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Human Milk Practices in Swedish Neonatal Units: Results From a Nationwide Survey

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ABSTRACT

Aim: The aim of this study was to describe the routines for handling mother's own milk and donor human milk in Swedish neonatal care units related to national guidelines.

Methods: A web-based survey of 24 of 38 neonatal units and 19 of 28 human milk banks in Sweden.

Results: Despite national guidelines, breast milk handling varied widely. All units offered lactation support and free breast pumps during hospital stays; nine continued post-discharge. Use of mother's milk differed; some prioritised fresh, others mixed or used frozen milk by age. Donor milk was mainly given to infants < 34–35 weeks or post-surgery, though criteria varied. Some also provided it for hypoglycaemia, growth restriction or hypothermia treatment. Fortification routines varied in both target groups and preparation, ranging from bedside at each feed to once daily. Most milk banks tested donor milk before pasteurisation; one tested both before and after. Five units never declined donations, while others did due to storage limits, surplus supply or time constraints.

Conclusion: Substantial variation in practices indicates a need to clarify and update national guidelines and strengthen milk banking, with relevance both nationally and internationally.

1 | Background

Human milk is recognised as the ideal nutrition for all newborns, including those needing specialised care in neonatal units. Mother's own milk (MOM) is the primary option [1]; however, when breastfeeding or MOM is unavailable, donor human milk (DHM) is recommended as the second-best choice for infants born preterm and infants needing neonatal care [2–4]. Even though both MOM and DHM are defined as human milk, there are some differences due

to donor lactation state and the processing of donor milk [5, 6]. In most countries, DHM is pasteurised, reducing or eliminating many of the bioactive factors in human milk [7].

Breast milk provides all the energy and essential nutrients that a healthy newborn requires during the first six months of life [8]. Antibodies transferred through the breast milk also play an important role in the early protection of newborn infants [9]. For preterm infants, human milk provides protection against

Abbreviations: DHM, donor human milk; ESBL, extended spectrum beta lactamase; HIV, human immunodeficiency virus; HMB, human milk bank; HTLV, human T-lymphotropic virus; MOM, mother's own milk; MRSA, methicillin-resistant *Staphylococcus aureus*; NEC, necrotizing enterocolitis; NSAID, non-steroidal anti-inflammatory drugs; VLBW, very low birth weight.

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Summary

- This study highlights variations in practices at neonatal units and Swedish HMBs regarding routines for mother's own milk and donor human milk handling and administration.
- There is a need to facilitate milk donation and increase the capacity of human milk banking in Sweden.
- There is a need for improved standardisation, clarification and implementation of guidelines at the national level.

diseases such as necrotizing enterocolitis (NEC) [10]. Human milk enhances cognitive development in preterm infants [11] and reduces the risk of various illnesses, including sepsis, respiratory infections and urinary tract infections [12]. Additionally, infants in neonatal units are more likely to achieve full enteral feeding volumes when human milk, instead of formula, is provided, which can help reduce the duration of parenteral nutrition [13]. Moreover, when human milk is provided to preterm infants, the risk of developing high blood pressure later in life is decreased, reducing the risk of cardiovascular diseases [14–16]. In neonatal units, MOM is during the initial period mainly provided through maternal breast milk expression, often by using a breast milk pump. Research shows that initiating breast milk expression within six hours of an extremely preterm birth is associated with higher overall milk production and greater yield per expressing session [17]. To promote timely initiation of breast milk expression, evidence based information is ideally provided to both parents during a prenatal consultation with the neonatology team. The importance for the infant's health of providing MOM as soon as possible after birth should be emphasised. Many Swedish neonatal units provide a so-called colostrum kit, which includes detailed instructions and practical guidance for the early initiation of breast milk expression to support the mother in this process [18, 19]. A colostrum kit includes written information about factors associated with milk production, how to perform milk expression, as well as devices to collect the expressed milk. A national network, Milknet, was created in 2001, providing guidelines [20] and support to the HMBs and neonatal units. Ahead of an upcoming update of guidelines, a survey of existing routines was carried out.

1.1 | Aim

The aim of this study was to describe the current routines regarding MOM and DHM in Swedish neonatal units and HMBs related to national guidelines.

2 | Methods

2.1 | Setting

There are currently 38 neonatal units in Sweden (Appendix S1). All neonatal units have access to a so-called 'milk-kitchen', a facility in which MOM, DHM and formula, including fortification of these when required, are prepared and stored. The definition of a HMB in this study is a facility that handles all parts of the

DHM processes, including pasteurisation. The HMBs in Sweden are responsible for the processing of DHM and are hospital-based and managed by staff from the neonatal unit or staff from other departments. Neonatal units without a HMB in their hospital collaborate regionally to access DHM.

2.2 | Survey Design and Data Collection

The Milknet board developed a web-based survey with a total of 102 questions designed as either single-choice questions, multiple-choice questions or open-ended questions (Appendix S2). In total, the survey included 23 possible follow-up questions and 79 primary questions. The survey was based on the current Milknet guidelines [20], the scientific literature and clinical experience. The survey design, including the investigated themes, is illustrated in Figure 1. An invitation email with a web-link to the survey was sent in November 2022 to all neonatal units in Sweden.

2.3 | Response Rate

Not all questions were answered in each survey. In most cases, the survey was completed by several professions, for example, physicians, registered nurses, assistant nurses, midwives, nutrition assistants, biomedical analysts and department heads. Only two surveys were completed by a single professional. For organisational reasons, three neonatal units gave joint responses; hence, the maximum number of responding neonatal units was 36 rather than 38. The survey was completed by 24 out of 36 units, resulting in an overall response rate of 67%. The included neonatal units represented all six healthcare regions in Sweden (Table 1).

2.4 | Data Analysis

Data were analysed using descriptive statistics; due to the small sample size, only numbers are presented. A simplified form of qualitative content analysis [21] was used for the follow-up answers in free text, and its results are presented descriptively.

2.5 | Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Swedish Ethical Review Authority (Dnr 2022-01841-01).

3 | Results

Background information regarding the responding neonatal units, including which parts of the donor milk processes the units are involved in, is presented in Table 1. In all neonatal units, parents could be together with their infant 24/7.

3.1 | Staff Training Regarding Lactation and Breastfeeding

Regular staff training regarding lactation and breastfeeding was out of the 24 responding units reported as follows: 13 units

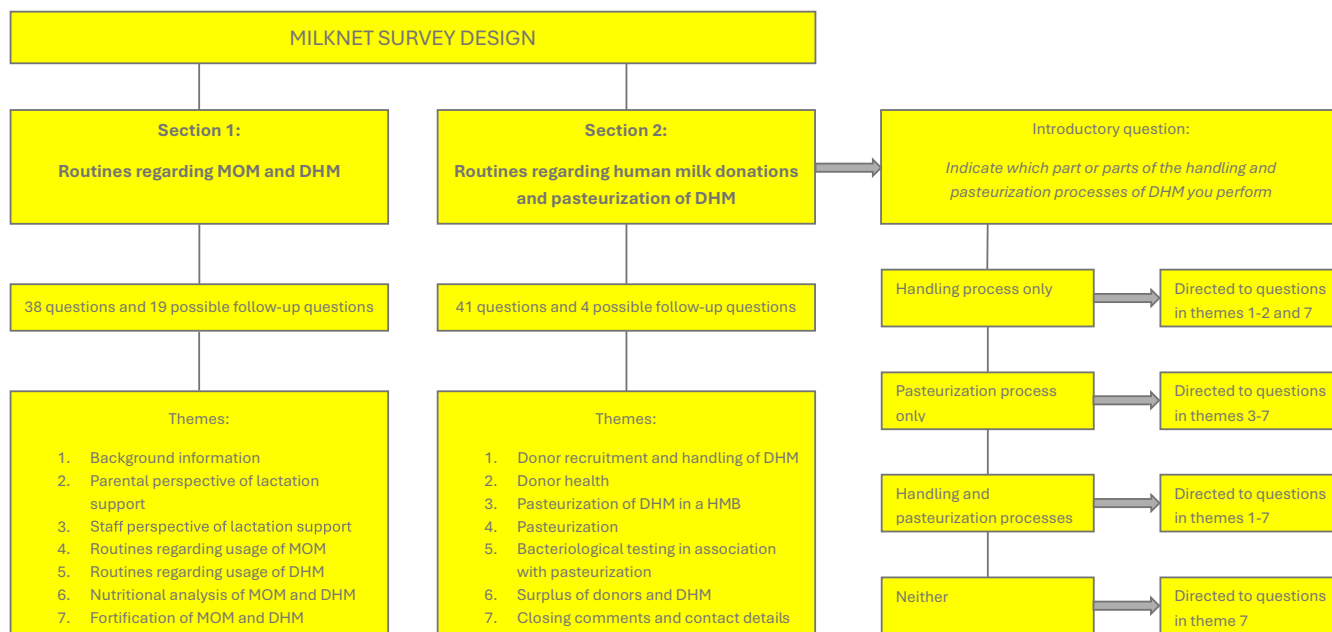


FIGURE 1 | Survey design.

provided training to all newly hired staff, 10 units provided training to all staff once a year, one unit provided training to all staff every second year, seven units provided training to all staff more seldom, and two units did not offer any training at all. Nine of the 23 units offered the training to all professions working in the neonatal unit. Twenty-one units reported that the training was provided by internal staff, seven units collaborated with the associated university for these training sessions and one unit sought assistance from industry.

3.2 | Lactation Support and Parental Education

All units offered lactation support (Table 2), the staff providing this support was primarily from the neonatal unit but also from the maternity ward. Information was provided regarding differences between MOM and DHM: however, two units reported that they did not educate the parents regarding differences between MOM and DHM and four units stated that they only did so occasionally. All units except one followed up on maternal milk expression during the hospital stay.

Other factors that may facilitate lactation in the neonatal unit and after discharge may be provision of meals for mothers and breast pumps. Seven of 24 units provided meals for mothers during neonatal care.

3.3 | Routines Regarding Mother's Own Milk

3.3.1 | Prioritisation of Fresh or Frozen MOM to the Infant

Nineteen of the 24 responding units reported that when MOM was frozen it was provided to the infant in chronological order, that is, frozen MOM with older expression dates were used before frozen MOM with more recent expression dates. In cases where both

freshly expressed MOM and previously expressed frozen MOM were available, four of the 24 responding neonatal units prioritised providing the infant with frozen MOM in chronological order, 10 units prioritised giving fresh MOM and the remaining 10 units prioritised providing the infant with a combination of fresh and frozen MOM. In the written responses one unit clarified prioritising fresh MOM over frozen; however, they opted for the frozen MOM if it contained more energy/fat. Two of the units that prioritised providing frozen MOM made an exception during the first postnatal week to provide the infant with fresh colostrum.

3.3.2 | Practices and Guidelines Regarding Lactating Mothers' Intake of Medications, Alcohol and Caffeine

Practices regarding maternal intake of medications and allowance of concurrent feeding of MOM to the infant are presented in Table 3. Additional medications that were specified in the open-ended question which prohibited MOM feeding included radioactive substances, high-dose hormones, cytostatic agents and lithium.

Nine out of 24 responding units reported having guidelines regarding maternal alcohol consumption. Responses to the open-ended question regarding alcohol consumption included: 'At least two hours after a small glass of wine' and 'There is no guideline for this; however, if a mother were to ask about it, we would explain that knowledge regarding alcohol consumption during breastfeeding is very limited, and we do not know how it affects the infant. We refer to the Swedish Food Agency's guidelines, which state that it is likely not harmful to the infant if the mother consumes 1–2 glasses of wine per week. Mothers of severely ill infants cared for in the neonatal unit rarely ask about alcohol consumption'. Others responded that a delay in pumping/breastfeeding was needed for 2, 12 or 24 h. Three out of 23 units had guidelines regarding maternal coffee and caffeine intake. Responses to the open-ended

TABLE 1 | Characteristics of participating units.

	<i>n/N</i>
Level of care provided ^a	24/24
Neonatal intensive care	17
Neonatal care	23
Couplet care	14
Neonatal home care	19
Neonatal follow-up clinic	18
Provision of neonatal care from birth: gestational age criteria (weeks + days)	24/24
22 + 0	4
28 + 0	12
29 + 0	3
30 + 0	3
32 + 0	1
35 + 0	1
National health care region	24/24
South (<i>N</i> = 8)	5
South-east (<i>N</i> = 5)	4
West (<i>N</i> = 4)	4
East (<i>N</i> = 6 ^b)	2
Middle (<i>N</i> = 8)	6
North (<i>N</i> = 7)	3
Donor milk processes	24/24
Handling process only	5
Pasteurisation process only	0
Handling and pasteurisation processes	19
Location of human milk bank	19/19
Neonatal ward	15
Own premises outside ward	4

^aMultiple answer possible.

^bThree hospitals have the same organization and gave a joint answer.

question regarding coffee and caffeine consumption included: 'a reasonable amount, three cups daily' and 'one can eat/drink everything in moderation'.

3.4 | Routines Regarding Donor Human Milk

The criteria used for determining infant eligibility of DHM feeding varied (Table 4). Most units provided DHM to infants born before 34–35 weeks' gestation and to all infants who had undergone abdominal surgery. Some units also offered DHM to infants with hypoglycaemia, growth restriction or those undergoing hypothermia treatment after asphyxia independent of gestational age at birth. Responses to the open-ended question included: 'It

depends a bit on availability, but for most of the year we can offer it to all infants' and 'If there is a large supply, it is also offered to full-term infants with issues such as gastrointestinal problems'. Moreover, several units had a clear prioritisation system regarding which infants should receive the DHM with the highest protein content, with the lowest gestational age and weight being given the highest priority. If there was an abundant supply of DHM, it could also be offered to infants in the paediatric intensive care unit or maternity ward when needed, but infants cared for in the neonatal units were always prioritised.

3.5 | Storage, Nutritional Analysis and Fortification of Human Milk

Information regarding current practices of storage, as well as nutritional analysis and fortification of human milk (both MOM and DHM) in Swedish neonatal units is presented in Table 4.

3.6 | Human Milk Donations and Processing of Donor Human Milk

All responding units participated, to various degrees, in the processing of DHM (Table 1). Depending on the degree of the handling process, the maximum answers on part 1 of the survey (pasteurisation process excluded) were 24, and in part 2 (pasteurisation process included) the maximum was 19. The number of staff involved in handling human milk donations varied across neonatal units, between one to five members of the staff to all members of the staff (Table 5). The professions responsible for handling DHM were assistant nurses, or both assistant and registered nurses. One unit relied solely on registered nurses for handling DHM, and in one ward, assistants (with no formal education) managed this process. In 20 units, the staff handling DHM also worked with patient care. Two units reported having separate staff dedicated exclusively to handling milk donations. In those units with staff involved in both tasks, 11 units reported that staff handled both responsibilities during the same shift, while nine units assigned different tasks, DHM handling or infant care, on separate days.

3.6.1 | Recruitment of Human Milk Donors

The primary recruitment of new donors occurred at the neonatal units, where all units reported recruiting new donors. Additional recruitment sites included the postnatal ward, Child Health Centres, social media platforms, postnatal follow-up visits, maternity clinics, and posters and informational pamphlets distributed in various healthcare settings (Table 5). When DHM is scarce, advertising efforts are extended to newspapers, radio and social media platforms. All units provided milk donors with a free electric breast pump. In addition, all units offered the donor financial compensation, between SEK 125 per litre and SEK 250 per litre (SEK 125–250 per litre currently corresponds to USD 11–23). Five units reported that they never needed to decline any milk donors. Other units mentioned declining donors on isolated occasions, up to turning away donors 10–20 times per year. Reasons for not accepting donors

TABLE 2 | Lactation support and parental education.

	N = 24
	n (missing^a)
Staff providing lactation support and education for parents	24
Assistant nurses (college-level education in nursing)	24
Registered nurses	22
Midwives	9
Dietitian	0
Medical doctors	8
Other	5 ^a
Lactation consultant available	1
Units with written guidelines for lactation support	
Yes	11 (1)
No	12 (1)
Content of education and support provided to parents	
Importance of breast milk	24
Yes	21
Sometimes	3
Difference between MOM and DHM	24
Yes	18
No	2
Sometimes	4
Using Colostrum-kit as a tool	24
Yes	16
Sometimes	3
No	5
When is the Colostrum-kit provided to mothers?	19
Distributed before birth	5
Distributed after birth	8
Could be distributed either before and/or after birth	8
Follow-up provided on mother's milk expression	24
Yes	23
No	1
Follow-up on mother's milk expression provided by	23
Assistant nurses (college-level education in nursing)	22
Registered nurses	23
Midwives	5
Dietitian	0
Medical doctors	5
Other	5 ^b

(Continues)

TABLE 2 | (Continued)

	<i>N</i> = 24
	<i>n</i> (missing ^a)
Follow-up on mother's milk expression includes	23
Maternal emotions on milk expressions	18
Expressed milk volume	17
Other	11 ^c
How often is follow-up on mother's milk expression provided	23
Daily	17
< 3 times a week	3
Once a week	3
Facilitating lactation in the neonatal unit and after discharge	
Provision of meals to lactating mothers of infants cared for in the neonatal ward	24
Yes	7
No	17
Which meals are provided to lactating mothers of infants cared for in the neonatal ward	7
Breakfast	7
Lunch	5
Evening meal	6
Milk expression privacy	24
Mothers could express privately at the hospital	19
Mothers could occasionally express privately	5
Provision of breast pumps for free during hospital stay	24
Electric breast pump	24
Manual breast pump	7
Provide electric breast pumps after discharge	24
Free of charge	9
For a fee	15 ^d

^aFree text answers were midwives' responsibility and experienced (not new) nurses, assistants with a high-school degree in Children and Leisure studies (*n* = 3), specific staff in a breastfeeding group in the neonatal ward, and a lactation consultant.

^bFree text answers were assistants with a high-school degree in Children and Leisure studies, physicians, nutrition assistants and lactation consultants.

^cFree text answers were pumping frequency, support to pump often, mothers' feelings of time for pumping, right size of shield, practical information, used pumping programme, according to individual needs, support for maternal rest and food intake.

^dFree text answers, 11 units reported free of charge while in home care but for a fee after discharge from home care, three units reported free of charge if the mother was a milk donor and three units reported free of charge if certain diagnoses in the mother or infant.

included bacteriological testing indicating milk not reaching the standard, excess donors, limited storage capacity, limited supply of breast pumps, donor medical treatments, donors not meeting the health declaration requirements and time limits of 3 months after birth for donation. Regarding transportation of breast milk to the milk bank, most DHM was delivered by the donors themselves. Other methods included transport by home care staff or alternative transport arrangements (Table 5), such as donors leaving frozen breast milk at the nearest Health Care Centre or Child Health Clinic, from which it would be transported frozen by the ordinary lab transport vehicle used for

transport of other samples and material in the region. In one region, nutrition assistants from the neonatal unit collected milk from mothers in their homes once a week. Sixteen of the units had a time limit on how long a woman could donate breast milk, whereas seven did not. The time limit for donations ranged from 3 months post-birth, where some allowed an extension of the donation period by an additional 3 months. One unit reported a time limit of 4 months, and two units had a limit of 6 months. One unit did not impose a specific time limit; instead, the decision was based on the results of breast milk nutritional analysis.

TABLE 3 | Maternal and donor medications.

Pharmaceuticals	MOM				DHM			
	Immediate consumption allowed	Immediate consumption not allowed (MOM frozen and used later)	Discarded	Both/ either or	Missing	Allowed/ permitted	Not allowed/ permitted	Missing
			N = 24				N = 24	
Hormone preparations (e.g., thyroid hormone and insulin)	21	21			3	19	1	4
Local treatment with inhalation preparations for asthma	22	22			2	16	4	4
Local treatment of skin, nose and eyes (e.g., corticosteroids and sodium cromoglicate [Lomudal])	22	22			2	17	3	4
Contraceptives in the form of progestogens	20	18			4	13	6	5
Pain-relieving medications: temporary treatment, e.g., after a caesarean section (<7 consecutive days)	22	17	3	1	2	NA	NA	NA
Pain-relieving medications: long-term treatment (>7 consecutive days)	21	9	5	2	3	NA	NA	NA
Pain-relieving medications	NA	NA	NA	NA	NA	8	12	4
Antihypertensives	22	14	2	2	2	3	17	4
Psychopharmaceuticals	22	7	3	2	2	2	18	4
Herbal medicines	19	13	1		5	2	16	6

TABLE 4 | Milk handling and procedures at the Neonatal unit.

	MOM		DHM
	N = 24		N = 24
	n/(missing)		n/(missing)
Storage			
Time for MOM in room temperature	Freshly expressed MOM	Time for DHM in room temperature	Thawed pasteurised DHM
Immediately to refrigerator	5	Directly from fridge at time for feeding	12
1 h	7	Should be given within 20–30 min	2
2 h	2	Should be given within 1 h	3
4 h	7	Should be given within 2 h	3
6 h	3	According to Milknet guidelines	1
		1 h in room, 3 h for thawing	1
Time in refrigerator		Time in refrigerator	
24 h	2	24 h	6 (1)
48 h	18	48 h	16 (1)
72 h	4	72 h	1 (1)
Time in freezer*		Time in freezer*	
3 months (–18°C)	3 ^a	3 months (–18°C)	3 (1)*
6 months (–21°C)	22	6 months (–21°C)	21 (1)
Nutrition analysis*			
Analyses performed at unit/hospital	MOM 24	Analyses performed at unit/hospital	DHM 23 (1)
Yes	14	Yes	14
Sometimes	2	Sometimes	1
No, performed at HMB at other hospital	8	No, performed at HMB at other hospital	8
Criteria for nutritional analysis of MOM	24	Criteria for infant eligibility of DHM feeding	24
Gestational age and/or birth weight (not specified)	4	Only infants born preterm or SGA/IUGR	12 ^b
All infants < 32 weeks gestation	7	Infants at units outside neonatal care	11 ^c
Birth weight below 1500 g	2	Other	8 ^d
Infants < 34–35 weeks gestation	9		
Hospital stays long enough (not specified)	1		
Hospital stay > 7 days	1		
How often is nutrition analysis of MOM performed?	MOM 24	Prioritisation of DHM with higher protein content	DHM 24
Regularly	22	Yes	17 ^e
Occasionally	2	No	7
Once a week	14		
Every other week	5		

(Continues)

TABLE 4 | (Continued)

	MOM	DHM
	N = 24	N = 24
	n/(missing)	n/(missing)
Other, individual depending on situation and over time	3	
Procedure for milk collection for nutritional analysis	23/24 (1)	
A mixed sample of collected milk over a 24-h period	21	
A mixed sample of pumped milk at 4–5 pumping's	2	
Minimum amount of MOM to perform nutritional analysis	16/24 (8)	
3 mL	4	
8 mL	2	
10 mL	7	
12 mL	1	

*Analyse for its nutritional content (i.e., energy, protein, fat and carbohydrates).

^aOne unit given both answers.

^bFree text answers were gestational week 34 ($n=3$), gestational week 35 ($n=2$), mainly to preterm infants and SGA but if enough supply also to term infants with gastrointestinal problems, infants in need of gastrointestinal surgery, infant weight <1500 g, <2000 g ($n=2$), <2500 g and not mature enough to have infant formula, infants with hypoglycaemia, and according to supply but mainly all infants.

^cFree text answers were, postnatal care ($n=9$), delivery ward ($n=3$), paediatric ward or in homecare in specific cases to infants with gastrointestinal problems, in exceptional cases due to medical reasons, and infants on leave from ward to home.

^dFree text answers were, as many as possible when enough supply but always infants <35 weeks and infants with hypoglycaemia, all infants <34 gestational weeks and >34 weeks if infant formula is not tolerated, all infants <32 gestational weeks and if enough supply to all infants instead of infant formula with an aim to give as first feed if the mother cannot express her own milk, at few occasions also to term infants with problems of vomiting, all preterm infants are prioritised but sometimes term infants with difficulties feeding and/or hypoglycaemia, infants to mothers with insulin treated diabetes, and one unit did not handle donor milk at their unit.

^eFree text answers were that infants with the lowest gestational age and infant weight are prioritised ($n=13$), based on three categories according to protein content, and in consultation with dietitian and staff with a focus on nutrition.

3.6.2 | Practices and Guidelines Regarding Donor Health and Intake of Medications, Alcohol, Caffeine and a Vegan Diet

Most units reported having local routines for donor health declarations, based on the national guidelines. Responses to the open-ended question regarding medical treatments for human milk donors indicated that the neonatal units were very restrictive in permitting donors undergoing medical treatment. One unit noted that their criteria for permitted medications were stricter than those for breastfeeding one's own infant; donors may only take medications approved by the guidelines, and any donation that did not comply was declined. The physicians used the website Janusinfo [22] to assess the safety of medications on an individual basis. Some analgesics, such as paracetamol, ibuprofen and non-steroidal anti-inflammatory drugs (NSAID), were approved for short-term use (Table 3). Approval of other medications depended on the dosage. Most antiepileptics, neuroleptics, opioids, immunomodulating drugs and thyreostatics were not permitted for human milk donors. Twenty-one of 24 units answered questions regarding whether alcohol consumption or a vegan diet was permitted for donors; three were missing. Seven out of 21 neonatal units accepted some level of alcohol consumption among milk donors, while 14 units did not. For those units permitting alcohol consumption, it was reported that occasional intake was acceptable, with a maximum of one glass of wine per week. Moreover, responses revealed that it was recommended that donors

refrained from expressing milk for donation for 2–24 h after alcohol consumption. Similarly, seven out of 21 units had guidelines regarding caffeine intake, whereas 14 units did not. The reported guidelines indicated that a reasonable caffeine intake was a maximum of three cups of coffee per day. Moreover, one unit also noted that donors should avoid energy drinks due to their high caffeine content. Fourteen units permitted donors adhering to a vegan diet, while seven units did not. Two units reported evaluating vegan diets of donors to determine if nutritional supplementation was necessary; in one unit this was performed by a dietician and the other unit by a physician.

3.6.3 | Pasteurising and Pooling of Donor Milk

Nineteen units pasteurised DHM (Table 1), and the pasteurisation method used in all units was Holder pasteurisation. Regarding pooling of DHM, 18 of the 19 pasteurising units reported not practising pooling whereas one unit occasionally pooled milk from different donors when there was a shortage of DHM.

3.6.4 | Serological Screening of Potential Milk Donors

The serological screening at recruitment of donors was mostly uniform among respondents (Table 5). One unit did not perform Hepatitis C and Syphilis at the time of recruitment, noting that

TABLE 5 | Handling processes for donor human milk and routines at the HMB.

Handling processes for donor human milk EXCEPT pasteurisation	
Definition: The handling process of DHM involves for example contact with human milk donors, collecting donor health declarations and performing serological screening of donors, providing donors with breast milk pumps and collecting milk donations	
	<i>n/N (missing)</i>
Staff working with handling processes	
Professions working with handling DHM	24/24
Assistant nurses (college-level education in nursing)	16
Childcare assistants (college-level education in Children and Leisure studies)	11
Registered nurses	6
Ward assistants (with no formal medical/nursing education)	1
Do the staff work both with handling DHM and with patient care?	22/24 (2)
Yes	20
No	2
Do the staff work with handling DHM and with patient care on the same day?	18/20 (2)
Yes	11
No	9
Routines regarding recruitment of milk donors	
Recruitment of milk donors	23/24 (1)
At the neonatal unit	22
Postnatal ward	19
Child Health Centres	18
Social media platforms	18
Postnatal follow up visits	11
Maternity clinics	10
Posters and information pamphlets	10
Transportation of donor milk to HMB	24
By donors	22
By home care staff	7
Other alternatives	7
Serological screening at donor recruitment	22/24 (2)
HIV 1/2	22

(Continues)

TABLE 5 | (Continued)

HTLV-I	20
HTLV-II	19
Hepatitis B	22
Hepatitis C	21
Syphilis	4
Time limits for milk donations	23/24 (1)
3 months	12
4 months	1
6 months	2
3 months + 3 months	7
Based on nutritional analysis	1
Are new serological screening required after 3 months, if the donor wish to continue donating?	22/24 (2)
Yes	20
No	2
Have you needed to decline donors related to organisational shortages?	20/24 (4)
Yes	9
No	11
Routines in the HMB INCLUDING pasteurisation	
Definition: The pasteurisation process of DHM involves pasteurising milk donations and performing bacteriological testing and nutritional analysis of the DHM	
	<i>n/N (missing)</i>
Staff working in the HMB	
How many of the staff works with pasteurisation processes	19/19
1 person	1
1–2 persons	5
3 persons	5
4 persons	5
5 persons	1
All staff in the unit	2
Professions working in the HMB	17/18 (1)
Assistant nurses (college-level education in nursing)	15
Childcare assistants (college-level education in Children and Leisure studies)	11
Registered nurses	6

(Continues)

TABLE 5 | (Continued)

Ward assistants (with no formal medical/nursing education)	1
Do the staff work both in the HMB and with patient care?	17/18 (1)
Yes	14
No	3
Do the staff work in the HMB and with patient care on the same day?	14/14 (0)
Yes	3
No	11
Are all donor milk pasteurised?	19
Yes	18
No, if donor milk is too old it is discarded	1
Do you mix milk from different milk donors (pooling)?	19
Yes	0
No	18
Sometimes	1
When is nutrition analysis of DHM performed?	13/19 (6)
Before pasteurisation	11
After pasteurisation	1
Both before and after pasteurisation	1
Protein analysed	
True	12 (2)
Crude	4 (2)
Do not know	6 (2)
Is the donated breast milk evaluated for bacterial content according to the following guidelines?	18
No potentially pathogenic bacteria such as beta-haemolytic streptococci group A, C or G, streptococci group B, Listeria or Salmonella	17 (1)
< 107 cfu/L of <i>Staphylococcus aureus</i>	16 (2)
< 107 cfu/L of Enterobacteriaceae	16 (2)
< 107 cfu/L of <i>Pseudomonas aeruginosa</i> or other <i>Pseudomonas</i> species	16 (2)

(Continues)

TABLE 5 | (Continued)

< 107 cfu/L of <i>Stenotrophomonas maltophilia</i>	15 (3)
< 107 cfu/L of Acinetobacter	16 (2)
Aerobic bacteria, e.g., coagulase-negative staphylococci or alpha-streptococci	15 (3)
When is the bacterial testing conducted?	18
Before pasteurisation	17
Before and after pasteurisation	1
How is the bacterial testing conducted?	19
From liquid milk, fresh or thawed	10
From frozen milk, a scratch-test	5
Both methods	4
Is all donor milk tested for bacterial growth?	18/19 (1)
A pooled sample from each batch	9
A random sample from one batch	4
The oldest milk	2
At recruitment, then occasionally	1
Do you provide other units or hospitals with DHM?	18/19 (1) ^a
Yes, other units in our hospital	9
Yes, other hospitals within our region	6
Yes, other hospitals outside our region	3
No, we do not provide DHM to other units/hospitals	5
If excess of DHM, do you share with other hospitals or regions?	19
Yes	5
No	5
Sometimes	9

^aFree text answers were, postnatal ward (n = 5), delivery ward (n = 2), other neonatal units.

these tests had already been conducted during pregnancy. If a woman had donated milk for 3 months, 20 units indicated that new serological screening should be conducted if she wished to continue donating. In contrast, two units responded that they did not require an additional serological screening for prolonged milk donation, and three units reported that they did not accept milk donations after 3 months.

3.6.5 | Bacteriological Testing of Donor Milk

Apart from those bacteria presented in Table 5 the survey responses to the open-ended question indicated that growth of the following bacteria in DHM was not accepted: *Candida*, *Serratia*, extended-spectrum beta lactamase (ESBL)-producing bacteria, methicillin-resistant *Staphylococcus aureus* (MRSA) and *Bacillus cereus*. Furthermore, one neonatal unit reported that for the total number of aerobic bacteria, including coagulase-negative staphylococci or alpha-streptococci, there was no upper limit. Another unit reported that for mould or bacilli, they looked at the donor's history: if it was the first occasion, they re-cultivated the sample and if it still showed presence of mould or bacilli, they requested a new sample of the same milk. If the new sample continued to be positive, it was rejected.

3.6.6 | Sharing of DHM Within Swedish Healthcare

The provision of pasteurised DHM to other units primarily occurred within the hospital, for example between the birth unit and the neonatal unit, and within the healthcare region. It was less common for DHM to be provided to other healthcare regions (Table 5). In cases of excess DHM, six units donated or sold milk to other hospitals and regions, while five units did not. The price set for DHM varied between USD 22–88 per litre. One unit reported no fixed price and stated that the price would be negotiated at the time of sale. The varying costs may depend on whether the DHM was pasteurised, with a higher price for pasteurised DHM.

4 | Discussion

This study highlights variations in practices for handling both MOM and DHM in Swedish neonatal units and HMBs, suggesting a need for improved implementation, clarification and the updating of national guidelines.

4.1 | Supporting Mothers to Provide MOM as the First Choice

All units reported giving lactation support to mothers, but only 11 reported having written guidelines. According to the WHO/UNICEF's 10 Steps to Successful Breastfeeding, all facilities providing maternity and newborn services should have written guidelines which are routinely communicated to staff and parents [23].

Only a third of the units in this study reported giving information about the differences between MOM and DHM. Furthermore, there were differences between units regarding staff training and education on lactation and breastfeeding, ranging from no training at all to giving all new staff education and regular training once a year. These differences may lead to families meeting staff with different competencies, which may affect their lactation and breastfeeding process [24, 25]. However, more than half of the units used colostrum kits when informing parents. The colostrum kit was developed in a previous quality improvement project to help staff give standardised basic information and tools for milk collection to parents regarding milk

expression and production, aiming to empower parents with knowledge about the physiology of initiation of a milk production. Hellström et al. have demonstrated reduced time to first infant colostrum intake after implementing the colostrum-kit in the NICU [18]. They further demonstrated that previous differences in time to infant colostrum intake related to mode of delivery were reduced and that the effect of the implementation persisted over time [18].

In a review, Meier et al., the authors describe the evidence, mechanism and priorities for research and practice regarding DHM, demonstrating the superiority of MOM for the reduction of mortalities and to be cost effective [6]. They conclude that providers of neonatal care need to find ways to support the superiority of MOM over DHM that results in higher doses and longer periods of MOM intake for infants [6].

4.2 | Handling, Storage and Fortification of Human Milk

There were differences among units regarding whether MOM was given frozen in chronological order or mainly given fresh. There are ongoing studies on whether giving fresh MOM may improve infant health outcomes [26, 27]. Further research on the potential biological benefits of fresh MOM and the changes that occur during storage is needed [28].

Furthermore, there was variation in fortification routines. Fortification is standard practise for very-low-birth-weight (VLBW) infants and is needed to support growth and development, but there may be dilemmas regarding the type of fortification, when timely initiation and continuation of fortification, and the duration of fortification [29]. In a study by Ericson et al., they found no significant differences in neurological outcomes, growth or health in children aged 6 years between moderately preterm infants (32–36 weeks of gestation) who were given fortification or formula compared with those exclusively given breast milk [30]. Additionally, in a review by Hard et al., the authors demonstrate that donor milk does not promote growth and development as well as MOM [7], why infants receiving donor milk may have an increased need of fortification. Moreover, there were differences in routines regarding the preparation of fortification, ranging from at bedside for every feeding to once every 24h. Fortification has been associated with an increase of osmolality in human milk, which may happen immediately after fortification [31]. Furthermore, concerns have also been raised regarding microbial growth in fortified DHM, which may be affected by storage time in a refrigerator [32].

4.3 | Acceptance of Medications, Caffeine and Alcohol

There is a lack of guidelines for maternal medication related to infant MOM intake in Sweden. Several discrepancies were observed among the neonatal units regarding the acceptance of maternal medication intake and providing MOM to their infants. These differences were mainly related to analgesics, contraceptives containing progesterone, antihypertensives and

psychopharmaceuticals. These differences indicate a need for clarified and updated guidelines regarding what medications should be considered safe to consume by a mother currently providing MOM to her infant.

In contrast, stricter guidelines regarding medical treatment were reported for milk donors. However, there were differences between HMBs, most commonly regarding analgesics, antihypertensives and psychopharmaceuticals. Again, this suggests a need for clarifications and updated evidence in future Milknet guidelines. There were also differences among units regarding both MOM and DHM, as to whether they had guidelines for alcohol intake, caffeine intake and vegan diets. The results indicate a need for clearer guidelines in these areas.

4.4 | Routines for Milk Donations

4.4.1 | Milk Donations

Only five units reported never having declined milk donations, while other units reported a frequency of occasionally up to 20 times a year. Several of the reasons mentioned for rejecting donors were modifiable, such as inability to take on willing donors, limited storage capacity and breast pumps, as well as time limits on donation. If the storage capacity were improved in Swedish HMBs, donor milk could be used throughout the infants' hospital stay at both the neonatal and postnatal units. In most units today, DHM is only given to preterm infants born before 34 weeks' gestation, being phased over to formula when the infants reach 34 weeks' gestation if MOM is unavailable or does not meet the infants' needs. In both the WHO/UNICEF global guidelines [23] and the Swedish guidelines [20], DHM is recommended as the next choice if MOM is unavailable or does not meet the infant's needs.

There were also reported differences in where the milk donors could deliver their milk. Most units reported that the donors had to leave the milk at the milk bank, but other units allowed mothers to deliver their milk to other health services closer to their homes, where it could be transported by regular channels (e.g., as used for blood samples) within the health and welfare organisation. Other units reported collecting DHM at the milk donors' homes. It is imperative to establish a system that facilitates the donation of milk for the donors. This is particularly relevant given that donors are often women who have recently given birth and may face difficulties in travelling to HMBs to deliver their milk [33, 34]. To support and facilitate milk donations, the above examples may be implemented by others.

4.4.2 | Serological Screening of Milk Donors

All units performed serological screening when recruiting new milk donors. Most units that accepted donor milk for more than 3 months reported repeating the initial serological screening for a new donation period. Enabling repeated serological screening may facilitate a longer period of milk donation and improve the availability of DHM, extending its use to all infants needing supplementation during their hospital stay.

4.4.3 | Bacteriological Testing of Donor Milk

Most HMBs reported bacteriological testing before pasteurisation, with only one unit stating that testing is done both before and after pasteurisation. Routines for bacterial testing before pasteurisation have been discussed internationally, as related to milk not being accepted for donation, even though pathogens will be eliminated through pasteurisation [35], which may lead to a lack of supply of donor milk. Both the American Academy of Paediatrics (AAP) [36] and the Human Milk Banking Association of North America (HMBANA) guidelines (2024) [37] recommend bacteriological testing of each batch after pasteurisation. Testing after pasteurisation may be beneficial for both the safety and increased availability of donor milk.

There were also different routines reported for bacteriological testing of the same batch of donated milk, related to testing all milk in a batch or only random samples of the milk.

Most units reported accepting donor milk according to the Milknet guidelines [20]. However, some units reported evaluating and imposing restrictions based on other possible pathogens as well, such as *Candida*, *Serratia*, ESBL, MRSA and *Bacillus cereus*. These results and a review of new literature and evidence indicate a need for an update of the revised Milknet guidelines for possible pathogens to be screened.

4.4.4 | Handling and Pasteurisation

All units reported pasteurising all donor milk. Guidelines related to handling and pasteurisation vary among countries [38], but there is consensus on the need for quality control to ensure safe donor milk [38]. Since the pasteurisation process affects many of the bioactive components of human milk, both pasteurisation methods and the possibility of not pasteurising donor milk have been subjects of research and discussion [38].

4.4.5 | Collaboration to Utilise Resources When There Is Excess Donor Milk

In Sweden there is no national HMB organisation. Collaboration among HMBs differed in terms of the provision of pasteurised donor milk to other units in cases of excess. The establishment of a network to provide other units with donor milk is imperative to enhance collaboration in Sweden, preventing the discarding of surplus donor milk in one unit when supply is inadequate in another. An organization of Swedish HMBs on a national level could facilitate collaboration and optimise the use of DHM.

4.5 | The Importance of Supporting Both MOM and DHM Supply: Ways Forward?

There are several factors beyond pasteurisation that may affect the clinical properties of DHM. Meier et al. [6] highlighted that factors including mammary gland maturity, lactation stage, freeze–thaw cycles, and the storage and handling of

DHM. They further emphasised a specific mismatch that occurs when MOM is replaced with DHM in the early postnatal period. This is related to previous studies suggesting that the composition of MOM during the early stage of lactation reflects the immaturity of the mammary gland and is uniquely tailored to the infant's biological needs during this critical window after birth [6].

MOM contains numerous bioactive factors, including microbiota that are involved in the health effect for infants [8]. Since DHM is pasteurised, several bioactive factors and microbes are reduced or abolished [7]. There have been studies on possibilities to recolonize donor milk with microbiota from MOM, a milk microbiome transplantation [39–41]. This approach is a way to personalise DHM with the individual mother's milk microbiota [39].

Furthermore, in a study by Tan et al., the authors demonstrated that very preterm infants fed MOM, compared to infants fed DHM, had a trajectory of immune development with greater resemblance to term infants [42]. This normalisation in development was explained by NK cell development and not by differences in microbial colonisation, suggesting a direct effect of bioactive factors in milk. These results strengthen the need to continue to support maternal lactation in neonatal care.

Hendricks-Munoz et al. [43] suggested that utilising DHM while supporting MOM at discharge can reduce the need for formula in VLBW infants. However, they emphasised that without additional resources for lactation support, increasing MOM intake at discharge may be challenging. They advocated individualised maternal education and lactation support to positively influence MOM feeding practices at discharge [43]. Further, Kontopodi et al. [44] conducted a web-based survey of European HMBs, revealing significant variability in practices across the continent. This variability highlights opportunities to enhance the effectiveness of DHM banking. Despite well-established national guidelines in Sweden, the present study also found considerable variations in practices, underscoring the need for greater standardisation.

4.6 | Method Discussion

The survey contained 102 questions, some similar in content but related to different aspects of human milk handling, which may have affected the response rate of 63% for part 1 of the survey and 68% for part 2. Several reminders were sent to improve the response rate. Furthermore, in the information provided with the survey, different professions were asked to answer different questions, which also may have negatively affected the response rate. However, receiving answers from different professions may have strengthened the results within this field. Additionally, having responses from neonatal units of different care levels in Sweden, as well as responses from all regions in the country, may have strengthened the generalizability of the results nationally.

Author Contributions

Ylva Thernström Blomqvist: conceptualization, investigation, writing – original draft, methodology, validation, visualization, writing – review and editing, project administration, formal analysis, data curation, supervision. **Anna-My Lund:** conceptualization,

investigation, writing – original draft, methodology, validation, visualization, writing – review and editing, formal analysis, data curation. **Fredrik Ahlsson:** conceptualization, methodology, writing – review and editing. **Jenny Ericson:** conceptualization, methodology, writing – review and editing. **Charlotta Karlsson:** conceptualization, methodology, writing – review and editing. **Josefin Lundström:** conceptualization, methodology, writing – review and editing. **Ingela Sandström:** conceptualization, methodology, writing – review and editing. **Anna Gustafsson:** conceptualization, investigation, writing – original draft, methodology, validation, visualization, writing – review and editing, formal analysis, project administration, data curation, supervision.

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The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** apa70448-sup-0001-AppendixS1.docx. **Appendix S2:** apa70448-sup-0002-AppendixS2.docx.