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Currents in Human Milk Banking

The Cost-effectiveness of Using Banked Donor Milk in the Neonatal Intensive Care Unit: Prevention of Necrotizing Enterocolitis

Lois D. W. Arnold, MPH, IBCLC

Abstract

Necrotizing enterocolitis (NEC) adds significantly to the cost of care for premature infants and to negative long-term and short-term outcomes for these infants. It is thus in the best interest of the health care system to prevent the occurrence of NEC through feeding protocols that foster NEC prevention (ie, use of breast milk in the neonatal intensive care unit). Banked donor milk has been shown to be as effective in preventing NEC as mother's milk. Three models of cost analysis are presented to show savings that could accrue to a health care system or individual family if banked donor milk were provided as first feedings when mother's milk is not available. The cost of using banked donor milk to feed premature infants is inconsequential when compared to the savings from NEC prevention. *J Hum Lact*. 18(2):172-177.

Keywords: banked donor milk, human milk banking, donor breast milk, cost savings, necrotizing enterocolitis

As health care costs have spiraled upward around the world, health care providers, payers, and governmental agencies responsible for health care delivery face the emerging importance of cost analysis in providing health care services. Prioritization of community needs may direct program decisions, especially those related to prevention of massive expenditures for critical or chronic care in the future. For example, hospitals analyze the cost-effectiveness of certain services or programs and make decisions on whether to continue or discontinue programs strictly on the basis of cost analysis. A community health department finds that money spent on car seat education campaigns is cost-effective because less will be spent on continuing care and special disability programs for children injured in automobile accidents. Similarly, vaccination programs are extremely cost-effective in that they prevent childhood diseases that can cause permanent disabilities and even death across an entire population.

Banked donor milk has similar potential for preventing short-term and long-term morbidity and mortality. Previously in this journal, cost-effectiveness of the use of donor milk was demonstrated, examining several specific case studies.[1] In one particular case, kidney dialysis was avoidable for the entire first year of life because banked donor milk was used as the primary source of nutrition.[2] Considerable savings were realized even after considering the processing fee charged for the banked donor milk. None of these case studies looked at the early use of banked donor milk in a premature population. This article examines the potential cost of early (ie, from the first day of life) use of banked donor milk for premature infants in a neonatal intensive care setting in relation to the prevention of necrotizing enterocolitis (NEC) and demonstrates the cost-effectiveness of the use of banked donor milk.

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Relationship Between Human Milk Feedings and NEC

Banked donor milk is commonly used in countries around the world as first feedings for premature infants. For most of these countries, banked donor milk is in short supply and only premature infants are fed this precious commodity; little donor milk is available for the older infant with a life-threatening condition. In the United States, the opposite is true, with approximately 60% to 70% of the volume of banked donor milk dispensed going to older infants, children, and the occasional adult with medical needs.[3] Rates of NEC are demonstratively lower when there is a concerted effort to supply newly born premature infants either their own mother's milk (MOM) or banked donor milk as the "first alternative" to MOM.[4]

As an example, Ostra Sjukhuset is a tertiary referral center for the lengthy west coast of Sweden. Infants born prematurely are transported to the neonatal intensive care unit (NICU) of this hospital, with the exception of those requiring surgery and those with cardiac defects, who are taken to the pediatric hospital across the street for care. This NICU population is therefore slightly different from one seen in a tertiary care facility in the United States, where all babies are in the same unit regardless of their surgical or cardiac status. Infants with fluid restrictions are thus not part of the population of infants at Ostra Sjukhuset. As a result, incidence rates for NEC in this NICU may be slightly lower than in other NICUs where fluid-restricted infants are part of the patient population. However, in this NICU, the protocol is to start all premature infants on trophic (ie, minimal enteral) feedings within 6 to 12 hours of birth at the rate of 1 to 2.8 cc/kg of banked donor milk every 3 hours supplemented with MOM as it becomes available.[5] The neonatologist for this NICU stated that infants received 2 to 3 cc every 3 hours (K. Sanderson, personal communication, October 1998). Based on weight, however, the range works out to be 1 to 2.8 cc/kg, which averages out to between 10 and 20 cc/kg/d. Fortification of the donor milk and/or MOM is not begun until the infant is well established on full enteral feedings, usually at the end of the first week of life. With 800 to 900 admissions per year, only 1 or 2 cases of NEC are seen, for an incidence rate of 0.1% to 0.125%. In a multicenter study of the biodemographics of NEC in the United States, Uauy et al[6] found that the rate of proven NEC was 10.1%. This high rate may be due to the nature of the patient population and to feeding policies that do not emphasize the importance of MOM and do not use banked donor milk as the first alternative when beginning enteral feedings in premature infants.

Lucas and Cole[7] demonstrated that there was a significant reduction in NEC when infants were fed banked (pasteurized) donor milk compared to preterm formulas, and that the same dose response decrease in NEC was seen with banked (pasteurized) donor milk and with (raw) MOM (reduction from 7.2% for formula-fed infants to 1.2% for human milk-fed infants). Research by Narayanan et al[8] has shown that premature infants fed solely on banked donor milk have much lower rates of infection than when fed infant formulas in combination with banked donor milk (33% infection rate in mixed feeding group vs 14.3% in donor milk group). Although the rates of sepsis were slightly higher in the infants fed pasteurized donor milk compared to the infants fed their own raw (unpasteurized) mother's milk (14.3% vs 10.5%), the differences in infection rates between these 2 groups were not statistically significant. Eibl et al[9] postulated that it was the immunoglobulin A in human milk that was the protective factor, a human milk component that partially survives the heat processing that donor milk must undergo in order to be dispensed in the United States. It is more likely that a number of different human milk components behaving in a complex bioactive mechanism are responsible for this protective effect.

Cost-effectiveness of Banked Donor Milk: 3 Models

There are several ways of looking at the cost-effectiveness of the use of banked donor milk in the NICU. The following models are based on different approaches to this issue.

Model 1: Direct Cost Model

Wight[10] analyzed the cost of using donor milk in an NICU in San Diego, California. Using data from a study by Schanler et al[11] on differences in (1) length of stay, (2) number of cases of NEC per infant, and (3) number of cases of late-onset sepsis per infant, Wight calculated that after factoring the cost of the donor milk, approximately $8800 could be saved per infant. Costs used for these calculations were direct costs only for her hospital. Direct costs will differ from one institution to another, depending on the method of accounting used. Wight estimated that if donor milk is as effective in preventing NEC and sepsis and shortening hospital stays as MOM, then for every $1 spent on donor milk, the NICU saves

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between $11 and $37 in NICU costs. If the donor milk is only half as effective as MOM, then for every $1 spent on donor milk, the NICU will save between $6 and $19 in NICU costs. When insurers pay only a percentage of the actual hospital costs, savings such as these could substantially decrease the amount of money a hospital loses in this type of intensive care. Wight estimated that "donor human milk for 21 very low birth weight infants could save almost $200,000 per year."[9]

Model 2: Charge Model (Cost Reduction From Shorter Hospital Stays as a Result of NEC/Sepsis Prevention)

This model uses approximate hospital charges calculated by the March of Dimes.[12] According to this model, it costs approximately $50,000 in 1997 for a 15-day stay in a US NICU. Adjusted on a per diem basis, this is an average daily cost of approximately $3300. Using a rate of 60% hospital initiation based on 1998 baselines of initiation of breastfeeding for all women in the hospital, one can assume that, in a hypothetical hospital in the United States with 500 premature admissions per year, 300 infants would have access to and be fed MOM.[13] The actual initiation rate for the NICU population is usually reported as being lower, depending on the unit, which means that more than 200 infants would actually be at risk for developing NEC. It is therefore reasonable to ask what the costs would be of supplying the other 40% (200 babies) exclusively with banked human milk as opposed to formula. From Schanler et al's[11] data, we know that babies fed MOM are discharged as much as 15 days earlier than formula-fed infants. For these 200 babies, assuming donor milk is as effective as MOM, providing them with donor milk could save an approximate average of $10,000,000 in additional hospital stay days, assuming that all are discharged 15 days earlier. For a single baby, the savings would amount to $50,000 before consideration of the cost of the donor milk.

For purposes of this exercise, it is assumed that the average NICU infant is born at 1100 g (2 lb, 4 oz). The infant is "healthy" and simply needs to feed and grow and will be discharged 60 days later at 1800 g (4 lb) (Appendix A). A second assumption is that the infant's feeding advances in a steady (linear) fashion. Mathematical calculation gives an estimate of approximately 330 oz used to feed this baby over a 2-month period, which is within reasonable limits.[10] At $2.75 an ounce for the processing fee for banked donor milk, this amounts to a total cost for the 2 months of $907.50. If one uses $3.00 an ounce as a processing fee to include shipping costs as well, the total cost of the donor milk for 2 months would be $990.00. Cost of fortifiers would also need to be factored in at a cost of $360.00 for 360 packets (K. Marinelli, personal communication, July 2001) (Appendix A, assumption 5). Multiplied by 200 babies who would not otherwise be fed any human milk at all, savings would amount to an impressive $9,630,000 (200 babies multiplied by savings from 15 fewer days of hospitalization) (Appendix B). For a premature infant, the cost of the donor milk is insignificant compared to the savings from earlier discharge.

If the cost of NEC is considered, costs increase. According to Bisquera et al,[14] a resolved case of NEC extends the stay by approximately 2 weeks. (Marinelli, personal communication, July 2001) estimated that a case of NEC can add 2 to 3 weeks to the infant's total hospital stay. The infant's costs may also include 10 to 14 days of additional total parenteral nutrition (TPN) plus antibiotics and then a very slow reintroduction to oral feedings (during which TPN continues but at decreasing doses), specialists, additional x-rays, cultures, and laboratory tests. In a multicenter study in the United States, approximately 35% of cases require surgery.[14] When surgery is involved, there are additional costs for the surgeon, the operating room, and the anesthesiologist, all doubled because there are 2 surgeries: one for the removal of the necrotic parts of the intestine and the placing of the ostomy and then again for repair of the ostomy and reanastomosis of the intestine. The infant may experience dumping syndrome after the surgery and be unable to achieve full enteral feedings, requiring a continuation of some TPN. Long-term consequences are death (26% in Lucas and Cole's[7] multicenter study in Britain; 30% in Bisquera et al[14]) or surgical short-gut syndrome, which leaves the patient with life-long malabsorption problems, a depressed immune system from malnourishment due to malabsorption (and a concomitant higher rate of infection and illness), and diminished quality of life. At a minimum, 14 days of additional hospitalization (at $3300/day) will add $46,200 to the cost of an infant contracting NEC. One must also factor in the cost of TPN; specialist consults; costs of tests, procedures, and additional medication; and the cost of surgery and anesthesia. Brink[15] reported that banked donor milk is efficacious in the management of surgical short gut in a preterm infant. A number of reports from milk bank personnel in the past 5 years have shown benefits to many infants with surgical short gut (P. Sakamoto and A. Radcliffe, personal communication, June 1998).

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Model 3: Costs to an Individual State

Looking only at the survivors, Bisquera et al[14] found that the cost of stay for premature infants was markedly higher in those with NEC when compared to premature infants without NEC (the control group). A case of confirmed nonsurgical NEC cost an additional $138,000 per infant, and a case of surgical NEC cost an additional $238,000 per infant.

It is readily acknowledged[6,7] that incidence rates for NEC rise among infants with earlier gestational ages and lower birth weights. No attempt will be made in this model to account for differences in gestational age and birth weight. In the 2 multicenter studies that have examined the biodemographics of NEC,[6,14] the rate of suspected or unconfirmed NEC is different from the NEC rate confirmed by radiological methodology. This model uses rates only for confirmed cases of NEC when estimating cost savings and, therefore, may be an underestimation of savings. Additionally, a very small percentage of human milk-fed infants will go on to develop NEC as well.[6]

Using the Centers for Disease Control and Prevention "Wonder" statistics, it has been calculated by Morgan (personal communication, July 2001) that in 1994 in the state of Texas, 5898 infants were born at less than 32 weeks gestation. Forty percent of these infants will not be fed either MOM or banked donor milk in hospital, for a total of 2359 infants. Using the overall prevalence rate for proven NEC of 10.1%[6] and subtracting a confirmed NEC rate of 1.2% in exclusively human milk-fed infants,[7] one arrives at a total rate of confirmed NEC of 8.9% among formula-fed infants. Using this rate to multiply the number of non-human-milk-fed infants in Texas, one arrives at 189 predicted cases of confirmed NEC. Of these 189 babies, one can assume that 35% will go on to require surgery, for a total of 66 babies (Appendix C).[7]

Appendix D shows the calculations for the additional costs that the state of Texas might have paid in 1994 for treating these 189 babies with confirmed NEC. Adding the additional cost of both surgical and nonsurgical NEC together in this model, we arrive at a possible additional total expense to the state of Texas of $32,682,000 from inadequate use of MOM and banked donor milk.

Summary

Disparity of care is observed with higher rates of prematurity in low-income groups who have less access to adequate prenatal care. It is safe to assume that in the United States, state and federal health care payments and, by extension, taxpayers are subsidizing costly health care for premature infants at risk for NEC. From the 3 models calculated here, it would be cost-effective for a payer to prevent a substantial percentage of cases of NEC at a fraction of the cost. Money thus saved could then be applied to other quality health care programs and services that would reduce disparity of care, including improving breastfeeding education and support among minority populations of women who initiate breastfeeding at much lower rates.[12]

Appendix A: Cost of Donor Milk for Hypothetical Premature (HP) Infant

Birth weight of hypothetical premature infant (HP) = 1100 g (2 lb, 4 oz)
Gestational age at birth = approximately 28 weeks
Discharge is 60 days later at approximately 36 weeks corrected age
Discharge weight = 1800 g (4 lb)
Estimate that 330 oz are used over 60 days
Cost of donor milk at $3.00/oz = $990.00
Cost of additional fortifier for human milk = $360.00
Total cost of donor milk and fortifier = $1350.00

Assumptions

1. *HP will have no complications*. Although many infants will not fit this model, some do, and it is a reasonable assumption. During the 60-day period, there are no times when the infant is removed from oral feedings.

2. *HP will begin feedings at approximately 30 cc/d (1 oz) fed every 3 hours (3.8 cc/feeding) and will be fed 300 cc/d (10 oz/day or 37.5 cc/feeding every 3 hours) at discharge*. To begin feedings, most infants are started on feedings at 10 to 20 cc/kg/d in addition to hyperalimentation. At 20 cc/kg/d, infants would consume approximately 2.8 cc/feeding. The estimate here has been set artificially high for the sake of the argument relating to cost; if the infant actually consumes less, then savings will be even larger.

3. *The amount of milk fed each day increases at a steady rate over the 60-day period*. The mathematical formula used to calculate the total amount required by HP also assumes that the infant progresses at even increments. This may not be an accurate assumption because most infants will require larger increments as they grow. Using this steady increase formula, the calculated total amount of donor milk fed to HP will total

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330 oz over a 60-day period. When compared to Wight's[10] estimates of approximately 250 oz per very low birth weight infant over a 2-month period, this amount is much higher, again illustrating the point that the savings realized may be larger than in this hypothetical case.

4. The cost of preterm formula is zero. Most hospitals in the United States do not purchase formula at fair market value. Costs to an individual hospital may vary considerably. For this hypothetical hospital, the assumption is that formula is free.

5. The cost of fortifier is calculated as follows. Assuming that the infant consumes 30 oz prior to the start of fortification, this would leave 300 oz or 9000 cc of milk that would be fortified. At 4 packets of fortifier per 100 cc of milk, this would mean that 360 packets of fortifier would be required. At approximately $1.00/packet, this would add an additional cost of $360.00

Appendix B: Cost Savings from Shorter Hospital Stay (Based on March of Dimes Costs of $3300/Day Less Cost of Donor Milk and Fortifier)

If stay cut by	*Savings will be*
1 day	$3300 – 1350 = $1950
7 days	$23,100 – 1350 = $21,750
15 days	$49,500 – 1350 = $48,150

Savings for 200 babies would be $9,630,000.

Appendix C: Infants at Risk for Necrotizing Enterocolitis (NEC) in Texas, 1994

Number of infants born <32 weeks gestation = 5898

Number of infants at risk for NEC = 2359 (40% × 5898)

Number of infants at risk for confirmed NEC = 189 (8.9% × 2359)

Number of infants predicted to require surgery = 66 (35% × 189)

Number of infants not requiring surgery = 123 (189 – 66 = 123)

Appendix D: Cost of Necrotizing Enterocolitis (NEC) in Texas, 1994

One hundred twenty-three infants with proven NEC not requiring surgery × $138,000 additional costs for nonsurgical NEC = $16,974,000

Sixty-six infants requiring surgery for NEC × $238,000 additional costs for surgical NEC = $15,708,000

Total additional costs to the state of Texas for NEC = $32,682,000

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Resumen

La enterocolitis necrotizante (EN) suma costos significativos en el cuidado de niños prematuros y tiene consecuencias negativas a corto y largo plazo en estos niños. Así que es de gran interés por parte del sistema de salud prevenir la incidencia de EN a través de protocolos de alimentación que incluyan la prevención de la EN como por ejemplo el uso de leche materna en las unidades de cuidado intensivo neonatal. La leche de bancos de leche humano ha demostrado efectividad en la prevención de la EN cuando se utiliza la leche de la misma madre. Este artículo presenta tres modelos de análisis de costo que muestran ahorros para el sistema de salud o las familias si se utiliza leche de bancos al iniciar la alimentación cuando la leche de la misma madre no esta disponible. El costo de alimentar niños prematuros con la leche de banco es fútil cuando se compara con los ahorros en la prevención de la EN.

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