Pumping Milk Without Ever Feeding at the Breast in the Moms2Moms Study

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Abstract

Background: More than 85% of contemporary lactating women in the United States express their milk at least sometimes. Some produce milk exclusively through pumping. We characterized women who pumped but never fed at the breast and compared their infant feeding practices with those of women who fed at the breast with or without pumping.

Subjects and Methods: Study participants were those delivered at Ohio State University Wexner Medical Center in 2011 and completed a questionnaire at 12 months postpartum ($n=478$). We used bivariate and multivariate approaches (survival analysis) to compare women who pumped but never fed at the breast with women who fed at the breast with or without pumping.

Results: Women ($n=33$, 6.9%) who pumped but never fed at the breast comprised a diverse group but were more likely to have delivered preterm and were of lower socioeconomic status on average. They initiated pumping and formula feeding earlier (median=day 1 after delivery) and were more likely to report difficulty making enough milk compared with women who fed at the breast with or without pumping. They had much shorter total duration of milk production (adjusted hazard ratio=3.3, 95% confidence interval: 2.1, 5.2) after controlling for clinical and sociodemographic confounders.

Conclusions: Pumping without feeding at the breast is associated with shorter milk feeding duration and earlier introduction of formula compared with feeding at the breast with or without pumping. Establishing feeding at the breast, rather than exclusive pumping, may be important for achieving human milk feeding goals.

Keywords: breast pump, human milk expression, feeding at the breast, breastfeeding, human milk supply

Introduction

HUMAN MILK EXPRESSION (pumping) has become popular in the United States. More than 85% of infants fed human milk are fed expressed milk from a bottle at least sometimes.^{1,2} Major reasons women express milk include latch difficulty, facilitating someone else feeding the infant, building an emergency supply, relieving engorgement, and increasing milk supply.^{1,3} In addition, mothers of preterm neonates are often encouraged to express milk because their infants are too immature to feed at the breast.

Women who pump frequently have been found to have shorter overall human milk feeding duration than women who pump less, thereby reducing the infant's total exposure to human milk.⁴ Recent observational studies have suggested

that feeding expressed human milk from a bottle may be less optimal for a variety of child health outcomes.^{5–7} Thus, expressed milk may not be an equivalent substitute for feeding at the breast.

Milk expression has traditionally been considered a complement to feeding at the breast, something that is practiced out of necessity because mother and infant are temporarily separated or because the infant cannot feed at the breast. However, today some women pump without ever feeding their infant at the breast. In the U.S. Infant Feeding Practices Study II (IFPS II), 5.6% of women feeding human milk did so exclusively by milk expression.⁸ The characteristics of these women and how long they are able to produce milk for their infant remain largely unexplored. This hampers efforts to provide tailored lactation support for these dyads.

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The objective of this study was to characterize women who pumped milk to feed their infant but never fed at the breast ("Pump Only" group) in comparison with a group of women who fed at the breast with or without also pumping ("Breast $\pm$ Pump" group), in terms of sociodemographics and infant feeding practices. We analyzed data from our Moms2Moms cohort of women who delivered their infants at a major academic medical center in 2011.

Materials and Methods

Study population and data collection

A roster was assembled of all English-speaking women ≥ 18 years old who delivered a singleton, liveborn infant at >24 weeks' gestation at The Ohio State University Wexner Medical Center (OSUWMC) during 5 months of 2011 ($n=1,244$). A 5-month window was the available period between when the study was ready to begin and when the hospital changed medical record systems. OSUWMC operates a large delivery service for both high- and low-risk obstetric patients in Columbus, Ohio. Women lacking contact information ($n=111$), prisoners ($n=11$), and infant deaths ($n=6$) were excluded. Women whose medical record indicated their intention to exclusively "bottle feed" their infant ($n=303$) were also excluded. On this labor and delivery unit, the "bottle feed" designation was for women who intended to formula feed.

Twelve months postdelivery, a questionnaire was mailed to eligible women to assess breast milk production by the mother and infant feeding behaviors from birth through 12 months and demographics. A \$10 incentive was provided.

Study variables

Maternal age, parity, mode of delivery, health insurance status, gestational age, and whether the infant was admitted to the neonatal intensive care unit (NICU) were obtained from the obstetric medical record. Maternal education, marital status, race and ethnicity, household income, receipt of women, infants, and children (WIC) benefits during pregnancy or postpartum, maternal smoking during pregnancy or postpartum, maternal employment or school enrollment since delivery, use of child care outside the home, and infant length of hospital stay were measured through the questionnaire. Perceptions of low milk supply or overproduction were assessed by asking on the questionnaire whether she ever had difficulty in making enough breast milk to feed her child and whether she ever made more milk than needed. These formed binary variables for analysis.

The questionnaire inquired about the age of the woman's infant when she initiated and ceased feeding the infant directly at the breast, pumping milk to feed the infant, feeding the infant pumped milk, and feeding the infant formula, and also when she started feeding foods other than breast milk, formula, juice, or water. Duration variables in units of days for each milk production or feeding behavior were calculated by subtracting the infant age when the behavior was initiated from the age when it ceased. Women who had not ceased a given behavior by the time of questionnaire completion were censored at 365 days for the purposes of survival analysis. Binary variables (ever/never) for each behavior were also created.

Women were grouped based on their lactation history for the entire 12-month infancy period. Women who ever pumped milk and never fed their infant directly at the breast formed the group of primary interest ("Pump Only" group). Women who ever produced human milk to feed their infant, whether by feeding directly at the breast and/or pumping but not exclusively by pumping, served as the comparison group ("Breast $\pm$ Pump" group). There were too few women who exclusively fed at the breast and never pumped to serve as the comparison group. Women who never pumped or fed directly at the breast (i.e., exclusive formula feeders) were excluded.

Statistical analysis

Univariate statistics were used to examine each variable and describe the sample. The characteristics of the Pump Only group were compared with the Breast $\pm$ Pump group using chi-square, Fisher's exact, and Wilcoxon rank sum tests. The groups were also compared in terms of milk production and infant feeding practices (continuous and binary variables). Median total milk production duration and pumping duration were calculated by group and stratified by infant hospital length of stay to show how duration varied by each of these variables simultaneously.

Cox proportional hazards regression was used to examine differences between the Pump Only group and the Breast $\pm$ Pump group in their total duration of producing milk, pumping duration, and the child's duration of feeding expressed milk. Adjusted hazard ratios (HRs) were generated from models that included a parsimonious set of confounders associated with pumping without feeding at the breast (Table 1): mode of delivery, insurance status, infant hospital length of stay, maternal education, smoking, and employment or school enrollment since delivery. Highly collinear covariates based on Pearson's $r > 0.7$ were omitted.

To further examine the role of hospital length of stay, the Pump Only group was categorized into three subgroups based on logical groupings identified through visual inspection of the plotted data: (1) those who pumped during the infant's hospital stay only, (2) those who continued to pump after infant hospital discharge but for <60 total days, and (3) those who continued to pump after infant hospital discharge for >60 total days. Survival analyses were repeated as models stratified by preterm status. All analyses used SAS 9.3 (Cary, NC). This study was reviewed and approved by The Ohio State University Biomedical Institutional Review Board.

Results

Participant characteristics

Of 813 mailed questionnaires, 501 were completed (61.6%). Two were excluded for unintelligibility. Women ($n=21$) who never fed at the breast or pumped milk during the first 12 months postpartum, despite their stated intentions during the delivery stay, were excluded, leaving 478 questionnaires. Of these 478, 33 formed the Pump Only group and 445 formed the Breast $\pm$ Pump group. Almost all (401, 91%) of the Breast $\pm$ Pump group fed at the breast and pumped, only 39 women (8.9%) provided milk exclusively by feeding at the breast. The women in the Pump Only group did not differ from the women in the Breast $\pm$ Pump group in terms of age, parity, marital status, race and ethnicity, employment, or child care, although

TABLE 1. CHARACTERISTICS OF WOMEN WHO PUMPED WITHOUT FEEDING THEIR CHILD AT THE BREAST (PUMP ONLY GROUP) COMPARED WITH THOSE OF WOMEN WHO FED THEIR CHILD AT THE BREAST WITH OR WITHOUT PUMPING (BREAST ± PUMP GROUP) (N=478, Moms2Moms STUDY, OHIO, 2011–2012)

	Women who pumped without feeding their child at the breast (Pump Only group) (n = 33) n (%)			Women who fed their child at the breast with or without pumping (Breast ± Pump group) (n = 445) n (%) ^a	Chi-square or Fisher's exact test p-value (comparing Pump Only with Breast ± Pump)
	All (preterm + term)	Preterm	Term		
Maternal age—19–26	9 (29)	5 (29)	4 (25)	76 (18)	0.32
27–34	17 (52)	7 (41)	10 (63)	244 (58)	
≥35	6 (19)	4 (24)	2 (13)	98 (23)	
Missing	1	1		27	
Parity—1 (0 previous live births)	18 (55)	10 (59)	8 (50)	219 (49)	0.38
2	7 (21)	3 (18)	4 (25)	144 (32)	
≥3	8 (24)	4 (24)	4 (25)	82 (18)	
Health insurance—private	20 (61)	9 (53)	11 (69)	361 (81)	<0.01
Public or none	13 (39)	8 (47)	5 (31)	83 (19)	
Missing				1	
Maternal education—some college or less	22 (67)	13 (76)	9 (56)	123 (28)	<0.0001
College graduate+	11 (33)	4 (24)	7 (44)	321 (72)	
Missing				1	
Marital status—married or living with a partner	27 (82)	14 (82)	13 (81)	398 (90)	0.16
No partner	6 (18)	3 (18)	3 (19)	46 (10)	
Missing				1	
Race and ethnicity—non-Hispanic Caucasian/white	24 (73)	10 (59)	14 (88)	342 (77)	0.57
Other race and ethnicity	9 (27)	7 (41)	2 (13)	102 (23)	
Missing				1	
Household income—<\$35,000	18 (55)	10 (59)	8 (50)	122 (28)	<0.01
Missing				2	
WIC receipt	16 (48)	10 (59)	6 (38)	111 (25)	<0.01
Missing				2	
Smoker (pregnancy or postpartum)	7 (21)	3 (18)	4 (25)	27 (6)	<0.01
Missing				1	
Employed or enrolled in school >20 hours/week since delivery	18 (55)	10 (59)	8 (50)	307 (69)	0.09
Child has attended child care outside the home	16 (48)	9 (53)	7 (44)	218 (49)	
Missing				1	
Cesarean section	18 (56)	8 (50)	10 (63)	156 (37)	0.03
Missing	1	1		26	
Gestational age <37 weeks (preterm)	17 (52)	17 (100)	0 (0)	34 (8)	<0.0001
Infant admitted to NICU	19 (58)	15 (88)	4 (25)	49 (11)	
Infant hospital length of stay (days)	Median = 7 (IQR = 26)	Median = 29 (IQR = 112)	Median = 4 (IQR = 25)	Median = 2 (IQR = 1)	

^aProduced at least some breast milk through direct breastfeeding with or without pumping, but not exclusively by pumping. IQR, interquartile range; NICU, neonatal intensive care unit; WIC, women, infants, and children.

small number of women sometimes precluded detailed analysis. The Pump Only group was more likely to be publicly insured or have no insurance, have less than a 4-year degree, have household income of <\$35,000, receive WIC, smoke, have had a Cesarean section, have delivered preterm, have their infant admitted to the NICU, and have an infant with a longer postnatal hospital stay (Table 1). Because 52% of the infants in the Pump Only group were born preterm, characteristics by preterm status are also displayed. The preterm infants in the Pump Only group were born at a mean gestational age of 32 weeks (standard deviation [SD]=3), whereas the preterm infants in the Breast±Pump group were born at a mean 34 weeks (SD=2), and both ranged 26–36 weeks.

Producing human milk and other infant feeding practices

Although all women in the Breast±Pump group fed at the breast at least once, pumping was also very common: almost

all of them (91%) pumped at least once (Table 2). However, women in the Pump Only group initiated pumping earlier (median=1 day of life versus 5 days, $p<0.0001$), 76% of them on the day of delivery. The Pump Only group was also more likely to have ever fed formula by 12 months postpartum (100% versus 86%, $p=0.01$), and they started formula earlier (median=1 day of life [interquartile range (IQR)=13] versus 3 days [IQR=89], $p<0.01$). They were also more likely to report ever having difficulty making enough milk (91% versus 75%, $p=0.04$) compared with the Breast±Pump group.

The two groups did not differ by whether they ever made more milk than needed for their child or when they started solid foods, based on $p<0.05$. Table 2 also displays results for these practices separately by preterm status within the Pump Only group.

Woman in the Pump Only group had a median duration of producing milk of 56 days (IQR=99), meaning they were much more likely to stop producing milk sooner (HR=3.7, 95% confidence interval [CI]: 2.6–5.4) and to stop pumping

TABLE 2. INFANT FEEDING PRACTICES AMONG WOMEN WHO PUMPED WITHOUT FEEDING THEIR CHILD AT THE BREAST (PUMP ONLY GROUP) COMPARED WITH THOSE AMONG WOMEN WHO FED THEIR CHILD AT THE BREAST WITH OR WITHOUT PUMPING (BREAST±PUMP GROUP) (N=478, MOMS2MOMS STUDY, OHIO, 2011–2012)

	<i>Women who pumped without feeding at the breast (Pump Only group) (n=33) n (%)</i>			<i>Women who fed at the breast with or without pumping (Breast±Pump Group) (n=445) n (%)</i>	<i>Chi-square p-value (comparing Pump Only with Breast±Pump)</i>
	<i>All (preterm + term)</i>	<i>Preterm</i>	<i>Term</i>		
Ever fed own child directly at the breast	0	0	0	445 (100)	—
Ever pumped milk for the purpose of feeding own child	33 (100)	17 (100)	16 (100)	401 (91)	—
Missing				5	
Ever fed infant pumped milk	33 (100)	17 (100)	16 (100)	404 (91)	—
Ever fed formula during first year	33 (100)	17 (100)	16 (100)	382 (86)	0.01
Ever had difficulty making enough milk for own child	30 (91)	17 (100)	13 (81)	334 (75)	0.04
Ever made more milk than needed for own child	10 (31)	4 (24)	6 (38)	215 (49)	0.06
Missing	1		1	2	
			Median (IQR)		Wilcoxon rank sum test p-value
Infant age when woman initiated pumping (days)	1 (0)	1 (1)	1 (0)	5 (19)	<0.0001
Infant age when initiated expressed milk feeding (days)	2 (3)	2 (3)	2 (4)	10 (39)	<0.01
Infant age when initiated formula feeding (days)	1 (13)	1 (59)	1 (9)	3 (89)	<0.01
			Mean (SD)		t-test p-value
Infant age when started foods other than breast milk, formula, water, juice (days)	185 (75)	180 (60)	180 (90)	167 (50)	0.19

Missing data: age when started foods (1).
SD, standard deviation.

sooner (HR=2.6, 95% CI: 1.8–3.8) than the Breast±Pump group (Table 3). The Pump Only group's infants also had shorter expressed milk feeding duration (HR=2.9, 95% CI: 2.0–4.1). The Breast±Pump group had a median total duration of producing milk for their infant of 228 days (IQR=275) and a median pumping duration of 170 days (IQR=209). When separated by infant hospital length of stay, duration appeared to decrease with longer length of stay in both groups, but the magnitude of differences between the Pump Only and Breast±Pump groups was much larger in every length of stay group. Differences in the duration outcomes were somewhat attenuated after controlling for health insurance, education, smoking, and maternal employment or enrollment in school, mode of delivery (vaginal versus Cesarean section), and length of hospital stay, but effect estimates remained of medium magnitude.

The unadjusted survival models stratified by preterm status revealed similar findings for preterm and term infants, with slightly stronger associations for preterm infants and weaker associations for term infants (Table 3). The adjusted survival models for the preterm group were too unstable to produce reliable effect estimates.

Subgroups of women in the Pump Only group—by gestational age and hospital length of stay

Because gestational age at delivery and length of the hospital stay were associated with membership in the Pump Only group, we explored relationships among these variables by placing women in the Pump Only group into three subgroups (Fig. 1). Some women ($n=9$) pumped only while their child was hospitalized and stopped before or within a few days of discharge. Another group of 11 women pumped for <60 total days, which was generally well beyond their child's hospitalization. A third group of 13 women pumped for >60 total days, well beyond their child's hospital stay; half of these pumped for 6 months or more. Of the 17 women in this study whose infants were born extremely or very preterm (<32 weeks), 11 were in the Pump Only group (3 of them pumped for 6 or more months). The other six with gestational age <32 weeks transitioned to at least partial feeding at the breast, and four of these six continued to produce milk for 7 months or more.

Discussion

In this retrospective cohort study, women who pumped without feeding at the breast made up 6.9% of women who produced human milk for their infant, similar to the proportion in the IFPS II (5.6%).⁸ They were characterized by lower average socioeconomic status and a higher likelihood of having had a preterm infant and an infant with a longer hospital stay than women who fed at the breast with or without pumping. They also more commonly fed formula, started pumping, or formula feeding earlier, and were more likely to report having difficulty making enough milk.

In the end, the Pump Only group produced milk for a much shorter duration (>6 months less on average). A handful of these women were able to sustain lactation for >6 months. Overall, this study suggests that exclusive pumping is a suboptimal approach to producing milk for durations currently recommended by major health organizations.

About half of the Pump Only group delivered preterm. Nevertheless, socioeconomic status and length of stay were not major confounders of our finding that the Pump Only group had a much shorter duration of total milk production and duration of pumping. This is evidenced by the very large differences in duration between the Pump Only and Breast±Pump groups versus smaller differences across hospital length of stay. It is also seen in the small shift toward the null in the effect estimates upon adjustment. Results from models stratified by preterm status were imprecise because of the reduced sample size in these analyses, but they indicated consistently reduced duration of milk production in both term and preterm dyads in the Pump Only group, just slightly more so for preterm dyads. It appears that when the entire infancy period is considered as a whole, the NICU experience and delivering an immature infant were not the only drivers of the differences in the duration outcomes.

Although this study did not have data on the reasons women chose to pump without feeding at the breast, it is likely that some could not feed at the breast initially because their infant was too immature. However, it is possible for many to transition to feeding at the breast eventually.⁹ Nevertheless, prior research has documented sociodemographic disparities in maternal goals for providing human milk in the NICU setting, and these goals have been found to differ by feeding method.¹⁰ In this study, the majority of the very or extremely preterm infants were never fed at the breast, and a few of them consumed expressed milk for many months. Dyads that transitioned appeared to continue human milk feeding for longer in this study.

The lower average socioeconomic status of the Pump Only group contrasts much of the previous literature.^{8,11} This may be partly, but not completely, explained by the proportion of this group that delivered preterm because low socioeconomic status is a risk factor for preterm delivery.¹² Given what is already known about the relationship between socioeconomic status and breastfeeding initiation and duration, it is possible that some women in the Pump Only group would not have otherwise provided human milk for their infant if it had not been for the support for pumping in the NICU.

Research focused on exclusive pumping is scant, with the exception of studies limited to the NICU and neonatal period.^{13,14} To our knowledge, this is the first study to focus on this group of women in a broader sample. One study based on the IFPS II reported that women who pump the most and initiate pumping early, especially because of difficulties feeding at the breast, tend to stop feeding human milk sooner than women who pump less or for elective reasons.⁴ They did not specifically study women who pumped without feeding at the breast, however.

Shealy et al. reported that only one-third of women in the IFPS II who pumped without feeding at the breast produced milk for >1 month, much shorter than the women in this study (61% reported duration of >1 month).⁸ The findings of Felice et al. and this study contrast two studies that found lactation duration was longer for women who expressed milk than for those who never expressed.^{15,16} It appears that a modest amount of pumping (which may have been the case for most in the studies of Win et al. and Schwartz et al.) or establishing at the breastfeeding first before initiating pumping helps women produce milk for longer than not pumping, but frequent or exclusive pumping or initiating pumping early makes it difficult to sustain lactation for a long period.

TABLE 3. ASSOCIATIONS BETWEEN PUMPING WITHOUT FEEDING AT THE BREAST AND DURATION OUTCOMES
(N=478, MOMS2MOMS STUDY, OHIO, 2011–2012)

	Total milk production duration (feeding at the breast and pumping combined) (median, IQR in days)				HR (95% confidence interval)			
	By infant hospital length of stay				Unadjusted			
	All	≤3 days	4–15 days	>15 days	All (preterm + term)	Adjusted ^a	Unadjusted	Adjusted ^a
Pump Only group	56 (99)	60 (33)	25 (106)	58 (92)	3.7 (2.6, 5.4)	3.2 (2.0, 4.9)	4.7 (2.3, 9.4)	^b 3.3 (2.0, 5.4)
Breast ± Pump group (reference group for HR)	228 (275)	240 (275)	238 (249)	148 (118)				2.4 (1.4, 4.1)
Pumping duration (median, IQR in days)								
	≤3 days	4–15 days	>15 days					
Pump Only group	56 (99)	60 (33)	25 (106)	58 (92)	2.6 (1.8, 3.8)	2.3 (1.5, 3.6)	3.5 (1.8, 6.9)	^b 2.2 (1.3, 3.7)
Women who ever fed at the breast and ever pumped (reference group for HR)	170 (209)	167 (208)	180 (210)	148 (118)				1.7 (0.98, 2.9)
Expressed milk feeding duration (median, IQR in days)								
	≤3 days	4–15 days	>15 days					
Pump Only group	56 (100)	60 (34)	21 (104)	54 (102)	2.9 (2.0, 4.1)	2.0 (1.3, 3.1)	3.6 (1.8, 7.2)	^b 2.4 (1.4, 4.0)
Children who ever fed at the breast and ever consumed pumped milk (reference group for HR)	167 (205)	160 (212)	179 (222)	147 (119)				1.5 (0.8, 2.5)

^aAdjusted models included health insurance type (public or none versus private), maternal education (five categories), maternal smoking (during pregnancy or postpartum), employed or enrolled in school >20 hours/week since delivery, mode of delivery (Cesarean section, vaginal), infant length of hospital stay (continuous, in days).

^bSample size too small to generate stable adjusted effect estimates.

HR, hazard ratio.

FIG. 1. Total duration of pumping by infant gestational age at delivery.

Several studies suggest that feeding expressed milk may be less beneficial for child health than feeding at the breast. More expressed milk feeding has been associated with otitis media and coughing/wheezing episodes in infancy and reduced satiety responsiveness at age 6 as compared with feeding at the breast.⁵⁻⁷ The reasons may be that expressed milk has altered composition from handling and storage, or feeding from a bottle differs mechanically from feeding at the breast, among several possibilities. In addition, it is difficult to fully control for confounding factors associated with feeding mode and substance and child outcomes, and reverse causation may be possible.

This study has several limitations. It lacked details about reasons women pumped, antepartum intentions, and why they stopped. Because women were selected based on a medical record feeding intentions variable that was worded imprecisely, some women may have been unintentionally excluded. However, because that information is used by hospital staff to determine patients' feeding support needs, we would expect most errors to have been fixed during the hospital stay.

Also, we were unable to explore to what extent perceptions of low milk supply caused women to pump or start pumping earlier, or whether exclusive pumping made it more difficult for women to maintain an adequate milk supply. It is possible that women who experienced the most difficulties tended to use exclusive pumping to try their best to produce milk for their infant, rather than pumping itself being the cause of shorter milk production duration. However, the Pump Only group tended to initiate pumping very soon after delivery, most on the first day. It is possible that women elected to pump rather than feed at the breast out of personal preference, because they expected to have difficulties with milk supply or feeding at the breast, or because their infant was born very early. This would be compatible with the qualitative study by O'Sullivan et al., which reported these as reasons for exclu-

sive pumping.¹¹ It also parallels the findings of another of our studies wherein 98% of women who intended to breastfeed for at least 6 months also intended to pump, and 68% intended to start pumping within the first 6 weeks or had already started pumping during the delivery stay.¹⁷

Future research should examine whether initiating pumping so soon after delivery may undermine the breastfeeding. Finally, the relatively small number of women in the Pump Only group precluded more in-depth statistical analysis and resulted in some imprecise effect estimates. However, to our knowledge, this is the largest study focused on this group, and this is a major strength of this study. The cohort design and detailed feeding and obstetric data were additional strengths.

Conclusion

This study adds to evidence that predominantly pumping rather than feeding at the breast is related to shorter total human milk production duration. Although some dyads cannot feed at the breast initially, eventual transition to the breast is possible for many. This study suggests that many do not make that transition. Lactation support to first establish feeding at the breast rather than exclusive pumping, or eventual transition to the breast if direct breastfeeding is not possible initially, may be important to meeting human milk feeding goals and optimizing child outcomes.

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