Differentiating Normal Newborn Weight Loss From Breastfeeding Failure

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There is increasing concern for the risk of hypernatremic dehydration in infants breastfeeding poorly. It is important to differentiate normal weight changes as infants adapt to extrauterine life from excessive weight loss from breastfeeding failure or mismanagement. We review recent data on normal weight changes in exclusively breastfeeding infants and those at risk for hypernatremic dehydration to help health professionals determine when infants require further scrutiny and supplementation. The data suggest that perinatal practices influence infant weight changes. Protecting normal birth and early initiation of breastfeeding should reduce the incidence of excessive weight loss and risk of hypernatremic dehydration

Keywords: growth nomograms; weight loss; breastfeeding; hypernatremic dehydration; birth interventions

Newborns are expected to lose weight in the first few days after birth, as part of healthy adaptation to extrauterine life (DeMarzo, Seacat, & Neifert, 1991; Mulder & Gardner, 2015; Tawia & McGuire, 2014) and promptly begin gaining as milk production increases. Colostrum volume is low initially and milk production should increase rapidly over the first 72 hours of life (Neville et al., 1988).¹

Breastfeeding difficulties (infant, maternal, or dyadic, environmental or management related) can exaggerate normal weight loss (Dewey, Nommsen-Rivers, Heinig, & Cohen, 2003; Mulder, Johnson, & Baker, 2010). Frequent or daily weighing in the first 5 to 7 days has been proposed to reduce the risk of hypernatremic dehydration (HDN) (Iyer et al., 2008; Konetzny, Bucher, & Arlettaz, 2009). It can be challenging to differentiate normal weight loss from excessive loss that might signal lactation failure (Verd, de Sotto, Fernández, & Gutiérrez, 2018). Understanding the data we have about weight loss, and carefully assessing the breastfeeding dyad, can help prevent hypernatremic dehydration and conversely, unnecessary formula supplementation. Unnecessary supplementation impairs the infant's microbiota (Timmerman et al., 2017) and reduces breastfeeding success (Chantray, Dewey, Pearson, Wagner, & Nommsen-Rivers, 2014). More research is needed on the impact of excessive infant weight loss on continuation and long-term exclusivity of breastfeeding. Dyads with excessive early weight loss seem less likely to return to exclusive breastfeeding (Flaherman et al., 2017).

Strategies to Protect Infants From Hypernatremic Dehydration

Several strategies have been successful in protecting infants from hypernatremic dehydration while simultaneously protecting breastfeeding. The most effective programs modulate their intervention according to the level of weight loss.

- For infants who have lost 7% to 8% of birth weight, strategies included monitoring weight every 24 hours, providing breastfeeding support and assistance, and supplementing with expressed colostrum or milk if milk transfer at breast is poor.
- For infants who lost more than 10%, the first step is supplementation with expressed milk, then checking blood sodium levels, and rehydration and more intense supplementation if hypernatremia is identified.
- Infants displaying symptoms of dehydration are assessed and treated promptly (Davanzo, Cannioto, Ronfani, Monasta, & Demarini, 2013; Manganaro, Mami, Marrone, Marseglia, & Gemelli, 2001).

The Impact of Birth Interventions and Hospital Routines

Birth interventions and hospital routines affect breastfeeding opportunities and impact weight changes in newborns. Increased urination was associated with greater weight loss in the first 48 hours in successfully breastfeeding newborns (Mulder et al., 2010). Excessive intravenous fluids during labor and delivery may lead to increased weight loss in the first 24 hours of life as

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the infant urinates to restore normal fluid balance (Noel-Weiss, Woodend, Peterson, Gibb, & Groll, 2011). Infants born by cesarean lost more weight and were more vulnerable to hypernatremic dehydration (HDN) (Jain & Basu, 2010).

Tracking weight loss from the 24-hour weight (instead of birth weight) in infants born by cesarean in a Baby-Friendly hospital reduced supplementation without an increase in hypernatremic dehydration and rehospitalization (Deng & McLaren, 2018). In a retrospective chart review, infants who lost the most weight their first day ($>4.5\%$) were 3.5 times more likely to lose $>10\%$ of birthweight during their hospitalization (Flaherman et al., 2015). Flaherman et al. (2013) caution against diminishing maternal confidence in breastfeeding when this occurs.

Normal Versus Problematic Weight Loss

Commonly accepted values for normal newborn weight loss (7%) and problematic weight loss (10%) are based on a small number of data points per infant (DeMarzo et al., 1991). A systematic review by Noel-Weiss, Courant, and Woodend (2008) stresses that the weight loss data published up to that time were mainly median values derived from different populations with different methodologies. The great variability of individuals and environmental inputs makes it difficult to interpret any single infant's weight changes. It would be like buying t-shirts for a large public event, and only ordering size medium: some participants will be stuck with a shirt that is too small, and others with one that is too large. Similarly, attending only to median values gets some infants too much intervention, and others not enough.

The age of the infant at each weight is a vital variable. Earlier studies have followed healthy, exclusively breastfed newborn infants and tracked their weight nadir and time to regain birthweight using few measurements spread over several weeks (DeMarzo et al., 1991; Macdonald, Ross, Grant, & Young, 2003). Frequent measurements provide better information about the pattern and timing of weight changes in breastfeeding infants (Crossland, Richmond, Hudson, Smith, & Abu-Harb, 2008; Grossman, Chaudhuri, Feldman-Winter, & Merewood, 2012).

Identifying Babies at Risk

Nomograms are charts that help capture the time dimension and individual variations to help determine whether babies are progressing normally or are at risk. Several

groups have produced nomograms that clinicians can use to help screen newborns (Table 1). van Dommelen and colleagues (van Dommelen, van Wouwe, Breuning-Boers, van Buuren, & Verkerk, 2007) used statistical analysis of weight changes in large cohorts of exclusively breastfed infants from day 2 through 11 to construct normal growth curves, and compared them to those from two groups of infants with hypernatremic dehydration. They were able to see that infants who developed HDN had already lost significantly more weight than infants who did not long before showing symptoms. The group then produced a nomogram that predicts elevated risk of hypernatremic dehydration in the first week of life, so it can be prevented by breastfeeding assistance and stimulation of maternal milk production.

Bertini and colleagues used 12 hourly measurements in a Baby-Friendly birth center environment to extract normal growth patterns of exclusively breastfed infants (Bertini et al., 2015). Other groups used complex statistical techniques that pair the age of infants at a smaller number of measurements versus their birthweights to construct nomograms (Flaherman et al., 2015; Fonseca et al., 2015; van Dommelen et al., 2014) or prediction tools (Wilboux et al., 2016). Figure 1 compares the 50th percentile line of the nomograms created by different authors (Bertini et al., 2015; Flaherman et al., 2015; Fonseca et al., 2015; van Dommelen et al., 2014). It is important to note that the sample size in Bertini et al. (2015) is different at different points of time. By 72 hours, only a small number of infants remained, and it is possible that more slower growing infants were over-represented, so data from that time point are less reliable.

Factors Related to Risk

Nomograms developed by different studies point up some of the factors that support or interfere with breastfeeding initiation. Infants born in Baby-Friendly hospitals with limited birth interventions (Bertini et al., 2015; Pounds & Shostrom, 2018; Procaccini, Curley, & Goldman, 2018) had lower mean weight loss, whereas a Baby-Friendly hospital with many cesareans and instrumental births documented more excessive weight loss (Castilho, Miranda, Fernandes, Cunha, & Barroso, 2018). Infants born by cesarean section have a significantly higher weight loss and a delayed nadir (Fonseca, Severo, Barros, & Santos, 2014; Flaherman et al., 2015) compared with those born in institutions with low or null cesarean rates (Crossland et al., 2008; Bertini et al., 2015). The difference in cesarean rates explains

Table 1 Sample Size, C Section Delivery Rate, and 50th Percentile Nadir Data for Studies Which Produced Nomograms for Relative Weight Loss of Exclusively Breastfed Infants

Author	Setting	Design	# centers	N of BF infants	Cesarean births	50th percentile nadir		Comments
						RWL	time	
Crossland et al. (2008)	Sunderland, UK	prospective	single	111	Data unavailable	6.4% ± 0.9%	Approximately 48h	
Bertini, Breschi, and Dani (2015)	Florence, Italy	retrospective	single	1760	0%	5.9% ± 1.7%	43.7h ± 11.6h	Only physiological births and healthy infants; BF includes expressed BM ^a ; sample size at different point of time varies.
van Dommelen, Boer, Unal, and van Wouwe (2014)	Netherlands	retrospective	multicenter	2359	Approximately 10%	6.2%	48h	
Fonseca, Severo, and Santos (2015)	Oportoarea, Portugal	prospective	multicenter	1288	29.2%	6.7%	52.3h	61% of sample collected for less than 48h.
Flaherman et al. (2015)	Northern California	retrospective	multicenter	83433	0%	7.4% ^b	56h ^b	Excessive WL supplemented and excluded from sample Excluded infants with WL > 15% at any time, > 10% in the first 24h Excluded after supplementation.
				25474	100%	8.7% ^b	64h ^b	

Note. RWL = Relative weight loss; BF = Breastfeeding; BM = Breast milk; WL = Weight loss.

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^bNadir data for Flaherman et al. (2015) are taken from the percentile charts.

Figure 1. Comparison of relative weight loss median curves for different authors (Bertini et al., 2015; Flaherman et al., 2015; Fonseca et al., 2015; van Dommelen et al., 2014).

Note. CSD = cesarean section deliveries; VD = vaginal deliveries.

some of the variance in median weight loss in Figure 1: The cesarean rate in Fonseca et al. (2014) was 29%, as contrasted with 0% in Bertini's cohort, and 10% in van Dommelen's. Mothers over 40 had about 2.4 times the risk of their infant losing excessive weight (Fonseca et al., 2014).

Results of the European cohorts reveal similar median weight loss (Bertini 5.9%, van Dommelen 6.2%, Fonseca 6.7%), in contrast to the value found by Flaherman et al. (2015) for vaginal deliveries in the United States (7.4%), reflecting cultural differences in labor and postpartum practices. Indeed, a U.S. Centers for Disease Control report concluded that "Most U.S. hospitals have policies and practices that do not conform to international recommendations for best practices in maternity care and interfere with mothers' abilities to breastfeed." (Centers for Disease Control and Prevention [CDC], 2011). Epidural analgesia during labor was associated with increased newborn weight loss in a Canadian multi-hospital chart audit (Martens & Romphf, 2007).

Cultural practices around breastfeeding initiation matter also, weight loss was much lower in Bosotho mothers (Tjon A Ten, Kusin, & de With, 1986) who initiate breastfeeding in the first hour versus Ngiti and Bira (Enzunga & Fischer, 1990) who delay breastfeeding. This is unsurprising. Bystrova and colleagues found a 54% greater milk intake on day 4 in infants who initiated breastfeeding in the first 2 hours after birth versus those who started later in the first day of life (Bystrova, Bystrova et al., 2007).

Japanese women who initiated breastfeeding in the first 2 hours were more likely to be still breastfeeding at 4 months (Nakao, Moji, Honda, & Oishi, 2008). Infants also lost more weight in the summer (Davanzo et al., 2013; Jain & Basu, 2010; Shah & Javadekar, 2018). With so many variables, it is unsurprising that a systematic review by Thulier (2017) found insufficient research to pin down normal weight loss in breastfed infants.

Differences in weight loss by population decrease markedly at the low end of the dataset (Figure 2). The

Figure 2. Comparison of relative weight loss 90th percentile curves for different authors (Bertini et al., 2015; Flaherman et al., 2015; Fonseca et al., 2015; van Dommelen et al., 2014).

Note. CSD = cesarean section deliveries; VD = vaginal deliveries.

90th percentile of weight loss was unavailable for van Dommelen's data, as it was expressed in z scores in their study. The striking difference is that in Bertini's study no infant lost 10% or more of birthweight, and the 90th percentile nadir is 8%; while the other studies all exceed 10%. Births at the *Centro Nascita Margherita* are restricted to low-risk mothers and infants, births are all vaginal and unmedicated, conditions that according to the authors create a normative "standard" (Bertini et al., 2015).

van Dommelen et al. (2007) found no cases of hypernatremic dehydration before day 3. Their data revealed that a 10% weight loss in the first week of life provided too many false negatives, whereas losing more than 2.5 standard deviations on their normal growth curve identified all infants at risk. Infants remaining 10% below birth weight after 1 week were at high risk and should be hospitalized for biochemical tests and rehydration. Rapid rehydration during hypernatremic dehydration causes cerebral edema and increases the chance of poor

outcomes (Boskabadi et al., 2017; Laing & Wong, 2002; Lavagno et al., 2016). Continued provision of expressed breast milk (and breastfeeding, if the infant is able) is appropriate during rehydration. Previous concerns about sodium exposure from breast milk have proven unfounded when infants receive sufficient fluid volume (Laing & Wong, 2002; Oddie, Richmond, & Coulthard, 2001).

Symptoms Indicating Low Intake

Symptoms of dehydration or low breast milk intake should not be ignored at any age. Stool output in the first 5 days was negatively associated with weight loss in normal newborns (Shrago, Reifsnider, & Insel, 2006). Differences in stooling patterns was not significantly different until after day 2 in infants later diagnosed with hypernatremic dehydration (DiTomasso & Paiva, 2018; Thulier, 2017), by which time many U.S. infants are discharged. Fewer than three daily stools was almost universal before readmission for hypernatremic

dehydration in an Indian retrospective review (Yaseen, Salem, & Darwich, 2004).

Mothers and health-care providers need to understand the importance of normal stooling patterns in young breastfed infants (Livingstone, Willis, Abdel-Wareth, Thiessen, & Lockitch, 2000). Health-care professional education is particularly important in cultures where breastfeeding rates have previously been low and mothers have little breastfeeding knowledge. First-time mothers, and those with low breastfeeding exposure and education, are consistently identified as more likely to experience unrecognized lactation failure. A comprehensive list of risk factors for hypernatremic dehydration appears in a systematic review by Lavagno and colleagues (Lavagno et al., 2016).

Signs of dehydration may be subtle in hypernatremic dehydration, as fluid is shifted to extracellular compartment by osmotic pressure from the elevated sodium (Neifert, 2001). Dry mucous membranes and/or fever were early signs of hypernatremic dehydration in a recent retrospective review (Ünver Korgali, Cihan, Oğuzalp, Şahinbaş, & Ekici, 2017); lethargy or hypotension in another (Konetzny et al., 2009). Irritability or inconsolable crying with constant ineffective feeding attempts should also be investigated with a high index of suspicion.

Takahashi and colleagues found that infants with excessive weight loss showed increased rooting intensity (Takahashi, Takahashi et al., 2015). An increased number of feedings with excessive weight loss is a marker for lactation failure “perhaps as an expression of thirst” (Marchini & Stock, 1997). As the infant decompensates, the number of feeds may sharply decrease (Boskabadi et al., 2017). Jaundice is also common in underfed infants, starvation increases re-uptake of bilirubin through the enterohepatic circulation. In one retrospective review, 49% of hypernatremic infants were also jaundiced, and 65% had cesarean births (Uras, Karadag, Dogan, Tonbul, & Tatli, 2007).

Recommendations

Immediate or early skin-to-skin care is one evidence-based support for breastfeeding. A non-randomized trial showed that 120 minutes of skin-to-skin (S2S) contact initiated within 30 minutes of birth (vaginal, cesarean, or instrumental) was associated with about a five-fold greater odds of exclusive breastfeeding at 3 months versus no early skin-to-skin contact (Vila-Candel, Duke, Soriano-Vidal, & Castro-Sánchez, 2018). Since low milk production or low infant weight gain were the

most common reasons women gave for discontinuing breastfeeding before 3 months, and almost 60% of S2S dyads were still exclusively breastfeeding, it is probable that early, uninterrupted skin-to-skin care can reduce excessive newborn weight loss as well.

The data we found on infant weight changes highlighted the impact of perinatal practices including birth interventions and postpartum breastfeeding management. This is an obvious area for quality improvement in the Joint Commission perinatal core measure set.

We propose early assessment by IBCLCs of all dyads with higher than expected weight loss in the first 24 hours to ensure infant safety. If any signs of inadequate milk transfer or production are observed, manual expression and spoon feeding of colostrum can protect both maternal milk production and the infant’s metabolic health. Other potential interventions flow from the findings of a thorough clinical breastfeeding assessment (Genna & Sandora, 2016). We have provided a decision tree (see Appendix) to aid in these assessments.

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APPENDIX

Decision Tree

Note. BF = breastfeeding; EBF = exclusive breastfeeding; WL = weight loss.