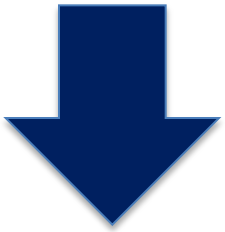
servicio
neonatología
hospital 12 de Octubre

Breast milk handling in neonatal units:

from milk expression to baby administration

Uppsala, May 2015

Mother´s Milk



Key Importance

Flow	Equipment
expression and collection	
mothers expressing at home	breastpump (Ameda Lactaline personal
or on the maternity unit	pump)
given written instructions and kit	breastshield - extension set - bottles
storage at home	refrigerator or freezer
↓	
transfer	
transport to the hospital	coolingbox
storage in the hospital (NICU)	refrigerator or freezer
↓	
storage	
milk defrosted	refigerator
defrosted milk aliquoted	bottles or syringes and tubing
pasteurized (optional)	pasteurizer (Sterifeed S75 TES)
↓	
ready for use	refrigerator
	bottle warmer (Devappa)

Fig 1. The flow of the milk.

Cossey V. Am J Infect Control 2011;

Milk Expression

"Every time I expressed milk at home I cried; that was when I most felt my daughter's absence"

Milk Expression

Milk expression is the key to success for a majority of women.

- It is a complex task that extends over a long period of time.

- It requires professional support.

- Little information is available about which expression method is best for achieving the greatest volume of milk and there is litle concern about the comfort of the mothers.

Milk Expression

Journal of Human Lactation
http://jhl.sagepub.com/

Volume of Milk Obtained in Relation to Location and Circumstances of Expression in Mothers of Very Low Birth Weight Infants

Juliana Acuña-Muga, Noelia Ureta-Velasco, Javier de la Cruz-Bértolo, Rosa Ballesteros-López, Rocío Sánchez-Martínez, Eugenia Miranda-Casabona, Almudena Miguel-Trigoso, Lidia García-San José and Carmen Pallás-Alonso

J Hum Lact 2014 30: 41 originally published online 8 November 2013
DOI: 10.1177/0890334413509140

Objective: to estimate the volume of milk obtained by mothers of very low birth weight infants as a function of proximity to the infant during the expression and the use of the kangaroo position during milk expression in the neonatal unit.

Milk Expression

Table 2. Volume (mL) of Breast Milk Expressions According to Location of Expression and Circumstances.[a]

Location and Circumstance of Expression	Unadjusted Estimate	Adjusted by Mother		Adjusted by Mother and Covariate	
	Mean (95% CI)	Mean (95% CI)	*P* Value	Mean (95% CI)	*P* Value
Far from the infant	106.3 (102.8-109.9)	97.2 (83.1-111.4)	Reference	97.4 (84.3-110.5)	Reference
Close to the infant	101.8 (97.8-105.9)	101.1 (86.9-115.3)	.045	101.2 (88.1-114.3)	.046
Far from the infant					
At home	107.6 (104.0-111.2)	98.0 (84.1-111.8)	Reference	98.4 (85.3-111.5)	Reference
In hospital, other room	74.8 (56.1-93.5)	87.3 (66.7-107.9)	.185	87.4 (67.3-107.4)	.17
In proximity to the infant					
Beside the incubator	99.4 (93.0-105.9)	96.9 (79.9-113.9)	Reference	96.7 (80.9-112.4)	Reference
KMC	104.2 (96.9-111.6)	108.0 (90.8-125.1)	.0030[b]	107.7 (91.8-123.5)	.0030[b]
After KMC	120.8 (111.1-130.5)	117.8 (98.0-137.6)	.0024[b]	117.7 (99.0-136.5)	.0024[b]
Kangaroo father care	96.2 (87.6-104.8)	103.0 (85.1-121.0)	.89[b]	102.6 (85.9-119.4)	.89[b]

Acuña Muga J, Ureta Velasco N et al. Journal Human Lactation. 2014; 30:41

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Milk Expression

Conclusions

Mothers increased the volumes of milk when pumping during kangaroo care or immediately after kangaroo care.

Pumping rooms in areas where the mother is far from the infant are **associated** with lower milk volumes than when expressions are close to the infant.

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Breastmilk Handling Routines

Breastmilk Handling Routines

- The consequences of the handling routines for the milk are poorly studied.

- There is little agreement on the breastmilk handling routines

Breastmilk Handling Routines

Quality

Safety

Nutrients are not our sole concern…

No Standardization of the Handling Routines

BREASTFEEDING MEDICINE
Volume 3, Number 3, 2008

DOI: 10.1089/bfm.2007.0033

Breastmilk Handling Routines for Preterm Infants in Sweden: A National Cross-Sectional Study

Soley Omarsdottir,[1] Charlotte Casper,[1,2] Agneta Åkerman,[3] Staffan Polberger,[3] and Mireille Vanpée[1]

No Standardization of the Handling Routines

TABLE 4. NUTRITIONAL ANALYSIS AND MAXIMUM FREEZING TIME OF DONOR MILK AND MATERNAL MILK IN THE NEONATAL UNITS

	Donor milk	*Maternal milk*
Nutritional analysis		
Before pasteurization	14	
After pasteurization	2	
Once per week		7
Every other week		15
When needed	1	3
No analysis	10	11
Maximum freezing time		
3 months	4	11
4 months		1
6 months	23	24

Omarsdottir S. Breastfeeding Medicine. 2008

No Standardization of the Handling Routines

TABLE 3. DURATION OF FREEZING AND GESTATIONAL AGE OF INFANTS ONLY RECEIVING FREEZE-THAWED MATERNAL MILK

Hospital	*Duration of freezing (−20°C)*	*Gestational age*
Västervik Hospital	At least 3–4 hours	≤32 weeks
Kalmar Hospital	1 day	≤32 weeks
Norrköping	1 day	≤32 weeks
Linköping University Hospital	1–3 days	≤32 weeks
Karlskrona Hospital	2 days	≤30 weeks
Umeå University Hospital	2 days	≤32 weeks
Östersund Hospital	2 days	≤32 weeks
Jönköping Hospital	3 days	≤32 weeks
Växjö Hospital	3 days	≤30 weeks
Örebro University Hospital	3 days	≤32 weeks
Lund University Hospital	7 days	≤32 weeks

Omarsdottir S. Breastfeeding Medicine. 2008

Key Points

1. Which are the optimum containers?
2. What happens to the milk during freezing?
3. What happens to the milk after defrosting?
4. What happens during administration?

1. Which are the optimum containers?

Risks surrounding bottling and handling

1. Risk of modifying the nutritional properties:
   - Adherence of nutritional substances to the surfaces.
   - Breaking the cold chain: mixing the milk of various expressions.

2. Risk of modifying the microbiological characteristics.

1. Risk of altering the organoleptic properties: Smell, color

1. Risk in handling the milk:
   - Cap, unbreakable containers.
   - Facilitate the bottling, processing and storage.

1. Which are the optimum containers?

Hard Plastic (polypropylens) Single Use

- **Glass (Pyrex)**
  - Repeated use
  - Risk of breakage.

Sterilized

•. Not recommended
- Plastic bags (polyethylene)
- Hard polycarbonate plastic (bisphenol A BPA)

1.Which are the optimum containers?

. Risks in labeling

.Risk in mixing up different milk from different mothers

Fleischman EK. Innovative application of bar coding technology to breast milk administration. J Perinat Neonat Nurs 2013; 27 (2): 145-150

2. What happens to the milk during freezing time?

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BREASTFEEDING MEDICINE
Volume X, Number X, 2011

DOI: 10.1089/bfm.2011.0079

Original Article

Effect of Freezing Time on Macronutrients and Energy Content of Breastmilk

Nadia Raquel García-Lara,[1] Diana Escuder-Vieco,[1,2] Oscar García-Algar,[2,3] Javier De la Cruz,[4] David Lora,[4] and Carmen Pallás-Alonso[1,2]

2. What happens to the milk during freezing time?

MACRONUTRIENT AND CALORIC CONTENTS OF BREASTMILK ADJUSTED FOR FREEZING TIME, TYPE OF HOMOGENIZATION, AND STAGE OF LACTATION

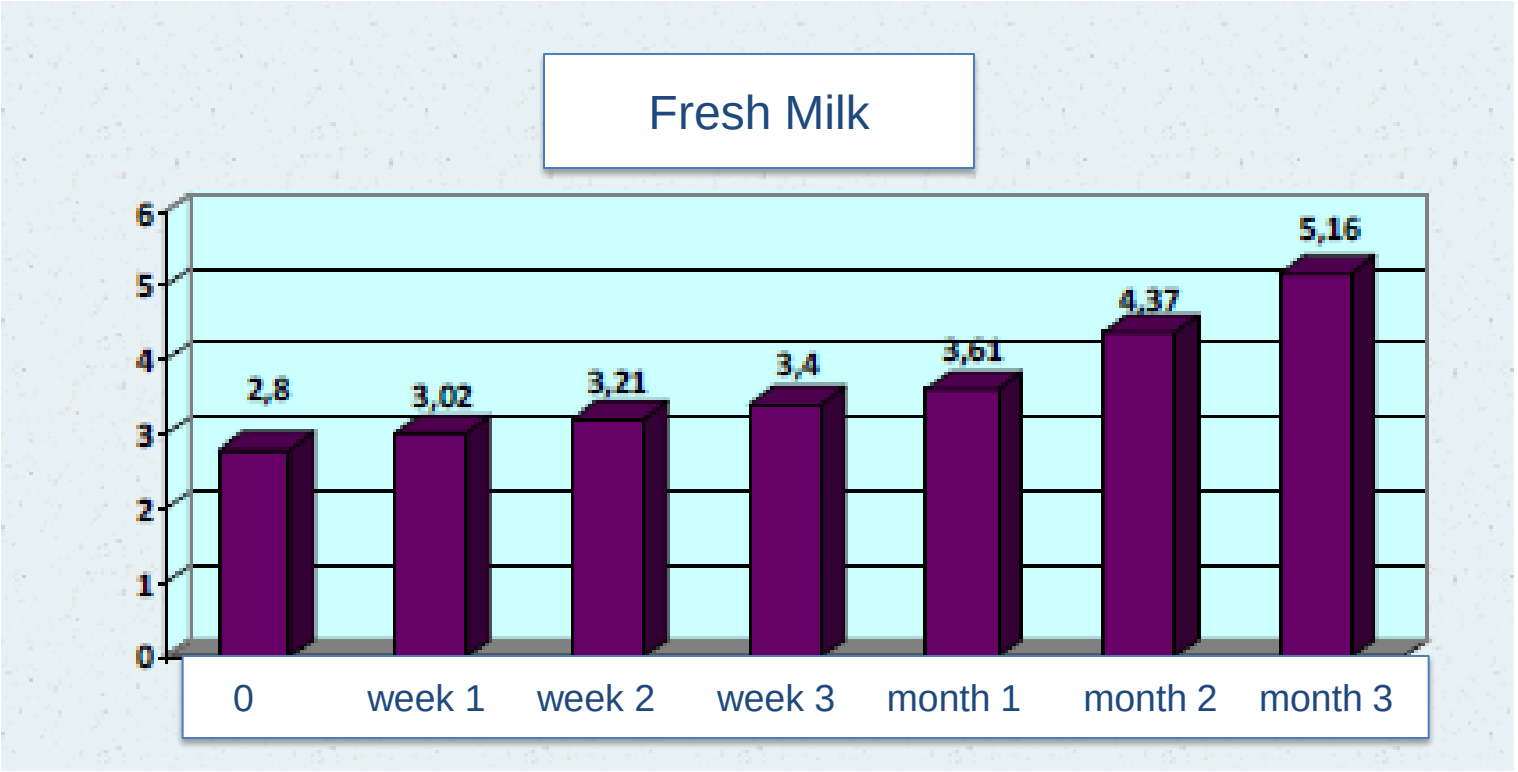
		Difference vs. raw milk for freezing time of				
Content	*Reference group*[a]	*7 days*	*15 days*	*30 days*	*60 days*	*90 days*
Fat (g/dL)	5.13 (4.68, 5.59)	–0.19 (–0.28, –0.09)	–0.24 (–0.34, –0.15)	–0.31 (–0.41, –0.22)	–0.42 (–0.51, –0.32)	–0.58 (–0.67, –0.48)
P	—	$p=0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$
Total nitrogen (g/dL)	1.22 (1.14, 1.30)	0.01 (–0.01, 0.04)	–0.02 (–0.04, 0.01)	–0.03 (–0.05, –0.01)	–0.02 (–0.04, 0.01)	–0.02 (–0.05, 0.01)
P	—	$p=0.2035$	$p=0.1202$	$p=0.0099$	$p=0.1158$	$p=0.0391$
Lactose (g/dL)	5.89 (5.8, 5.98)	0.03 (–0.001, 0.07)	0.05 (0.02, 0,09)	0.01 (–0.03, 0.04)	–0.004 (–0.04, 0.03)	–0.09 (–0.12, –0.06)
P	—	$p=0.0677$	$p=0.0017$	$p=0.9355$	$p=0.8616$	$p<0.0001$
Caloric (kcal/dL)	76.91 (72.66, 81.15)	–1.51 (–2.39, –0.63)	–2.01 (–2.89, –1.12)	–3.12 (–4.01, –2.23)	–3.99 (–4.89, –3.11)	–6.04 (–6.93, –5.15)
P	—	$p=0.0009$	$p<0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$

Data are mean (95% confidence interval of the mean) ($n=61$ samples).
Statistical analysis for p values was by regression mixed-model analysis.
[a]Values of the reference group are estimated for samples of raw milk, manually homogenized and with stage of lactation >15 days.

García Lara N. Breastfeeding Med. 2011

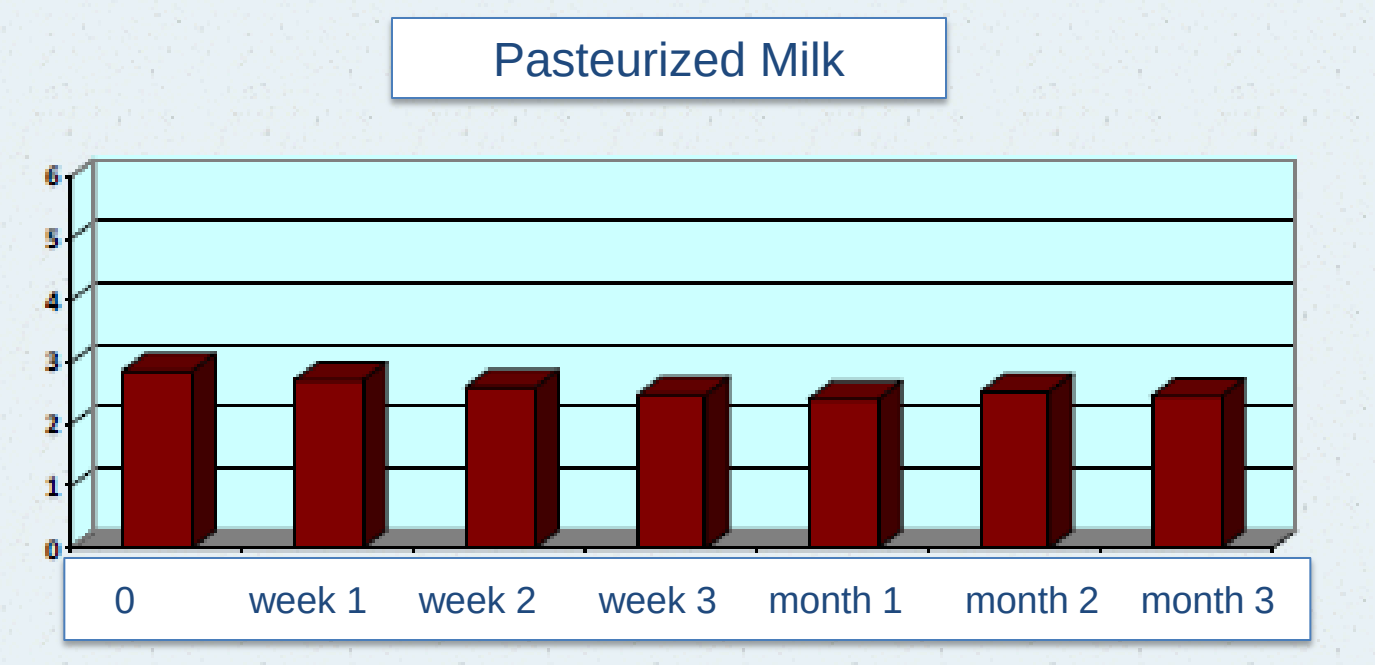
2. What happens to the milk during freezing time?

Influence of freezing time on the dornic acidity found in fresh human milk.



2. What happens to the milk during freezing time?

Influence of freezing time on the dornic acidity found in pasteurized human milk.



2. What happens to the milk during freezing time?

. Modifications are not very relevant, though freezing is only one of multiple steps during the milk processing.

. These modifications indicate that activity still occurs in milk even during freezing.

2. What happens to the milk during freezing time?

Journal of proteome research

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Article

Proteome mapping of human skim milk proteins in term and preterm milk

Claire Elisabeth Molinari, Ylenia S Casadio, Ben T Hartmann,
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J. Proteome Res., **Just Accepted Manuscript** • DOI: 10.1021/pr2008797 • Publication Date (Web): 07 Feb 2012

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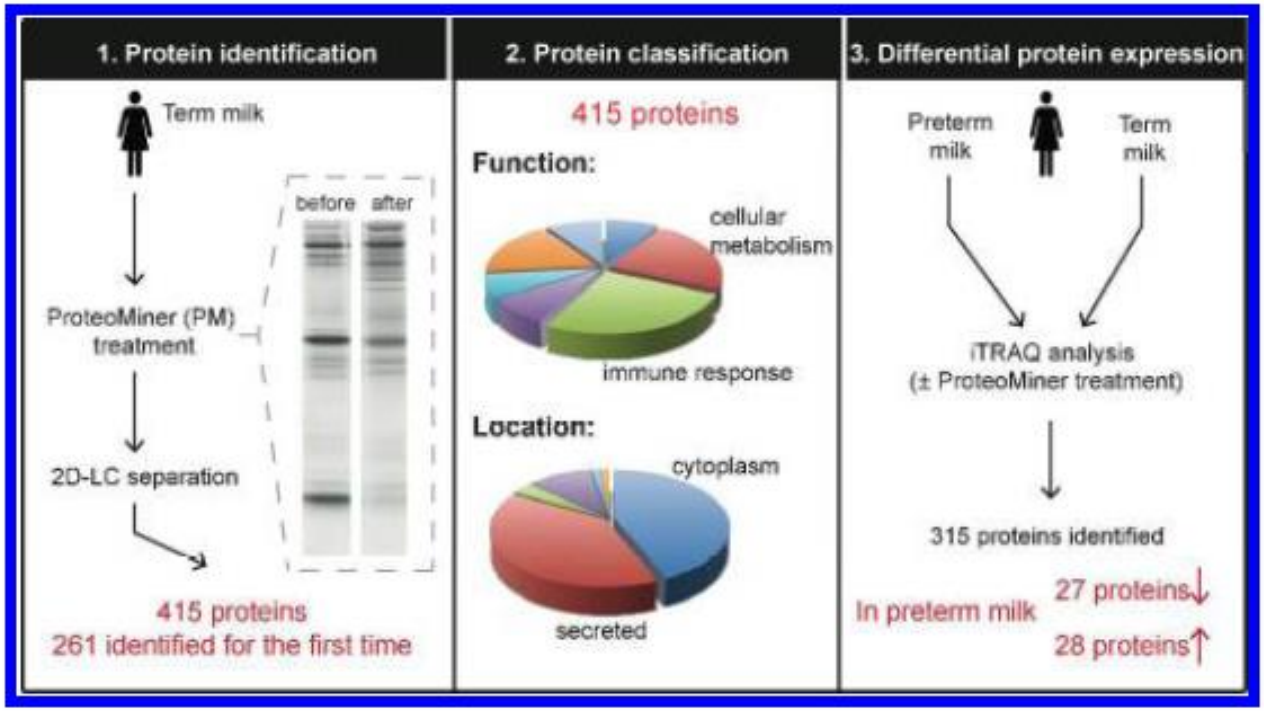

3. What happens to the milk after defrosting?

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Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Analysis of the influence of pasteurization, freezing/thawing, and offer processes on human milk's macronutrient concentrations ☆

Alan Araujo Vieira [1], Fernanda Valente Mendes Soares [1], Hellen Porto Pimenta [2], Andrea Dunshee Abranches [2], Maria Elisabeth Lopes Moreira [1,*]

Instituto Fernandes Figueira, Av. Rui Barbosa 716, Rio de Janeiro, RJ CEP 22540-020, Brazil

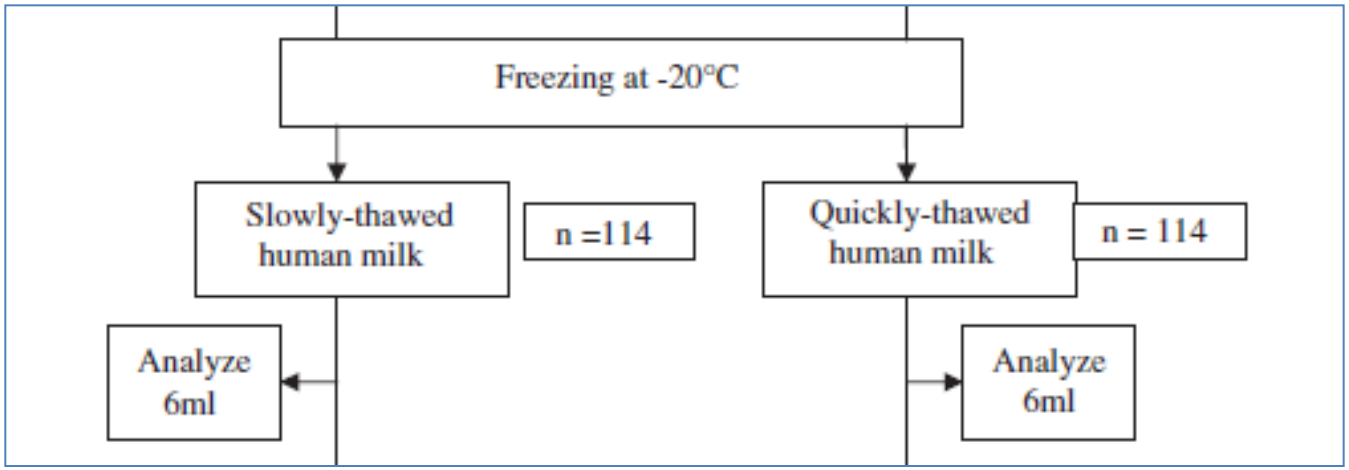

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Table 2
Comparison of mean fat, protein and lactose concentrations (mg%) in human milk between the thawing processes.

	Slow thaw		Quick thaw			
	Mean ± Sd	Median	Mean ± Sd	Median	z	P[a]
Fat	2.00 ± 1.42	1.61	2.00 ± 1.48	1.60	−0.056	0.956
Protein	0.95 ± 0.41	0.88	0.99 ± 0.42	0.92	−0.823	0.410
Lactose	6.35 ± 0.54	6.47	6.33 ± 0.57	6.48	−0.18	0.860

[a] Mann–Whitney test.

3. What happens to the milk after defrosting?

ORIGINAL ARTICLES

www.jpeds.com • THE JOURNAL OF PEDIATRICS

Refrigerator Storage of Expressed Human Milk in the Neonatal Intensive Care Unit

Meredith Slutzah, DO, Champa N. Codipilly, PhD, Debra Potak, RN, Richard M. Clark, PhD, and Richard J. Schanler, MD

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Conclusions Changes were minimal and the overall integrity of milk during refrigerator storage was preserved. Fresh mother's milk may be stored at refrigerator temperature for as long as 96 hours. *(J Pediatr 2010;156:26-8)*.

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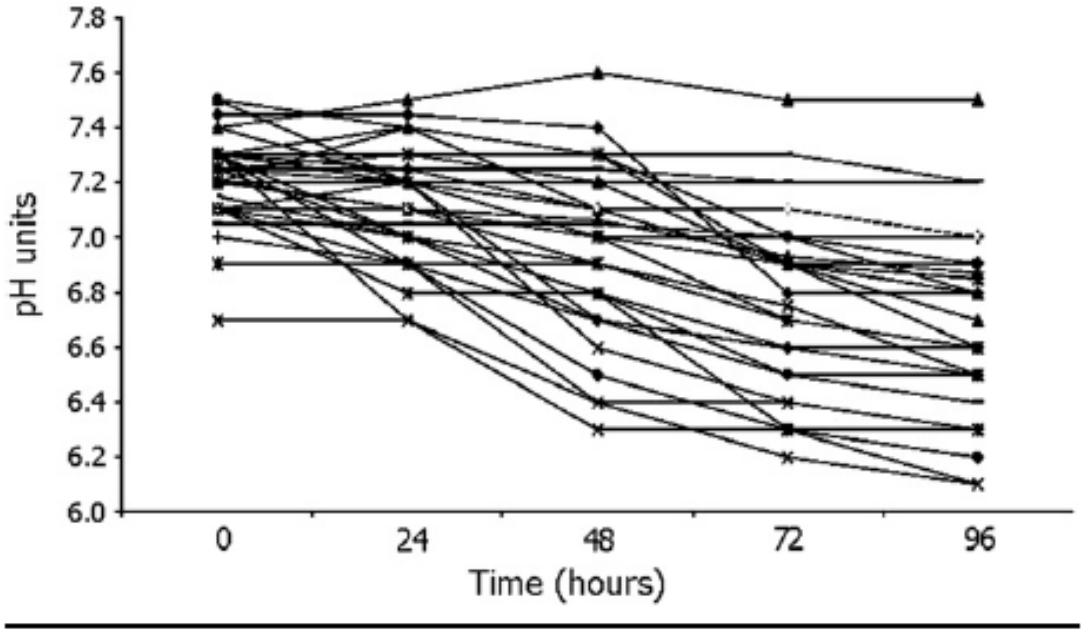

Figure 1. Milk pH declined over 96-hour refrigerator storage ($P < .001$). Each time point differs from the preceding value ($P < .05$).

Slutzah M. Journal Pediatrics. 2010

3. What happens to the milk after defrosting?

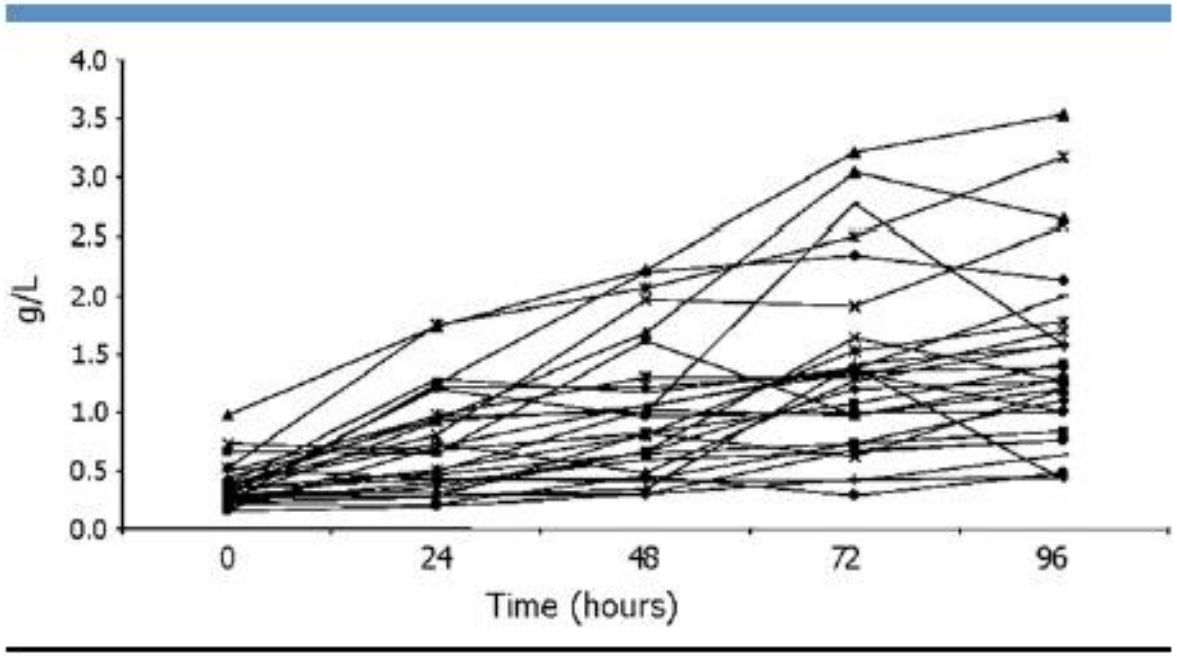

Figure 3. Free fatty acid concentrations increased 3-fold over 96-hour storage ($P < .001$).

Slutzah M. Journal Pediatrics. 2010

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Safety
Quality

Slutzah M. Journal Pediatrics. 2010

3. What happens to the milk after defrosting?

Journal of Human Lactation
http://jhl.sagepub.com/

Storage of Human Milk: Accepting Certain Uncertainties

Riccardo Davanzo, Laura Travan and Sergio Demarini

J Hum Lact 2010 26: 233
DOI: 10.1177/0890334410374601

3 What happens to the milk after defrosting?

Table 1. Metavariability of Advice on Refrigerated Human Milk.

Scientific Source	*Expiration Time of Human Milk Stored in Refrigerator (0-4°C)*
• Hanna 2004	2 days
• Lawrence 2005	
• Silvestre D 2006	
• Martinez 2007	
• Jocson 1997	3 days
• Ogundele 2000	
• Santiago 2005[a]	
• Sosa 1987	5 days
• Academy Breastfeeding Medicine 2004	
• American Academy of Family Physicians 2008	
• CDC 2009	
• Pardou 1994	8 days
• Biagioli 2003	
• La Leche League International 2010	
• UNICEF/WHO 2009	

[a]Fortified human milk.

Davanzo R. Journal Human Lactation. 2010

3 What happens to the milk after defrosting?

Everything depends on the balance between **quality and safety.**

4. What happens during administration?

4. What happens during administration?

Loss of breast milk nutrients during tube feeding

R J STOCKS, D P DAVIES, F ALLEN, AND D SEWELL

Department of Child Health, University of Leicester and Neonatal Unit Leicester Royal Infirmary, and Department of Human Biology, University of Loughborough

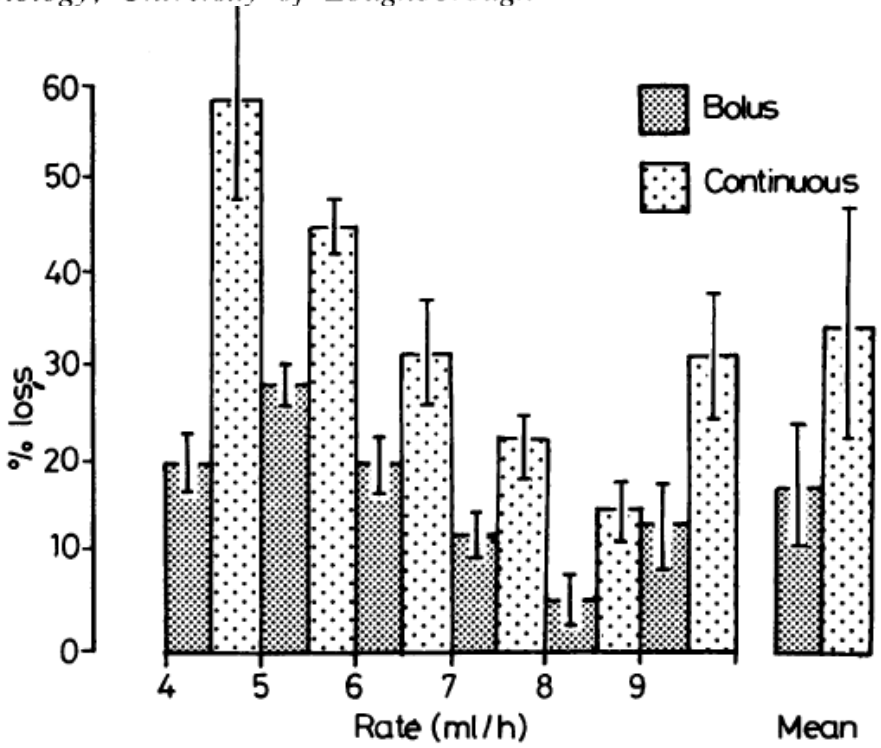

Fig. 1 *Fat loss: variation in relation to rate and method of feeding.*

Archives of Disease in Childhood, 1985, **60**

4. What happens during administration?

Fat loss during feeding of human milk

I NARAYANAN, B SINGH, AND D HARVEY

Queen Charlotte's Maternity Hospital, London

Table *Variations in fat concentration during feeding of human milk (estimated by creamatocrit method[2]; values percentage mean (SD))*

Method	*No of studies*	*Initial concentration*	*Final concentration*	*Difference*
(a) Intermittent bolus feeding	50	6·3 (1·7)	5·9 (1·7)	−0·3 (0·5)
(b) Continuous infusion				
Central nozzle syringe				
1 Horizontal	50	5·4 (2·4)	26·8 (5·3)	21·4 (6·0)
2 Vertical	10	3·7 (0·8)	16·2 (3·2)	12·5 (3·5)
3 Horizontal with hourly mixing by syringe agitation	10	4·8 (1·4)	26·7 (2·7)	21·9 (2·0)
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Archives of Disease in Childhood, 1984

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Archives of Disease in Childhood, 1984

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Journal of Human Lactation
http://jhl.sagepub.com/

Type of Homogenization and Fat Loss during Continuous Infusion of Human Milk

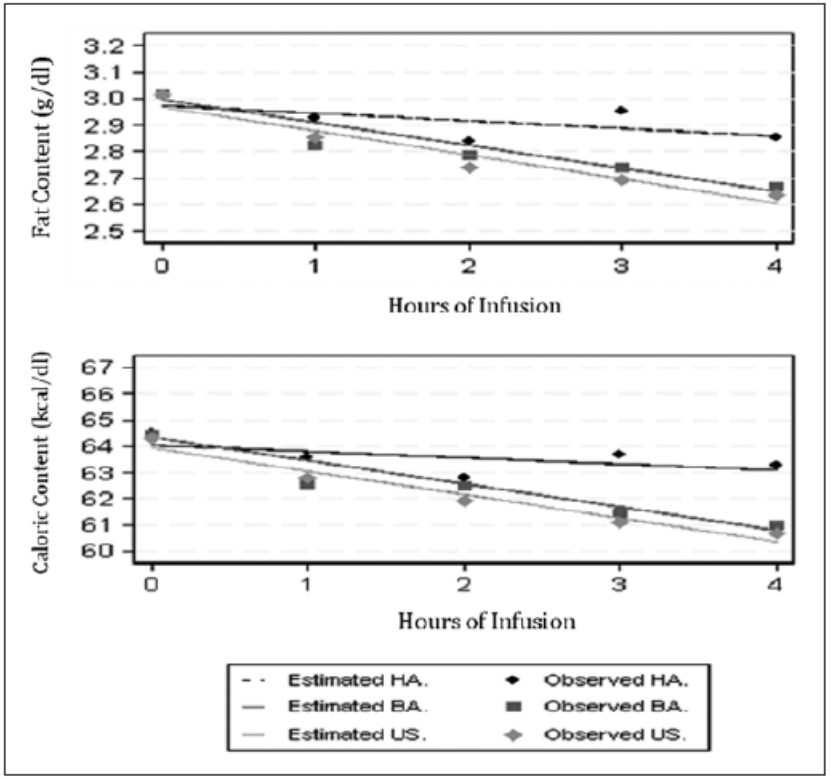
Nadia Raquel García-Lara, Diana Escuder-Vieco, Clara Alonso Díaz, Sara Vázquez Román, Javier De la Cruz-Bértolo and Carmen Rosa Pallás-Alonso

J Hum Lact published online 13 August 2014
DOI: 10.1177/0890334414546044

The online version of this article can be found at:
http://jhl.sagepub.com/content/early/2014/08/11/0890334414546044

4. What happens during administration?

Figure 2. Nutritional Content over Time.



Mean observed values are shown for each study group (BA corresponds to baseline agitation, HA to hourly agitation, and US to ultrasound). Lines represent estimated means across time and homogenization groups with a mixed-effect linear regression model.

García Lara N et al, Journal Human Lactation. 2014

4. What happens during administration?

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nutrients

ISSN 2072-6643

www.mdpi.com/journal/nutrients

Article

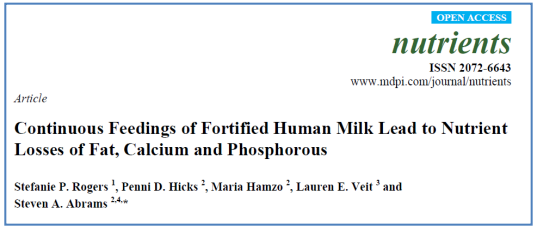
Continuous Feedings of Fortified Human Milk Lead to Nutrient Losses of Fat, Calcium and Phosphorous

Stefanie P. Rogers [1], Penni D. Hicks [2], Maria Hamzo [2], Lauren E. Veit [3] and Steven A. Abrams [2,4,*]

4. What happens during administration?

Table 3. Percent nutrient losses by fortifier.

	HM-DonF	HM-BovF	*p*-value
Number of samples	35	35	
Ca (%)	8 ± 4	28 ± 4	<0.001
Phos (%)	3 ± 4	24 ± 4	<0.001
Fat (%)	17 ± 2	25 ±2	0.001
Protein (%)	0 ± 1	−1 ± 1	0.56



4. What happens during administration?

- Growth is key in the care of newborns
- During administration, much of milk's caloric contribution and other essential elements **needed** for growth can be lost
- The entire administration process should be optimized.

What can we do?

Steps to control critical points of expressed breast milk

Expressed breast milk on a neonatal unit: A hazard analysis and critical control points approach

Veerle Cossey, MD,[a,b] Axel Jeurissen, MD, PhD,[b,c] Marie-José Thelissen,[b] Chris Vanhole, MD, PhD,[a] and Annette Schuermans, MD, PhD[b]
Leuven and Wilrijk, Belgium

With the increasing use of human milk and growing evidence of the benefits of mother's milk for preterm and ill newborns, guidelines to ensure its quality and safety are an important part of daily practice in neonatal intensive care units. Operating procedures based on hazard analysis and critical control points can standardize the handling of mother's expressed milk, thereby improving nutrition and minimizing the risk of breast milk–induced infection in susceptible newborns. Because breast milk is not sterile, microorganisms can multiply when the milk is not handled properly. Additional exogenous contamination should be prevented. Strict hygiene and careful temperature and time control are important during the expression, collection, transport, storage, and feeding of maternal milk. In contrast to formula milk, no legal standards exist for the use of expressed maternal milk. The need for additional measures, such as bacteriological screening or heat treatment, remains unresolved.

Key Words: NICU; infection control; mother's milk; quality control.

Steps to control critical points of expressed breast milk

Table I. HACCP plan for expressed breast milk

Steps in the process	Potential hazards	Control measures	Control point	CCP
Milk expression and collection	• Hands may touch breast and milk during pumping. Breasts or nipples may be colonized or infected.	• Teach mothers to perform careful hygiene of hands before expressing or handling milk, as well as daily hygiene of breasts.	• No compliance with hygienic advice.	
	• Pump may be contaminated with pathogens (exterior and interior; backflow of aerosol of milk).	• Use a correctly designed type of pump with separated internal circuits and a safety valve. Perform regular pump cleaning and maintenance.	• Visibly not clean.	
	• Accessory kits may be contaminated.	• Thermal disinfection of shields and other parts in contact with milk after each use. Use clean disposable or sterile bottles or containers.	• Visibly not clean.	
	• Milk not placed in cool storage after expression.	• Educate parents to refrigerate or freeze the milk within 1 hour.		

Cossey V. Am J Infect Control 2011;

Steps to control critical points of expressed breast milk

Steps in the process	Potential hazards	Control measures	Control point	CCP
Milk transfer to the unit	• Growth of microorganisms if a break in cold chain occurs.	• Provide information regarding appropriate storage conditions for transporting milk in an icebox or isothermal bag.		• (Partially) thawed milk at arrival (visual inspection)
	• Contamination of bottles.	• Educate parents about general hygiene and the use of a clean transfer box.	• Visibly not clean.	
	• No or poor identification on	• Check name, date and time of		• Missing labels.

Cossey V. Am J Infect Control 2011;

Steps to control critical points of expressed breast milk

Steps in the process	Potential hazards	Control measures	Control point	CCP
Storage in the unit	• Exceeding storage time and risk for contamination.	• Use fresh milk within 48 hours. Freeze milk that will not be used within 48 hours. Use thawed milk within 24 hours. Use frozen milk within 3 months.		• Storage >48 hours if fresh milk; >24 hours if thawed milk; >3 months if frozen milk.
	• First-in, first-out principle may not be followed.	• Place newly delivered milk at the back of the drawer in the freezer. Label containers clearly with waterproof ink.	• Each deviation from chronologic rank.	
	• Temperature of refrigerator is too high.	• Keep doors closed. Monitor core temperature continuously with central alarm connected to the hospital building management system. Calibrate the logger system regularly. Control environmental	• Core temperature > 5°C.	• Core temperature >7°C
	• Temperature of freezer is too high.	• Keep doors closed. Monitor temperature continuously with central alarm connected to the hospital building management system. Clean and defrost periodically and whenever visually contaminated.	• >1 cm of ice or visibly not clean. Temperature >−15°C.	• (Partially) thawed milk.
	• Other products or dirt in freezer or refrigerator may contaminate the milk.	• Keep a freezer and refrigerator in a secure room exclusively dedicated to milk. Clean daily.	• Visibly not clean.	

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Steps to control critical points of expressed breast milk

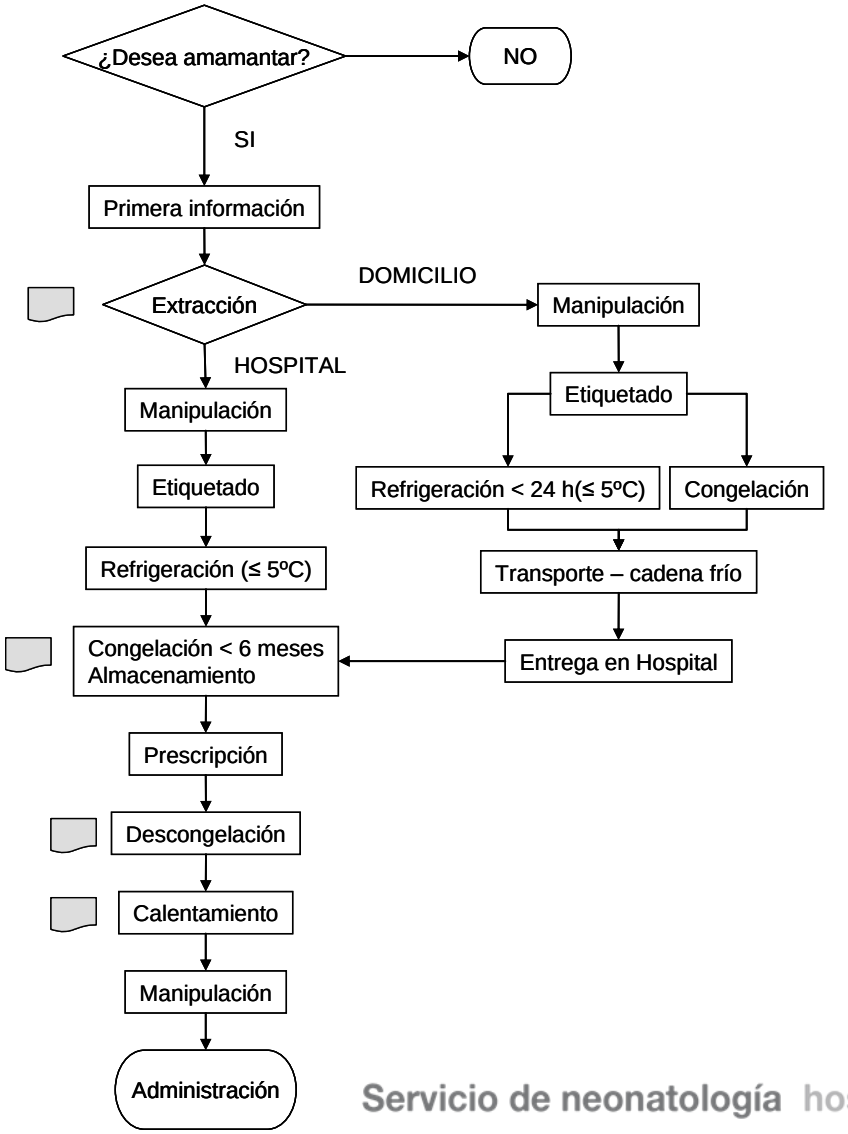
Guidelines

Expression, storage and administration of breast milk to babies hospitalized in the neonatology unit using their own mothers' milk

Year 2009

Steps to control critical points of expressed breast milk

4.- **Diagrama de flujo del proceso antes de la vía clínica**

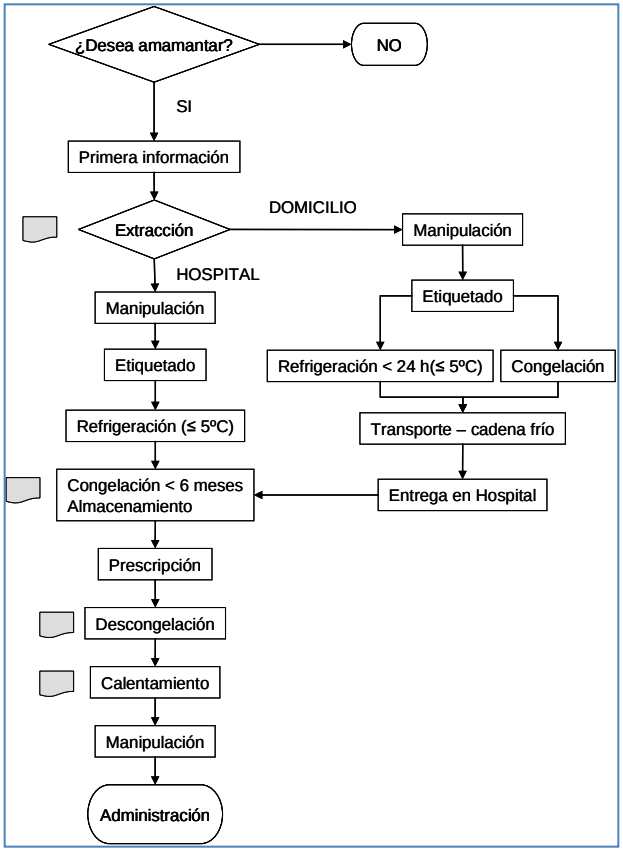


Conclusions

- Mother´s milk undergoes multiple procedures in neonatal units with little control or standardization
- Little is known about the optimum conditions for milk expression. The maximum volume of milk may possibly be obtained after kangaroo care.
- During freezing and refrigeration, certain biological activity occurring in mothers' milk, produces a modification in quality of the milk.
- The consequences of defrosting have been little studied.
- Despite the great concern in all units regarding the growth of preterm babies, a significant part of the nutritional value of the milk may be lost during administration.

Conclusions

The sum of proceedures = The sum of consequences in the milk



Final Comments

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The more the milk is subject to change, the greater the risk of altering or losing these elements.

Final Comments

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Let's not deprive the most vulnerable preterm babies of all the potential benefits of mother's milk