Reliability and Validity of Swallows as a Measure of Breast Milk Intake in the First Days of Life

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Abstract:

Background: Breastfeeding assessment in the hospital to determine adequacy of feeds remains controversial. Swallow evaluation is integral to current assessment tools, but the literature is not clear about whether the number of swallows is an accurate indicator of breast milk intake in early postpartum.

Objectives: To determine the reliability and validity of swallows as a measure of breast milk intake in the first days of a newborn's life.

Methods: Thirty mother-baby dyads were observed at one breastfeeding; pre- and postfeed weights were done, bedside audible swallows were counted, and feeds were videotaped for independent rating. Milk intake was determined from weight change, adjusted for insensible water loss.

Results: Number of swallows was significantly and positively correlated with breast milk intake (r = .71). Number of swallows alone, however, accounted for only 50.8% (R^2 = .508) of the variation in milk intake. Infant age was the best predictor of milk intake (β_{age} = .56 vs $\beta_{No.\ swallows}$ = .36), accounting for 68% of the variation in milk intake when combined with swallows. The majority of infants took in 10 g or less of breast milk (77%); length of feeds was variable. In-room (at bedside) lactation consultant (LC) and video rater LC swallow counts were significantly and positively correlated (r = .93;P < .01). However, the 2 lactation consultant swallow numbers include clinically important discrepancies in a Bland-Altman analysis.

Conclusions: Number of swallows was not supported as a reliable or valid indicator of milk intake and adequacy of a feed in the first few days of life.

Keywords: swallows | postpartum care | milk intake | lactation consultant | breastfeeding | breastfeeding initiation | assessment tools

Article:

Well Established

Pre- and postfeed weights have been established as the best way to determine adequacy of breast milk intake. However, assessments such as listening for swallows are done to evaluate breastfeeding.

Newly Expressed

This study indicates that, in the first few days of life, audible swallows are not a reliable or valid measure of breast milk intake.

Background

Maternal and infant specialists agree that breastfeeding should be supported from the moment of birth on.[1-3] Agreement on how to assess the status of breastfeeding and determine the need for intervention, however, remains unsettled.[4-6] The ultimate questions are, "Is breastfeeding going well?" and "Is the infant getting adequate milk?" Determining adequacy of milk intake in the first days after birth is challenging due to multiple maternal and neonatal variables and because common assessments such as weight gain, frequency of voids and stools, and breast softening postfeed are nonspecific in the early postpartum period.[7,8] The first days after birth are critical for successful initiation of breastfeeding and are when nurses and lactation consultants (IBCLCs) have ready access to mother-infant dyads to facilitate effective feeds and promote breastfeeding continuation.

Several breastfeeding assessment tools have been developed (eg, Infant Breastfeeding Assessment Tool [IBFAT], Mother-Baby Assessment Tool [MBA], and LATCH), and all include an assessment of swallows.[4-6] The literature is not clear, however, about whether swallows are an accurate indicator of breast milk intake in the early postpartum period. Therefore, the purpose of this study was to determine whether the assessment of swallows is a reliable and valid measure of breast milk intake in the first days of life.

Currently, the gold-standard measure of single-feed breast milk intake is pre- and postfeed weights.[9,10] Meier and colleagues[9] found that the BabyWeigh Scale (Medela, Inc, McHenry, Illinois) provided accurate milk intake estimates during breastfeeding, but routine weights are impractical due to staffing restrictions and inconvenience in the hospital setting and the lack of equipment in the home setting.

Audible swallowing, listening for the sound of a click or a gulp, is often suggested to nurses, IBCLCs, and mothers to determine feeding effectiveness.[4,10] However, the quantities of colostrum in the first days postpartum are varied, and swallowing, found to be directly related to the quantity of fluid in the mouth, may be very quiet and difficult to detect.[11]

Ultrasound studies[12] provide detailed descriptions of the patterns of swallowing and breathing during breastfeeding.[13] Term infants have been found to have more coordinated suck-swallow rhythms than preterm infants, with fewer apneic periods during swallowing. An infant's ability to coordinate suck-swallow-breathe is essential for feeding safety and effectiveness.[12]

Lau and Henning[14] conducted pre- and postweights on 1 pair of 2-month-old twins and found a significant strong positive correlation between swallow counts and weight gain (r = .92 and .98). Videotapes of these feeds were found to be effective and did not disrupt the feeding.

More recently, Riordan et al[10] conducted a study of breast milk intake indicators with 82 infants, including audible and observable swallows, pre- and postfeed weights, rooting, length of time to latch, latch, and suckle. Assessments were done at 96 hours of age and greater than 96 hours; separate regression models were tested to determine the best predictors of milk intake. The significant finding—that it was the interaction between type of swallow and age of baby that predicted breast milk intake—was published after data for the study reported here were collected.

No identified study has examined the accuracy and consistency of swallowing assessments to evaluate breast milk intake in the first 2 to 3 days postpartum. Therefore, the broad purpose of this study was to examine whether counting swallows during a breastfeed in the first days of life is a reliable and valid measure of breast milk intake. The specific research questions were: (1) What is the relationship between the number of swallows and breast milk intake? (2) What is the interrater reliability of swallow counts by 2 experts at the bedside and on videotape? (3) What variable is the best predictor of breast milk intake?

Methods

Institutional review board approval was received from Syracuse University and St Joseph's Hospital Health Center. Data were collected May to August 2004.

Sample

A convenience sample of healthy postpartum mothers and infants at an urban hospital were recruited to participate in this study. Inclusion criteria were the following: healthy, stable term infants with a healthy mother, determined to be "breastfeeding well." Infants and their mothers were excluded if the infant was less than 37 weeks' gestation or had congenital anomalies that would interfere with breastfeeding (eg, cleft lip), mother had a history of invasive maternal breast surgery, or breastfeeding difficulties were identified that required IBCLC assessment and intervention (eg, supplementary or complementary feeds).

Procedure

Staff nurses identified mothers and infants who met the inclusion criteria, in consultation with the lactation consultant if necessary, and asked eligible mothers if they would be willing to learn about a breastfeeding study. The principal investigator (PI) then obtained informed consent. The equipment was set up prior to the next anticipated feeding so as not to interfere with the infant's own cues to feeding readiness. Telephones and televisions were turned off to reduce noise.

One naturally occurring feeding segment was observed of each dyad. The length, determined by the infant and mother, was often at a single breast. The PI was at the bedside; she assisted the mother and infant with good position and latch, as needed, and offered quiet verbal support to increase mother's relaxation. The PI focused on listening (not on watching the feed) once mother stated that baby was comfortably latched and started recording, noting each audible swallow by tapping a silent calculator. The entire feeding was also videotaped by a research assistant using a Canon NSC ZR70 digital video camcorder (Canon, Tokyo, Japan) with an external lapel microphone clipped to the infant's T-shirt.

Interrater Reliability

Two ratings of swallowing were completed. The first was done at the bedside by the PI, a certified LC with 30 years of experience, as described above. The second rater, a Master's prepared nurse and a certified hospital-based LC with more than 20 years of experience, blind to the infant data, independently viewed the video recordings of each feeding. Methods of assessing interrater reliability from this procedure are described below in the Statistical Analysis section.

Measures

Infant Characteristics

Infant age was calculated as hours since birth at the time of the index feeding. Gestational age was calculated as the difference between the estimated date of confinement (EDC) and the birth date, rounded to the nearest week. Birth weight, in grams, was gathered from the medical records.

Maternal Characteristics

Maternal age was recorded in years on the day of admission. Type of delivery, either vaginal or cesarean, was extracted from the delivery record. Previous breastfeeding experience was verbally collected from the mother by asking, "Have you ever breastfed before?" and "Did you feel that you were successful?" Possible answers were never breastfed before, tried but never successful, breastfed 1 baby successfully, breastfed 2 babies successfully, and breastfed 3 or more babies successfully. The definition of "successful breastfeeding" was individually determined by maternal self-report.

Swallows

Audible swallow is defined as the sound produced when an infant closes his or her glottis and moves the bolus of liquid toward the esophagus with his or her tongue; each distinct sound is counted as a single swallow. The quality of the swallow (gulp vs "ku" vs click) was not a component of this measure, simply the presence of a swallow sound. Each swallow sound was counted as one. The number of audible swallows obtained by the PI's in-person assessment was used in subsequent correlation and regression analyses.

Length of a feed in minutes was collected at the time of the feed, confirmed by the time on the videotape. The recorder was started when good latch was achieved and confirmed by the mother.

Natural segment of a feeding

Prior to data collection, mothers were instructed to continue to feed their baby until they determined that the baby was "done." Baby coming off the breast on his or her own, as well as content, was a common sign to mothers that their baby was done. If the infant indicated a desire to continue nursing, he or she was relatched, and the remainder of the feeding segment was counted and videotaped.

Milk Intake

Milk intake was determined through pre- and postweights, adjusted by the estimation of insensible water loss during the feed.

A Medela Baby Weigh Scale was used for pre- and postfeed weights, accurate within ±2 g. This scale has been used in other studies[9] and found to have high levels of reliability and validity. A single scale was used in this study; it was housed on a utility cart that was pushed into the patient's room for data collection. Calibration was checked daily; recalibration was never necessary. The preweight was locked into the scale but also recorded by the research assistant; the scale calculated a change in weight postfeed, but each calculation was double-checked for accuracy. A single prefeed weight and a single postfeed weight were obtained. Data collected included preweight, postweight, and weight gain. The PI was blind to the weight until the session was complete.

All infant weights were measured in grams. Clothing was generally a T-shirt and diaper; all clothing included in the prefeed weight was included in the postfeed weight. One gram of weight is equal to 1 cc of breast milk.[15,16]

Insensible water loss was estimated in grams with the calculation used by Dewey and colleagues[17] (ie, the product of 0.05 g/kg of the infant's weight times minutes of each feed). The prefeed weight was used as the infant's weight in this estimate. The resultant variable was "milk intake," the dependent variable that reflected change in weight pre- and postfeed, as well as the estimated insensible water loss for the length of each feed.

Statistical Analysis

A power analysis, to determine minimum sample size to achieve power of .80, with an anticipated large effect size[14] and a significance level of $\alpha = .05$, indicated a minimum of 19 participants.[18]

SPSS 18.1 (SPSS, Inc, an IBM Company, Chicago, Illinois) and SAS v9.3 (SAS Institute, Cary, North Carolina) were used for data analysis. Demographic data were analyzed using descriptive statistics and frequency distributions. Scatter plots and Pearson or Spearman correlations were examined in bivariate analyses. For example, to further examine the relationships between audible swallows and infant age, as well as audible swallows and milk intake, in infants with low milk intake (10 g or less), scatterplots were created to visually display the association between data points of these variables according to the low milk intake group. Low milk intake was broadly defined as 10 g or less to include those at or below the mean intake in this sample. Interrater reliability for number of swallows from the 2 LCs was examined in bivariate analysis and with a Bland-Altman assessment.[19-23] A range of agreement was defined as mean bias (difference in number of swallows) $\pm\, t_{.025,29} \times$ SD of differences, where $t_{.025,29}$ is the appropriate quantile from a t distribution.

Multiple linear regression for milk intake as the dependent variable and infant age, audible swallows, weeks gestation, birth weight, and length of feed as potential independent variables was performed. Regression assumptions were checked and included an analysis of residuals.[24,25] One outlier was removed; the remaining data met the criteria. All analyses were based on the in-person swallow counts obtained by the PI. Multiple regression was conducted with 2 steps in a hierarchical regression approach[26]; infant age was entered in step 1. Primary interest then involved performing multivariable analyses to examine the following factors possibly related to milk intake, after controlling for infant age: audible swallows, length of feed, birth weight, gestational age, and type of delivery.

Results

Sample Characteristics

Three mother-baby dyads consented but not were included in the study due to missing data; 1 mother-baby dyad was an outlier on number of swallows and weight gain and was therefore not included in the analyses. Therefore, 30 mothers and their infants with complete data made up this sample (Tables 1 and 2 present sample characteristics for mothers, infants, and feeding).

Table 1.

Table 1. Characteristics of the Mothers in the Sample (n = 30)

	Range or No.	Mean or %	SD	Median	Interquartile Range
Characteristic of mothers					
Age, yr	21-39	30.9	5.1		
Race					
White	27	90.0%			
Black	2	6.7%			
Asian	1	3.3%			
Obstetrical history					
Pregnancies	1-6			2.0	2.0
Live births	1-5			2.0	2.0
Delivery mode					
Vaginal	15	50.0%			
Cesarean	15	50.0%			
Breastfeeding experience					
Never before	15	50.0%			
Tried without success	1	3.3%			
Success ×1 baby	5	16.7%			
Success ×2 babies	6	20.0%			
Success >2 babies	3	10.0%			

Characteristics of the Mothers in the Sample (n = 30)

Table 2.

Table 2. Characteristics of Infants and Index Feed in Sample (n = 30)

	Range or No.	Mean or %	SD	Median	Interquartile Range
Characteristics of infants					
Gestational age, wk	37-41	39.2	1.2		
Sex					
Male	18	60.0%			
Female	12	40.0%			
Birth weight, g	2105-5615	3682.2	625.4	3720.0	
Characteristics of feeding					
Age at time of feed, h	9-75			32.5	1.0
Length of feed, min	4-30	15.5	5.4	15.0	
Swallows at bedside (PI)	13-165			44.5	50.0
Swallows by rater 2 (LC)	5-205			41.0	53.0
Prefeed weight, g	2718-5322	3638.8	539.1		
Weight gain, g	–2.0-48.0			2.0	6.0
Milk intake, g	–0.3-52.3			4.6	7.0

LC, lactation consultant; PI, principal investigator.

Characteristics of Infants and Index Feed in Sample (n = 30)

Mothers were aged 21 to 39 years, primarily white, and multigravid; mode of delivery was evenly split between vaginal and cesarean section. Breastfeeding experience included the full range, with 50% having never before breastfed; 36.7% successfully breastfed 1 to 2 babies. Infants were 9 to 75 hours old (mean [SD], 35.0 [17.4]) at the time of the index feeding, and feeds lasted 4 to 30 minutes. Tables 1 and 2 provide descriptive statistics of the maternal and infant data.

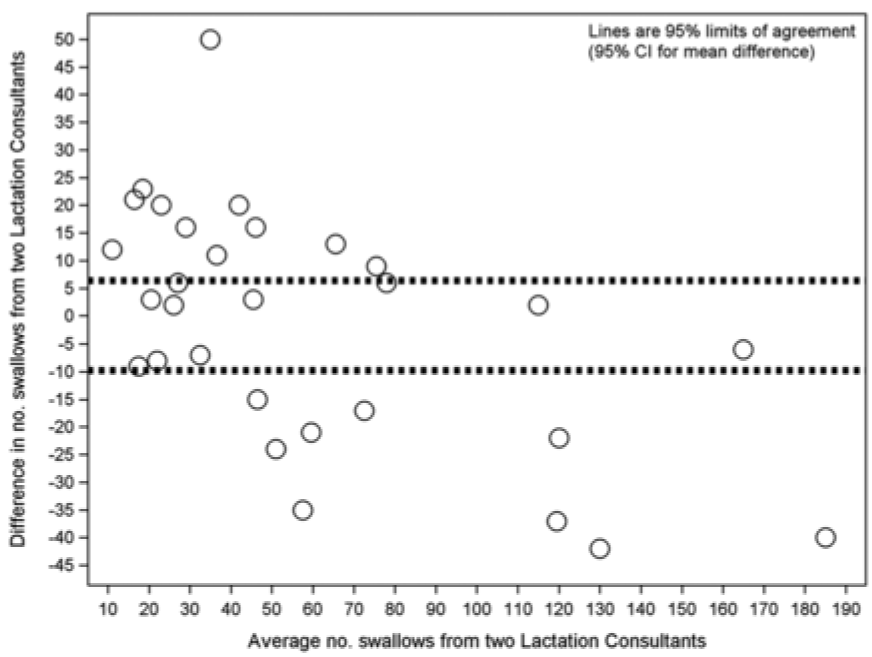
Swallows and Breast Milk Intake

The number of swallows at the bedside (n = 30) was significantly and positively correlated (Pearson product moment) with breast milk intake ($r = .71$; $P < .01$), indicating that the swallow count is related to intake but accounts for only 50.8% ($R^2 = .508$) of the variation in swallow count and milk intake.

Interrater Reliability

The PI and rater 2 swallow counts were significantly and positively correlated ($r = .93$;$P < .01$). However, a Bland-Altman analysis estimated that the 95% limits of agreement between the 2 methods ranged from −9.728 to 6.394 for mean differences in swallows (see Figure 1). The 2 LCs did not consistently provide similar swallow numbers because the level of disagreement includes clinically important discrepancies of up to 50 swallows, and 20 of 30 differences fell outside limits of agreement (with difference SD = 21.6 g). Therefore, number of swallows is not reliable based on the data from the 2 LCs in this study.

Figure 1.



Bland-Altman plot. CI, confidence interval.

Age in Hours Since Birth

Infant age in hours (n = 30) was significantly and positively correlated with milk intake (r = .79 P < .01). Thus, the older the baby, the more milk intake there was.

Predictors of Breast Milk Intake

Infant age in hours was entered as a first step, accounting for 62% of the variance. All independent variables were entered in step 2; audible swallows was the only variable that further explained breast milk intake (R^2 change = .078; F change = 6.98; P = .013). Thus, the overall model explained 70% of the variance in milk intake. Table 3 displays the final model.

Table 3.

Table 3. Final Regression Model Predicting Milk Intake (n = 30)

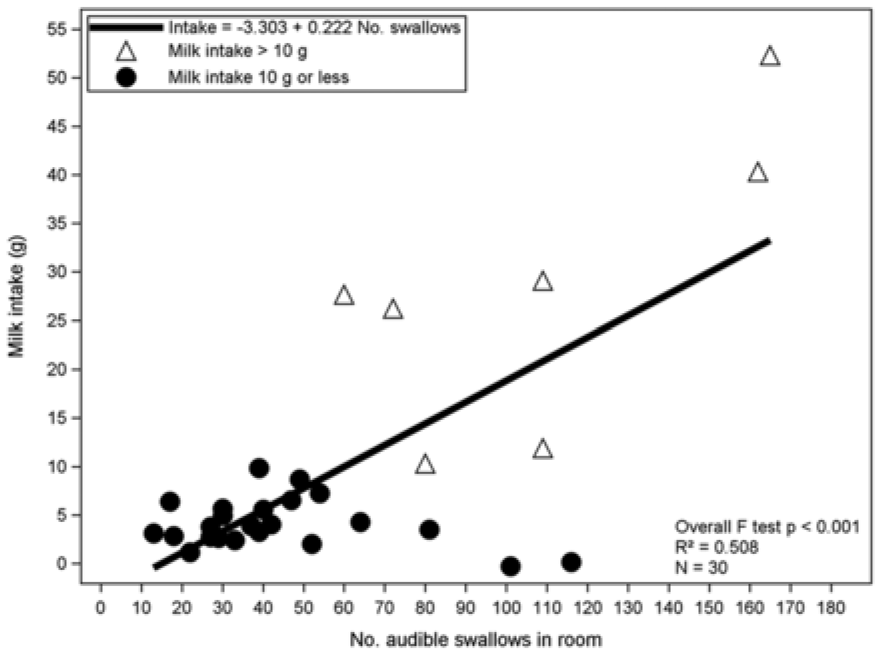
	b	95% CI for *b*	β	*t*	*P* Value
Intercept	−11.076	−17.211-−4.941		−3.704	.001
Infant age, h	.408	.206-.610	.563	4.147	<.001
Audible swallows in room	.112	.025-.198	.359	2.643	.013

R^2 = .700; adjusted R^2 = .677; *b* is unstandardized regression coefficient; β is standardized regression coefficient.

Final Regression Model Predicting Milk Intake (n = 30)

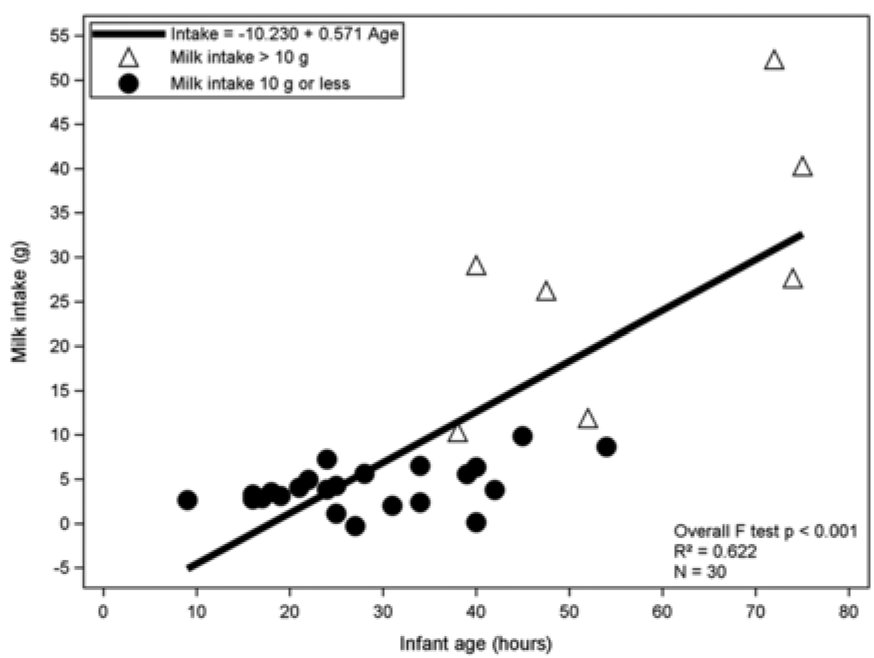
To visually examine the relationships of the key variables in the entire sample (regression line) as compared with the infants with intake 10 g or less (n = 23) with those with intake >10 g (n = 7), we generated scatterplots. Figure 2 depicts the bivariate relationships between audible swallows and milk intake for the individual infants with ≤10 g intake and >10 g intake as compared with the line of best fit for the entire sample (regression line). Figure 3 depicts the bivariate relationships between infant age and milk intake for individual infants with ≤10 g intake and >10 g intake as compared with the line of best fit for the entire sample group. Both scatterplots indicate no clear relationship within the intake groups.

Figure 2.



Simple linear regression of infants' milk intake on number of audible swallows.

Figure 3.



Simple linear regression of infants' milk intake on age in hours.

Discussion

Findings from this study of 1 breastfeeding session of 30 mother-baby dyads in the postpartum hospital setting indicate that although there is a significant, positive relationship between number of swallows and breast milk intake, swallows alone account for only half of the variance or variation in milk intake. Thus, there must be other, not yet identified predictors of milk intake beyond swallows to explain the other half of the variability in milk intake. Infant age was found to be the best predictor of intake in this study, which accounted for 62% of the variance in milk intake by itself. However, infant age and number of swallows together only accounted for 68% of milk intake. These findings are consistent with those reported by Riordan and colleagues.[10] These findings are also consistent with the fact that lactogenesis stage II occurs 48 to 72 hours after birth, and most of these data were collected prior to that period when quantity of milk is low. It therefore follows that assessment of swallows should be postponed until lactogenesis stage II has occurred, which coincides with the increase in the infant's age.

These findings are reasonable knowing that lactogenesis and breastfeeding are multifaceted processes with numerous variables affecting them. Neonates feed several times across a day, with varying length of feeds and with increasing amounts of breast milk available as time since birth increases.[22] The infants in this sample had highly variable lengths of feeds; it seems logical that shorter feeds would result in lower intake, but the median milk intake in this study was 2.6 ml, indicating that many infants had low intake at a single feed. Indeed, 23 of the 30 infants had intake of 10 g or less. The scatterplots provide further evidence that among the low-intake infants (the clear majority), swallow counts are not useful in relationship to milk intake or infant age. Although statistical significance should be noted, clinical significance must be considered. The case in point—a 24-hour-old infant with greater than 300 audible swallows during the 17-minute feed (the outlier removed from the regression analysis) but took in only 2 ml of breast milk—illustrates an instance where swallow counts would not be a clinically useful assessment of breastfeeding adequacy. A clear explanation for these data is not possible with available data. Nonnutritive sucking is not generally accompanied by many swallows (defined as 2 or more sucks per second), so this may not be the most plausible explanation; perhaps this baby had a lot of saliva or mucous that provided fluid to swallow. Genna[27] states that fluid volume is required for nutritive sucking, with a slower rate of 1 suck per second; the suck/swallow ratio cannot be calculated with available data. Clinical relevance and statistical significance are neither synonymous nor symmetrical. The current study demonstrates that swallows should not be one of the assessments clinicians make during breastfeeding assessments in the first days of life. Also, the swallow counts by different lactation consultants were not replicable, given the extreme variability in count differences observed.

Strengths of the study include the time period for data collection, in the days immediately following birth, and the sample size exceeding the minimum required to achieve adequate statistical power. It must be kept in mind that the infants in this study were all healthy, and were all determined to be nursing well. Infants who do not latch well need continued assessment and assistance. Findings of this study can be generalized only to other healthy, term infants who have a good initiation of breastfeeding in the hospital.

There were several notable limitations of this study. The study would have been strengthened if suck-to-swallow ratios were noted to allow the rate of swallowing to be calculated.[21] In addition, swallow assessments should have included both observable and audible swallow counts for all raters, as suggested by Riordan et al,[10] whose study was published after these data were collected. Although the scale used to assess infant weight was deemed appropriate in prior work, the margin of error is too imprecise for the first days of life, given that the median intake was 2 g (same as the margin of error of ±2).

Although it was not possible to have 2 raters at the bedside for each feeding session because of scheduling and space restrictions as well as concerns for the mother's comfort level, in-person assessments are superior to video recordings. Although the quality of video recordings was generally quite good, infant position and sound quality placed restrictions on the second rater.

The hospital setting poses many challenges to researchers, including restricted availability of infants of each and every hour of age. In addition, the hospital setting is not ideal from the standpoint of optimal breastfeeding establishment. Maternal discharge is often based on insurance coverage and not the quality of breastfeeds; maternal milk supply is rarely well established prior to discharge. Lactogenesis stage II is often just beginning at the time of discharge, making assessments of the adequacy of milk supply difficult. Clinicians need more specific criteria to determine need for intervention or delayed discharge. Follow-up following discharge is critical for all breastfeeding mothers and their infants.

Conclusion

The findings from this study do not support the use of swallow counts as a measure of breast milk intake in the first days of life. Future research is needed to determine what assessments are useful in those critical days in the hospital when breastfeeding is being initiated and neonatal intake data are limited.

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