preterm baby should gain between 142 g and 170 g per week, but the change of environment from hospital to home has a large impact on the energy use that may influence weight gain in the first week. To compensate for the additional energy requirements during the first week at home, rather track weight gain bi-weekly.

## 3 | CONCLUSIONS

Transition from gavage to oral feeding in preterm infants based on infant maturity may result in more successful oral feeding with less energy expenditure, higher rates of success, and even better parental functioning.

Clear, evidence-based guidelines should be available for the healthcare professional/care giver to enable effective assessment of infant maturity and readiness for oral feeding.

Clear recommendations must be available to healthcare professionals to direct the transition process ensuring optimal feeding success.

Findings portrayed in this article should be summarized in the format of an informational pamphlet understandable by mother and infant caregivers.

Cue-based feeding provides the best outcome and supports transition to independent oral feeding in the preterm infant very well. It also contributes to lower stress in parents and caregivers related to feeding success.

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