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ORIGINAL ARTICLE

Breastmilk use in preterm infants <29 weeks' gestational age in Australia, New Zealand and Singapore

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Aims: To describe the prevalence of use of breastmilk and explore demographic characteristics and clinical outcomes associated with breastmilk provision in infants born <29 weeks' gestational age in Australia, New Zealand and Singapore.

Methods: This is a secondary analysis of data from a randomised controlled trial, which enrolled 1273 infants in 13 neonatal units across Australia, New Zealand and Singapore from 2012 to 2015. Infants were classified as formula-fed, donor milk-fed or mother's milk-fed at their first enteral feed and separately, at hospital discharge.

Results: The percentage of infants receiving mother's own milk differed between centres both at first feed (79% to 100%), and at hospital discharge (47.1% to 71.6%). Aboriginal, Torres Strait Islander and Southeast Asian heritage, drug use and smoking were associated with lower rates of fully breastmilk feeding at hospital discharge. There was no significant difference in growth outcomes, length of stay and feeding tolerance between feeding groups.

Conclusions: Achieving high breastmilk feeding rates at hospital discharge for all preterm infants born <29 weeks' gestational age at hospital discharge is possible; however, targeted support for mothers who are Indigenous, Southeast Asian and/or using recreational drugs and/or smoking and/or experiencing social disadvantage may be needed. A better understanding and shared knowledge of practice variations within neonatal units with high breastfeeding rates could improve breastmilk access and equity for preterm infants.

Australian New Zealand Clinical Trials Registry: ACTRN12612000503820.

Key words: breastfeeding or breastmilk or growth; intensive care units, neonatal; nutritional outcome; preterm infant.

What is already known on this topic

1. The recommended source of nutrition for preterm infants is mother's own milk, however if this is unavailable, donor milk is recommended before considering formula.
2. Breastmilk provides specific benefits to the preterm population, such as reducing risks of sepsis, necrotising enterocolitis and retinopathy of prematurity.
3. Despite the overwhelming evidence that breastmilk is beneficial for preterm infants, breastfeeding rates within many neonatal units remain low.

What this paper adds

1. This description of feeding practices in a high-risk group of preterm infants within Australia, New Zealand and Singapore indicates that it is possible to achieve high rates of mothers' own milk feeding on discharge.
2. Indigenous and Southeast Asian mothers of preterm infants and mothers with low socioeconomic status were more likely to stop breastfeeding before hospital discharge, identifying opportunities for targeted lactation support.
3. Further exploration of the contributing factors to low breastfeeding rates amongst mothers of NICU graduates and of the individual practice variations associated with high breastfeeding rates across units will provide an understanding of key services that may help promote breastmilk feeding beyond discharge.

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The World Health Organisation (WHO) recommends exclusive breastfeeding from birth to 6 months of age for all infant populations.[1] Nutrients in breastmilk are more bioavailable than commercial infant formulas and improve innate immunity, growth and long-term health.[2–4] The nutritional requirements of preterm infants following birth until term corrected age are higher than in any other period of infancy, and the recommended source of nutrition for preterm infants is breastmilk, supplemented with fortifier.[5,6] Breastfed infants are less susceptible to inflammatory disorders and infection and may have a reduced incidence of cardiovascular disease in adult life.[7–9] There are additional benefits amongst infants born preterm (<37 weeks' gestation),[10] including promoting intestinal maturation, improved feed tolerance, reduced time to reach full enteral feeds, fewer hospital readmissions and improved growth rates.[9,11] Evidence from meta-analysis has demonstrated that sustained breastmilk feeding in preterm infants is associated with reduced rates and severity of complications of prematurity, including necrotising enterocolitis (NEC), sepsis, retinopathy of prematurity (ROP), feeding intolerance and bronchopulmonary dysplasia (BPD).[12–14] Longer-term studies following neurodevelopmental outcomes found that infants who received breastmilk in the neonatal intensive care unit (NICU) showed improvement in intelligence test results, fewer behavioural symptoms, and total brain volumes on brain magnetic resonance imaging (MRI) in adolescence.[15,16]

Overall the Australian population has high rates of mother's own milk exposure, with 90% of Australian children between the age of 0–3 receiving any breastmilk,[17] However, despite this high rate and the evidence that breastmilk is beneficial in both the short and longer-term for preterm infants, breastmilk feeding rates upon hospital discharge from neonatal units are generally low.[18,19] Neonatal units present unique challenges to establishing breastfeeding not found in other newborn settings.[20] Mothers often have to establish and maintain a breastmilk supply without the assistance from their babies directly breastfeeding. Other barriers to breastfeeding success include maternal illness associated with preterm birth, perceived lack of breastmilk supply, lack of privacy for expressing milk, and the stress of having a preterm infant in NICU.[20] Additionally, preterm infants are born disproportionately to socioeconomically disadvantaged families, with already lower breastfeeding rates.[20] Thus, there needs to be planned support for breastfeeding initiation and maintenance. New knowledge about the prevalence and characteristics associated with provision of breastmilk for preterm infants will enhance the development of targeted implementation strategies and help decrease neonatal unit variations in practice.

Our study aims to provide a contemporary description of the use of breastmilk (including donor milk) at the first feed and on hospital discharge in infants born <29 weeks' gestational age (GA) in neonatal units in Australia, New Zealand and Singapore. We also aim to describe demographic characteristics of infants and families associated with providing maternal breastmilk compared to formula at the time of first feed and at discharge and describe growth outcomes in association with the provision of mother's own milk compared to donor milk or formula.

Methods

Participants

This is a secondary analysis of data from the N3RO (N-3 fatty acids for improvement in Respiratory Outcomes) randomised controlled trial conducted in infants born <29 weeks' gestation.[21] The N3RO trial randomly assigned 1273 infants (1098 mothers) to receive either (1) an enteral emulsion providing the n-3 fatty acid docosahexaenoic acid (DHA) at a dose of 60 mg per kilogram of body weight per day or (2) a control (soy) emulsion without DHA until 36 weeks PMA or discharge home, whichever occurred first. The emulsion was given directly to infants across three daily doses of 0.17 mL of emulsion/kg/day (total 0.5 mL/kg/day). The infants were recruited by neonatal nurses from 13 neonatal units across Australia ($n = 10$), New Zealand ($n = 2$) and Singapore ($n = 1$) from June 2012 to September 2015.

The research ethics committees responsible for each of the 13 participating centres approved the trial protocol. Written informed consent was obtained at entry into the trial.[21]

Primary outcomes

Type of feed at first feed and at discharge or term corrected (whichever occurred first) were key exposures of interest. Feed types were defined as the following:

- Infants who received only mothers' own milk.
- Infants who received any donor milk (exclusively or in combination with mother's own milk).
- Infants who received any formula (exclusively or in combination with mother's own milk and/or donor milk).

Fortification of mother's own milk and donor milk occurred as per individual neonatal unit policy. The N3RO study did not provide information on specific unit breastfeeding practices and nutrition policies, including whether donor milk was pasteurised or unpasteurised, and how donor milk was provided.

Characteristics

Information regarding infant and parental demographics, growth and feeding practices were collected during the original study up to the initial hospital discharge or term corrected age, whichever occurred first.

The N3RO primary outcome was physiological BPD, assessed at 36 weeks PMA or discharge home (whichever occurred first) and has been published previously.[21]

Secondary outcomes of interest to this analysis included

- Length of hospital stay
- Feeding tolerance (number of days to reach full enteral feeding and number of days on which one or more feedings were stopped)
- Growth (weight, length, and head circumference z scores at discharge home)

Statistical analysis

Descriptive statistics (count, % and mean, SD, where appropriate) were used to summarise demographic characteristics and feeding practices. We described variation in key exposures by country and study site. Logistic regression with generalised estimating equations (GEEs) was used to examine the relationship between demographic characteristics of infants and families and provision of mother's milk and formula. All analyses were

TABLE 1 Characteristics of first enteral feed by hospital†

Characteristic	Day of first enteral feed: Median (IQR)	Type of feeding at first enteral feed: N (%)		
		Mothers' own milk	Donor milk	Formula
Centre 1 ($n = 59$)	3.0 (2.0–4.5)	56 (94.9)	0 (0.0)	3 (5.1)
Centre 2 ($n = 108$)	1.0 (1.0–2.0)	107 (99.1)	0 (0.0)	1 (0.9)
Centre 3 ($n = 187$)	2.0 (1.0–3.0)	152 (81.0)	35 (19.0)	0 (0.0)
Centre 4 ($n = 127$)	3.0 (2.0–5.0)	102 (80.0)	0 (0.0)	25 (20.0)
Centre 5 ($n = 55$)	1.0 (0.0–1.5)	55 (100.0)	0 (0.0)	0 (0.0)
Centre 6 ($n = 72$)	2.0 (1.0–2.0)	64 (88.9)	6 (8.3)	2 (2.8)
Centre 7 ($n = 79$)	1.0 (1.0–2.0)	76 (96.2)	3 (3.8)	0 (0.0)
Centre 8 ($n = 73$)	2.0 (1.0–3.0)	73 (100.0)	0 (0.0)	0 (0.0)
Centre 9 ($n = 65$)	1.0 (1.0–2.0)	64 (98.5)	0 (0.0)	1 (1.5)
Centre 10 ($n = 194$)	1.0 (1.0–2.0)	194 (100.0)	0 (0.0)	0 (0.0)
Centre 11 ($n = 34$)	2.0 (2.0–3.0)	33 (97.1)	0 (0.0)	1 (2.9)
Centre 12 ($n = 81$)	1.0 (1.0–2.0)	79 (97.5)	1 (1.2)	1 (1.2)
Centre 13 ($n = 133$)	1.0 (1.0–2.0)	120 (90.2)	0 (0.0)	13 (9.8)
Total ($n = 1267$†)	2.0 (1.0–3.0)	1175 (92.7)	45 (3.6)	47 (3.7)

† Randomised $n = 1273$, missing data $n = 6$ (Centre 3 $n = 1$, Centre 4 $n = 2$, Centre 5 $n = 1$, Centre 9 $n = 1$, Centre 12 $n = 1$).

adjusted for treatment group and accounted for clustering of outcomes due to multiple births. Adjustments for other factors such as gestational age were not performed due to the small number of cases in the formula feeding group. Continuous growth outcomes, including weight, length and head circumference at discharge, were analysed using linear GEEs adjusted for treatment group and accounting for multiple births. All analyses were performed using R (version 3.6.1), R Foundation for Statistical Computing. Further adjusted analyses were not performed due to the small number of cases in the formula feeding group. Results were considered statistically significant when the P value for interactions was <0.05.

Results

The rate of mother's own milk at first feed varied from 100% in Centres 8 and 10 to 79.1% in Centre 4 (Table 1). Only four centres provided donor milk for the first enteral feed (Table 1). 94.6% of infants in Australian centres received mother's own milk as the first feed, Singapore 79.1%, and New Zealand 97.4% (Table 2). It was noted that in centres where no infants received donor milk, there was a lower rate of mother's own milk as the first feed. Statistical analysis was not performed for this data set. In regard to the provision of breastmilk at the time of first enteral feed, there was no significant association with the sex of the

TABLE 2 Description of use of breastmilk at time of first feed and at discharge or expected date of delivery (EDD)†

Characteristic	AUS ($n = 1028$)	Singapore ($n = 129$)	NZ ($n = 116$)	Total ($n = 1273$)
At time of first feed				
Formula: N (%)				
Missing	3 (0.3)	2 (1.6)	1 (0.9)	6 (0.5)
No	1005 (97.8)	102 (79.1)	113 (97.4)	1220 (95.8)
Yes	20 (1.9)	25 (19.4)	2 (1.7)	47 (3.7)
Mother's own milk: N (%)				
Missing	3 (0.3)	2 (1.6)	1 (0.9)	6 (0.5)
No	53 (5.2)	25 (19.4)	2 (1.7)	80 (6.3)
Yes	972 (94.6)	102 (79.1)	113 (97.4)	1187 (93.2)
Donor milk: N (%)				
Missing	3 (0.3)	2 (1.6)	1 (0.9)	6 (0.5)
No	981 (95.4)	127 (98.4)	114 (98.3)	1222 (96.0)
Yes	44 (4.3)	0 (0.0)	1 (0.9)	45 (3.5)
At discharge or EDD				
Formula: N (%)				
Missing	59 (5.7)	8 (6.2)	10 (8.6)	77 (6.0)
No	536 (52.1)	58 (45.0)	66 (56.9)	660 (51.8)
Yes	433 (42.1)	63 (48.8)	40 (34.5)	536 (42.1)
Mother's own milk: N (%)				
Missing	59 (5.7)	8 (6.2)	10 (8.6)	77 (6.0)
No	310 (30.2)	18 (14.0)	26 (22.4)	354 (27.8)
Yes	659 (64.1)	103 (79.8)	80 (69.0)	842 (66.1)
Donor milk: N (%)				
Missing	59 (5.5)	8 (6.2)	10 (8.6)	77 (6.0)
No	964 (93.8)	121 (93.8)	106 (91.4)	1191 (93.6)
Yes	5 (0.5)	0 (0.0)	0 (0.0)	5 (0.4)

† There were 77 deaths in N3RO (some may have occurred after discharge/EDD). EDD, estimated date of delivery.

TABLE 3 Demographic characteristics and associations with provision of maternal breastmilk at discharge or EDD†

Characteristic	Formula (*n* = 536)	Mother's own (*n* = 658)	Total (*n* = 1194)	Odds ratio (95% CI)	*P*-value	*P*-value (overall)
Sex: *N* (%)						0.17
Female	239 (42.7)	321 (57.3)	560 (100.0)	Reference		
Male	297 (46.8)	337 (53.2)	634 (100.0)	0.85 (0.66, 1.08)	0.17	
GA group: *N* (%)						0.0057
GA < 27 weeks	285 (49.5)	291 (50.5)	576 (100.0)	Reference		
GA ≥ 27 weeks	251 (40.6)	367 (59.4)	618 (100.0)	1.43 (1.11, 1.85)	0.0057	
Mother race: *N* (%)						<0.0001
Unknown/missing	12 (36.4)	21 (63.6)	33 (100.0)			
Caucasian	279 (38.3)	449 (61.7)	728 (100.0)	Reference		
Indigenous‡	61 (85.9)	10 (14.1)	71 (100.0)	0.10 (0.05, 0.22)	<0.0001	
Northeast Asian	42 (43.3)	55 (56.7)	97 (100.0)	0.81 (0.51, 1.31)	0.39	
Southeast Asian	53 (60.9)	34 (39.1)	87 (100.0)	0.40 (0.24, 0.65)	0.0003	
Southern and Central Asian	28 (37.3)	47 (62.7)	75 (100.0)	1.04 (0.58, 1.87)	0.89	
Other§	61 (59.2)	42 (40.8)	103 (100.0)	0.43 (0.27, 0.68)	0.0003	
Parental education (secondary): *N* (%)						
Unknown/missing	97 (67.4)	47 (32.6)	144 (100.0)			<0.0001
Both not completed	103 (69.6)	45 (30.4)	148 (100.0)	Reference		
One parent completed	100 (48.1)	108 (51.9)	208 (100.0)	2.47 (1.53, 4.01)	0.0002	
Both completed	236 (34.0)	458 (66.0)	694 (100.0)	4.44 (2.93, 6.73)	<0.0001	
Parental education (further study): *N* (%)						<0.0001
Unknown/missing	114 (67.5)	55 (32.5)	169 (100.0)			
Both not completed	110 (69.2)	49 (30.8)	159 (100.0)	Reference		
One parent completed	103 (46.0)	121 (54.0)	224 (100.0)	2.64 (1.68, 4.15)	<0.0001	
Both completed	209 (32.6)	433 (67.4)	642 (100.0)	4.65 (3.12, 6.94)	<0.0001	
Completed secondary school (mother): *N* (%)						<0.0001
Unknown/missing	49 (60.5)	32 (39.5)	81 (100.0)			
No	175 (69.7)	76 (30.3)	251 (100.0)	Reference		
Yes	312 (36.2)	550 (63.8)	862 (100.0)	4.06 (2.90, 5.69)	<0.0001	
Completed further study (mother): *N* (%)						<0.0001
Unknown/missing	55 (59.8)	37 (40.2)	92 (100.0)			
No	186 (65.7)	97 (34.3)	283 (100.0)	Reference		
Yes	295 (36.0)	524 (64.0)	819 (100.0)	3.41 (2.50, 4.65)	<0.0001	
Completed secondary school (father): *N* (%)						<0.0001
Unknown/missing	95 (67.9)	45 (32.1)	140 (100.0)			
No	161 (56.7)	123 (43.3)	284 (100.0)	Reference		
Yes	280 (36.4)	490 (63.6)	770 (100.0)	2.29 (1.70, 3.11)	<0.0001	
Completed further study (father): *N* (%)						<0.0001
Unknown/missing	109 (67.7)	52 (32.3)	161 (100.0)			
No	176 (58.5)	125 (41.5)	301 (100.0)	Reference		
Yes	251 (34.3)	481 (65.7)	732 (100.0)	2.70 (2.00, 3.65)	<0.0001	
Currently employed (father): *N* (%)						0.0008
Unknown/missing	142 (64.8)	77 (35.2)	219 (100.0)			
No	26 (68.4)	12 (31.6)	38 (100.0)	Reference		
Yes	368 (39.3)	569 (60.7)	937 (100.0)	3.35 (1.65, 6.80)	0.0008	
Currently employed (mother): *N* (%)						0.0001
Unknown/missing	251 (58.5)	178 (41.5)	429 (100.0)			
No	86 (51.8)	80 (48.2)	166 (100.0)	Reference		
Yes	199 (33.2)	400 (66.8)	599 (100.0)	2.16 (1.47, 3.18)	0.0001	
Smoke during pregnancy: *N* (%)						<0.0001
Unknown/missing	22 (59.5)	15 (40.5)	37 (100.0)			
No	368 (38.4)	590 (61.6)	958 (100.0)	Reference		
Yes	146 (73.4)	53 (26.6)	199 (100.0)	0.23 (0.16, 0.33)	<0.0001	
Alcohol during pregnancy: *N* (%)						0.75
Unknown/missing	35 (60.3)	23 (39.7)	58 (100.0)			

(*Continues*)

TABLE 3 (Continued)

Characteristic	Formula (*n* = 536)	Mother's own (*n* = 658)	Total (*n* = 1194)	Odds ratio (95% CI)	*P*-value	*P*-value (overall)
No	467 (44.0)	595 (56.0)	1062 (100.0)	Reference		
Yes	34 (45.9)	40 (54.1)	74 (100.0)	0.92 (0.56, 1.51)	0.75	
Recreational drugs during pregnancy: *N* (%)						<0.0001
Unknown/missing	36 (61.0)	23 (39.0)	59 (100.0)			
No	469 (42.8)	628 (57.2)	1097 (100.0)	Reference		
Yes	31 (81.6)	7 (18.4)	38 (100.0)	0.17 (0.07, 0.39)	<0.0001	
Multiple pregnancy: *N* (%)						0.31
Unknown/missing	0 (0.0)	0 (0.0)	0 (0.0)			
No	377 (43.7)	485 (56.3)	862 (100.0)	Reference		
Yes	159 (47.9)	173 (52.1)	332 (100.0)	0.85 (0.61, 1.17)	0.31	
Previous preterm births: *N* (%)						0.0005
Unknown/missing	1 (9.1)	10 (90.9)	11 (100.0)			
No	430 (42.9)	572 (57.1)	1002 (100.0)	Reference		
Yes	105 (58.0)	76 (42.0)	181 (100.0)	0.54 (0.39, 0.77)	0.0005	
Assisted conception: *N* (%)						0.037
Unknown/missing	6 (37.5)	10 (62.5)	16 (100.0)			
None	467 (46.6)	536 (53.4)	1003 (100.0)	Reference		
Yes	63 (36.0)	112 (64.0)	175 (100.0)	1.55 (1.03, 2.34)	0.037	
Place of birth: *N* (%)						0.097
Unknown/missing	0 (0.0)	0 (0.0)	0 (0.0)			
Non-tertiary hospital	40 (55.6)	32 (44.4)	72 (100.0)	Reference		
Born in hospital with level III NICU	490 (44.0)	623 (56.0)	1113 (100.0)	1.59 (0.95, 2.67)	0.081	
Born before arrival	6 (66.7)	3 (33.3)	9 (100.0)	0.63 (0.14, 2.73)	0.53	
Mode of birth: *N* (%)						0.062
Unknown/missing	0 (0.0)	1 (100.0)	1 (100.0)			
Vaginal	231 (49.6)	235 (50.4)	466 (100.0)	Reference		
Instrument	8 (40.0)	12 (60.0)	20 (100.0)	1.47 (0.59, 3.66)	0.40	
Caesarean section	297 (42.0)	410 (58.0)	707 (100.0)	1.36 (1.05, 1.76)	0.02	

† (%) are row percentages. ‡ Includes women of Aboriginal Australian and Torres Strait Islander ethnicity. § Includes women of African (*N* = 30), Māori (*N* = 56), other Indigenous (*N* = 1) and Pacific Islander (*N* = 16) ethnicity. EDD, estimated date of delivery.

child, multiple pregnancy, smoking, alcohol, or recreational drug use during pregnancy, assisted conception, previous preterm birth, place of birth, mode of birth or level of parental education (Table S2). Infants were less likely to receive breastmilk for their first feed if they were Indigenous (Aboriginal or Torres Strait Islander), Northeast Asian or Southeast Asian. Infants born at ≥27 weeks were more likely to receive breastmilk for their first feed (Table S2). In the mother's own milk and formula fed groups, the number of infants born at ≥27 weeks' gestation was 618 (52%) and the number born at <27 weeks' gestation was 576 (48%).

Rates of mother's own milk at discharge varied from 47.1% in Centre 4 to 71.6% in Centre 6 (Table S1). Between countries, the rates of mother's own milk feeding at hospital discharge varied, from 64.1% in Australia, 79.8% in Singapore and 69.0% in New Zealand (Table 2). Infants who had one or more parents who completed secondary school and/or further study, who had one or more parents who were employed were more likely to be receiving mothers' own milk at the time of discharge home (Table 3). Infants born *via* caesarean section or assisted conception were also more likely to receive mothers' own milk at discharge. Indigenous and Southeast Asian infants were less likely to receive mothers' own milk at discharge. Recreational, drug use and smoking during pregnancy were associated with significantly reduced mothers' own milk feeding at discharge. However, alcohol use during pregnancy and multiple pregnancy had no significant association. Women who have had a previous preterm birth also had reduced mothers' own milk feeding rates at discharge. The sex of the infant and place of birth had no impact; for further details (Table 3).

The median day of first feed varied from 1.0 to 3.0 (Table 1). Days to reach full enteral feeds varied from 15.1 to 18.0, and there was no significant difference in the number of days on which feeds were interrupted (Table S4). Length of stay did not vary significantly between centres or between mother's own milk fed, donor milk fed or formula fed infants (Tables S1 and S4, respectively). There was no difference in discharge weight and length between infants who received their mother's own milk (reference), formula or donor milk (Table S3). Head circumference at discharge was larger in infants who received formula feeding (0.589 cm increase, 95% CI 0.057 to 1.12) compared with mother's own (reference) or donor milk (Table S3).

Discussion

This study provides new data about breastmilk feeding in a high-risk group of preterm infants within Australia, New Zealand and Singapore. We found marked variability between included regions and neonatal units regarding breastmilk feeding rates at the time of first feed and discharge home. Maternal and infant demographics were determinants of breastmilk feeding rates at the time of discharge. There were no significant differences in growth, length of stay or feeding intolerance outcomes between groups. These findings are broadly generalisable amongst the very preterm (<29 weeks' gestation) population.

Our results are consistent with the literature, which shows that babies born to Indigenous mothers are less likely to be breastfed initially or at hospital discharge.[22,23] Aboriginal Australian and Māori infants have overall lower breastmilk feeding initiation rates, showing that health disparities often commence early for these children. It is vital that this information is reported and that programmes for working in partnership with Indigenous mothers continue to be developed and implemented within neonatal units. Culturally appropriate, targeted services for Indigenous women have been shown to improve breastfeeding rates following birth.[22] Lower rates of breastmilk feeding were also observed in women of Southeast Asian ethnicity, consistent with previous literature,[24] which highlights the need for culturally responsive breastfeeding support more broadly.

Recreational drug use and cigarette smoking were also associated with lower breastmilk feeding initiation and continuation rates. However, alcohol use was not. This should be interpreted with caution as there were small numbers of mothers in this study who reported they took these substances during pregnancy and acquiring valid data on these exposures around pregnancy is fraught with difficulty. Again, in keeping with other research, parental employment and higher education were positively associated with breastmilk provision at hospital discharge. Our study found that infants born ≥27 weeks were more likely to receive breastmilk as their first enteral feed. However, there was no clear difference in feeding at discharge. This is likely to reflect maternal health conditions, which can cause extreme preterm birth and prevent early breastmilk expression and feeding.

Amongst included neonatal units, there was a wide range of practice, with significant variation in the median day of first feed and type of feed. Centres where no infants received donor milk, had a lower rate of breastmilk feeding at the first enteral feed. It is worth noting however that since completion of the N3RO study, donor milk use within Australian neonatal centres has increased.[25] Overall, differences in breastmilk feeding rates may reflect distinct approaches to breastfeeding promotion in the neonatal units. The N3RO study did not provide information on specific unit practices and policies, so a correlation between focused breastfeeding promotion practices and breastfeeding rates could not be made. There are evidence-based strategies that can be implemented within neonatal units to improve breastfeeding rates in preterm infants. Those with supporting evidence include skin to skin care, use of peer counsellors, use of donor milk, early initiation of breastmilk expression, increased availability of pumps for breastmilk expression, non-nutritive sucking, and provision of oropharyngeal colostrum.[26]

This study was limited by the smaller number of centres included from New Zealand, compared with Australia. This study was also conducted before donor milk was widely available in Australasian neonatal units. There was no data collected on the timing of frequency of initial breastmilk expressing amongst mothers of preterm infants. There was also no information differentiating between infants who were being directly breastfed at discharge, or receiving expressed mothers' own milk. Other characteristics may confound the relationship between clinical and growth outcomes with breastmilk exposure; however, due to the limited number of infants in the formula-fed group, we could not run models adjusting for potential demographic confounders. Larger studies are required to examine the impact of breastmilk feeding on clinical outcomes, which were not evaluated due to the small number of events.

Conclusion

Neonatal units in Australia, New Zealand and Singapore can achieve high rates of breastmilk feeding rates at discharge for preterm infants born <29 weeks, however rates vary and are low in some units. Understanding the interventions used by units with higher rates of breastmilk feeding at discharge is important to help identify quality improvement initiatives that could be implemented in units with lower rates, and promote equity in breastmilk access for preterm infants. In some settings, targeted and tailored support strategies for Aboriginal and Torres Strait Islander mothers and their infants may be required to achieve and maintain high rates of breastmilk feeding, in addition to culturally appropriate breastfeeding support that can benefit other minorities.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1: Length of stay and characteristics of enteral feed at discharge by hospital.
Table S2: Demographic characteristics and associations with provision of maternal breastmilk at time of first feed.
Table S3: Descriptives for growth outcomes by type of feed.
Table S4: Descriptives for enteral feeding administration.