The Relationship of Breast Feeding to Third-Day Bilirubin Levels

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The purpose of this study was to determine the relationship of feeding method to serum bilirubin levels on the third day of life. Two hundred eighty-one apparently healthy full-term neonates had third-day bilirubin levels drawn between 58 and 82 hours of age. Mean serum bilirubin levels were 5.6 mg/dL for formula-fed, 6.9 mg/dL for mixed-fed, and 7.5 mg/dL for breast-fed infants.

The difference was statistically significant ($P < .01$) between the formula-fed and breast-fed groups. Breast-fed infants lost more weight by the third day than formula-fed infants (mean weight loss 180 g for breast-fed infants, 100 g for formula-fed infants). A third-day bilirubin levels among the feeding groups were then compared using an analysis of covariance with weight loss as the covariate. By this method, type of feeding was still a significant predictor of third-day bilirubin levels ($P = .04$) as was weight loss ($P = .03$).

With the increased interest in breast feeding in the United States, any contribution of breast feeding to higher and possibly dangerous bilirubin levels in the neonate becomes a very important consideration. The purpose of this study, therefore, was to determine the relationship of feeding method to serum bilirubin levels on the third day of life.

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The third day was chosen for serum bilirubin determination because nationwide this had been the usual length of hospital stay for mothers and their infants. Furthermore, the bilirubin level usually begins to show a clear upward trend by the third day if it is going to rise significantly. With the trend toward earlier discharge from the hospital, it would be helpful to the health care provider in planning follow-up visits to have some guidelines to determine which infants are at risk to develop hyperbilirubinemia.

A number of investigators have looked at the relationship of breast feeding to bilirubinemia, and most have concluded that bilirubin levels are higher in breast-fed than formula-fed infants. These studies are difficult to compare, as they were often carried out on different days of the neonatal period, and definitions of such terms as *jaundice, physiologic jaundice, physiologic hyper-*

bilirubinemia, and *hyperbilirubinemia* have varied considerably.

Dahms et al[1] concluded that breast feeding by itself does not result in significantly increased bilirubin levels during the first four days of life. Jeffares,[2] in a retrospective survey, demonstrated an association between severe neonatal jaundice and breast feeding. In another retrospective review, DeAngeles et al[3] showed 25.7 percent of 206 infants fed breast milk reached serum bilirubin levels of greater than or equal to 10 mg/dL compared with 8.9 percent of 45 formula-fed infants. The number of days after birth on which these levels were determined was not clear. Additionally, Stiehm and Ryan[4] surveyed the records of infants with unexplained jaundice and found increased incidence of severity of neonatal icterus in breast-fed compared with formula-fed infants.

In a study of Alaskan Eskimo newborns, Fisher et al[5] found differences between bilirubin levels in breast-fed and formula-fed infants to be statistically significant only on days 4 and 5. From bilirubin levels drawn at 48 and 72 hours, Drew et al[6] found a statistically significant correlation between breast feeding and increased neonatal jaundice in immigrant Greek infants.

In a study by McConnell et al[7] the mean third-day bilirubin levels were higher among breast-fed than formula-fed infants. Unfortunately, the number of breast-fed infants was very small. Wood et al[8] estimated plasma bilirubin levels on the sixth day of life and showed that a greater percentage of breast-fed than formula-fed infants had bilirubin levels greater than 12 mg/dL.

Methods

The study was carried out in a prospective manner during a four-month period in the fall (October and November) of 1980 and the winter (January and February) of 1981. All infants born at the University of Kansas Bell Memorial Hospital during that period were candidates for inclusion if they met the following criteria:

1. Full-term, apparently healthy newborn
2. Birth weight greater than or equal to 2,250 g
3. Entire hospital stay in the full-term, level I nursery
4. Apgar scores greater than or equal to 8 at 5 minutes after birth
5. Afebrile infant
6. Coomb's negative cord blood
7. No known reason to suspect the development of hyperbilirubinemia, eg, cephalohematoma, Coomb's-positive hemolytic disease of the newborn (ABO, Rh), sepsis
8. No medications given to the infant (all newborns routinely received vitamin K intramuscularly and silver nitrate eye drops)
9. No infant of an insulin-dependent diabetic mother
10. No infant whose mother had any condition known to affect serum bilirubin levels in the neonate
11. Total bilirubin determination carried out at three days of age

Information was collected on each mother-infant pair by a questionnaire administered postpartum and a review of the mother's and infant's charts. The questionnaire was administered by the principal investigator to each of the mothers during their hospitalization after a consent form was signed.

The following was recorded: feeding method—whether breast fed, bottle fed, or a combination of the two (mixed); any bilirubin value obtained from infant serum including bilirubin level on the third day of life; and birth weight and weight of the newborn on the third day of life.

In addition, other data were gathered to prepare medical and demographic profiles on the patients including existence of preeclampsia, medications ingested by the mother (during pregnancy, labor, delivery, and postpartum period), socioeconomic status, maternal age, gravidity and parity, race, type of delivery, and sex of the infant.

Bilirubin determinations were carried out by obtaining blood specimens by heel stick. Results were read on an American Optical Bilirubinometer, calibrated to a level of 14.75 mg/dL. If more than one bilirubin value had been obtained on the third day, the specimen obtained closest to 72 hours was used in the analysis.

The infants were placed under phototherapy if their bilirubin levels reached approximately 15 mg/dL. Bilirubin levels were routinely done at discharge, along with the neonatal thyroid and

phenylketonuria tests, and usually were not carried out until 58 hours of age, the most common time for earliest discharge according to University of Kansas Medical Center protocols. Thus, the majority of third-day bilirubin levels were drawn in the 24-hour period beginning at 58 hours of age.

Feeding schedules for formula-fed infants were as follows: 15 cc of 5 percent dextrose in water at 4 to 6 hours of age, and 30 to 60 cc infant formula every 3 to 4 hours after the first 5 percent dextrose in water feeding (approximate time elapsed before formula feeding was 10 hours). Infants were then offered 45 to 90 cc of formula every 4 hours for 24 hours, then 60 to 120 cc every 3 to 4 hours for the rest of their hospital stay.

For breast-fed infants time from birth to first feeding was variable from immediately postpartum to several hours later. All breast-feeding mothers were given the option of offering sterile water to the infant after nursing. The amount of sterile water ingested by each breast-fed infant bore no statistically significant relationship (using the *t* test) to the third-day bilirubin level. Nursing was generally done on demand, with breast feeding encouraged at least every 2 to 3 hours during the day and every 4 hours during the night. Breast-fed infants receiving more than 60 cc of formula or more than one formula feeding during the hospital stay were placed in the mixed-fed category.

Infants were weighed every morning. Vital signs were taken each shift as part of the normal nursery routine. All infants not under phototherapy were placed in open cribs, wearing cotton T-shirts, and wrapped in two lightweight cotton blankets. Fluorescent lights were left on continuously in the nursery, and light exposure was considered generally similar for all groups of infants.

Results

Study Group

During the four-month study period, there were 498 deliveries of which 374 (75 percent) fit the criteria for inclusion in the study. Ten infants had no discharge bilirubin levels recorded and were dropped from the study, leaving 364. As bilirubin values may fluctuate during the neonatal period, errors arising from the changes were minimized by selecting data from a single 24-hour period for inclusion in the study. Bilirubin values measured during the period from 58 to 82 hours were utilized as the third-day bilirubin values. Eighty-three infants (22 percent of the remaining group) were removed from the study because of the imposition of this 24-hour period (Table 1). In the infants removed from the study, the percentage of each feeding group was similar to the percentage in the study sample remaining. Further analyses were carried out on the remaining 281 infant-mother pairs. Table 2 shows that the number in each feeding group was as follows: group 1, formula, 160; group 2, mixed, 29; and group 3, breast, 92.

Table 1. Number of Subjects in Study Group

Deliveries during study period	498
Not fitting stated criteria for inclusion into study group	124
No discharge bilirubin determinations recorded	10
Not receiving bilirubin determinations (third-day bilirubin) between 58 and 82 hours of age	83
Total remaining in study group	281

Analysis According to Feeding Groups

The demographic data of the feeding groups are shown in Table 3. The groups were comparable with respect to the following variables: any previous use of birth control pills by the mother; history of preeclampsia during the pregnancy; sex of the infant; and average birth weight of infants.

Age of the mother was also similar among the groups, although mothers of formula-fed infants were slightly younger (group 1—22.5 years compared with group 2—24.3 years, and group 3—24 years). Gravidity and parity were slightly lower in the breast-feeding mother (2.0 and 0.7, respectively) compared with formula-feeding or mixed-feeding mothers (2.3 and 1.0, respectively, in both of these groups).

Members of group 1 were more likely to be indigent (59 percent) compared with group 2 (43 percent) and group 3 (31 percent). They were also

Table 2. Division of Sample By Feeding Groups

Group	Number in Group	Definition
1. Formula	160	Infants who were totally formula fed Most received 5 percent dextrose in water feedings early in life
2. Mixed	29	Breast-fed infants who received more than one formula feeding or more than 60 cc of formula during hospitalization. May or may not have received 5 percent dextrose in water or sterile water
3. Breast	92	Infants who were breast-fed, sterile water supplementation permitted. Infants who received a single formula feeding of ≤60 cc were included in this group
Total	281	

Table 3. Demographic Data—Comparison Among Feeding Groups

Variable	Group 1 (Formula)	Group 2 (Mixed)	Group 3 (Breast)
Previous use of birth control pills by mother (percent)	71	74	76
Medications ingested during the pregnancy (percent)	50	67	58
Preeclampsia during the pregnancy (percent)	8	4	6
Indigent (percent)	59	43	31
Maternal age (mean years)	22.5	24.3	24.0
Race (percent black)	33	21	12
Gravidity (mean)	2.3	2.3	2.0
Parity (mean)	1.0	1.0	0.7
Delivery by cesarean section (percent)	12	28	5.6
Sex of infant (percent male)	51	48	51
Birth weight of infant (grams)	3341	3325	3319

more likely to be black (33 percent) than members of the mixed-feeding group (21 percent) or the breast-feeding group (12 percent).

Group 3 infants were least frequently (5.6 percent) delivered by cesarean section using either epidural or general anesthesia compared with group 1 infants (12 percent) or group 2 infants (28 percent).

To determine whether any of the above characteristics might account for the bilirubin differences, the relationship of each one with bilirubin level was examined. None was found to be signifi-

Table 4. Comparative Results by Group

	Formula-Fed Babies	Mixed Feeding	Breast-Fed Babies	Total
Number entered into study	160	29	92	281
Number with total bilirubin ≥12 mg/dL	7	2	17	26
Mean infant weight loss for all infants	100 g (n = 148)	155 g (n = 25)	180 g (n = 57)	132 g (n = 260)
Mean infant weight loss for infants with total bilirubin ≥12 mg/dL	147 g (n = 7)	170 g (n = 2)	202 g (n = 16)	184 g (n = 25)
Mean total bilirubin (mg/dL)	5.6 ± 3.9 (n = 160)	6.9 ± 3.8 (n = 29)	7.5 ± 4.8 (n = 92)	6.4 ± 4.3 (n = 281)
Number receiving phototherapy	2	1	7	10

cantly associated.

The mean bilirubin levels of each feeding group on the third day of life (58 to 82 hours) are compared in Table 4. Mean bilirubin levels were 5.6 mg/dL for group 1 (formula), 6.9 mg/dL for group 2 (mixed), and 7.5 mg/dL for group 3 (breast). The mean was 6.4 mg/dL for the entire sample. Using an analysis for variance for the three groups, there was a statistically significant difference ($P < .01$) among groups. Significant differences were found between groups 1 and 3, but not between groups 1 and 2 or groups 2 and 3 by Duncan's multiple range test.

As many authors reserve the term *hyperbilirubinemia* for serum levels greater than 12 mg/dL in the neonate, this group was analyzed separately. Twenty-six infants had bilirubin values greater than or equal to 12 mg/dL (Table 4). Of those, 7 fell into group 1 (formula), 2 into group 2 (mixed), and 17 into group 3 (breast), 4.4 percent, 6.9 percent, and 18.5 percent of each feeding group, respectively. The bilirubin categories were significantly different among the groups using chi-square ($P < .005$). Ten infants were placed under phototherapy during their hospitalization (Table 4). Of those, 2 were in group 1, 1 in group 2, and 7 in group 3. The differences were statistically significant ($P < .005$) as computed by Fisher's exact probability test.

The mean weight loss for each of the feeding groups was as follows: 100 g or 3.0 percent of body weight for group 1 (formula), 155 g or 4.7 percent for group 2 (mixed), and 180 g or 5.4 percent for group 3 (breast) (Table 4). The entire sample had a mean weight loss of 132 g, but the mean weight loss for breast-fed infants was nearly twice that for formula-fed infants. These differences in weight loss among the three groups are statistically significant using an analysis of variance ($P < .001$). In addition, within the group whose bilirubin levels were greater than or equal to 12 mg/dL (26 infants), breast-fed infants lost more weight (202 g or 6.2 percent of total body weight) than formula-fed infants (147 g or 4.3 percent) or mixed-fed infants (170 g or 5.4 percent).

To determine whether the increased third-day bilirubin levels among breast-fed infants could be explained by the tendency for increased weight loss, the three groups were compared with an analysis of covariance using weight loss as the covariate. By this method, type of feeding (breast, mixed, or formula) was still a significant predictor of third-day bilirubin level ($P = .04$), as was weight loss on the third day ($P = .03$).

Discussion

In this study 281 apparently healthy neonates with no maternal or fetal risk factors known to influence neonatal bilirubinemia were studied over a four-month period in the fall of 1980 and winter of 1981. All had third-day bilirubin levels drawn between 58 and 82 hours of age.

The mean third-day bilirubin value for the total sample was 6.4 mg/dL, which is comparable to the mean value of 6.3 mg/dL determined by composite data from 3,668 infants in a review by Maisels.[9] The mean third-day bilirubin level was 7.5 mg/dL for breast-fed and 5.6 mg/dL for formula-fed infants. Using an analysis of variance, these differences are statisitcally significant. These data corroborate those of Dahms et al,[1] who showed a mean bilirubin level of 7.0 mg/dL for breast-fed and 5.8 mg/dL for formula-fed infants. Dahms did not find a statistically significant difference among the groups, probably because *t* tests were used when comparing four separate groups, and the numbers were small.

Two subsets of infants were also analyzed: those with bilirubin levels greater than or equal to 12 mg/dL and those whose bilirubin levels were greater than or equal to 15 mg/dL and thus were placed under phototherapy. These divisions exaggerated the differences in bilirubin levels among feeding groups.

Results of this study show a mean weight loss of 100 g for formula-fed and 180 g for breast-fed infants. Weight loss was found to be a significant predictor of higher third-day bilirubin levels. These results are similar to those of Stiehm and Ryan who showed a mean weight loss of 180 g for breast-fed and 110 g for formula-fed infants. In 1970, Sims and Neligan[11] reported greater weight loss in infants with bilirubin levels greater than 15 mg/dL.

Finally, Wood et al[12] showed poor weight recovery to be a factor associated with a bilirubin level of greater than 12 mg/dL. In this study, the mean weight loss for infants with third-day bilirubin levels greater than or equal to 12 mg/dL was greater than for the sample as a whole. Weight loss among this subset of each group was also greater when compared with the feeding group as a whole; that is, infants with bilirubin levels greater than or equal to 12 mg/dL lost more weight than infants with less than 12 mg/dL, regardless of their feeding type. Nonetheless, even when weight changes was taken into consideration, type of feeding was still a significant predictor of third-day bilirubin levels.

It may be concluded that breast-feeding infants as a group have statistically significant higher bilirubin levels than formula-fed infants on the third day of life, and the propensity for increased weight loss in the breast-fed infant is only partly responsible for this phenomenon. Whether the weight loss is mostly from dehydration or is caloric in nature remains to be determined. However, it would seem important that early and frequent nursing be encouraged for the breast-feeding mother. In fact, DeCarvalho et al[13] have recently shown that increased frequency of breast feeding in the early days of life may result in relatively lower bilirubin levels on the third day among breast-fed infants. Finally, infants' weights should be followed closely to identify those infants whose increased weight loss also puts them at risk for higher bilirubin levels.

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