CUSTOMER HAS REQUESTED:

Electronic Delivery (ELDEL)

Document Delivery/ILL
Arizona Health Sciences Library
520-626-6840
ahsill@ahsl.arizona.edu

Request #: 215540

Friday, October 07, 2011

TN: 215540

Patron: Jones, Desiree

Call #: **W1 BI793 v.41-42 1982**
Location:

Pages: 273-8

Journal Title: Biology of the neonate

Volume: 41
Issue: 5-6
Month/Year: 1982

Need by: 12/05/2011

Article Author: Butte NF, Calloway DH

Article Title: Proteins, vitamin A, carotene, folacin, ferritin and zinc in Navajo maternal and cord blood.

CUSTOMER INFORMATION:

Desiree Jones (djones)
2550 West Ironwood Hill Drive
#833
Tucson, AZ 85745

College of Public Health

Notes:

Paging History:

Method of Payment:

NOS LAC INC OTHER_____

djones1@email.arizona.edu
520-429-2746
Fax:

Re-Page by: _/_/_

Charge:

This is not a bill. Please do not pay from this slip.

Initials _____

Biol. Neonate *41:* 273–278 (1982)

Proteins, Vitamin A, Carotene, Folacin, Ferritin and Zinc in Navajo Maternal and Cord Blood[1]

Nancy, F. Butte, Doris Howes Calloway

Department of Nutritional Sciences, University of California, Berkeley, Calif., USA

Key Words. Cord blood · Folacin · Zinc · Vitamin A · Retinol-binding protein · American Indians

Abstract. Blood samples were obtained from 28 Navajo women at delivery and cord blood samples were collected from their healthy, full-term infants. The concentrations of retinol, folacin, ferritin and zinc in the cord blood fell in the normal range even though some mothers had blood levels suggesting a deficiency. Levels of maternal and cord blood retinol-binding protein were positively correlated. Although marginal and deficient levels of folacin in maternal blood did not result in significantly lower cord blood levels, the strong association indicated a dependence of fetal level upon maternal supply. Birth weight and the developmental indices were not related to any of the maternal or fetal nutrient levels.

Introduction

Fetal growth and development are dependent upon a supply of essential nutrients from the maternal blood stream. The placental mechanisms by which the fetus obtains these nutrients have not been fully elucidated, nor is it clear to what extent the fetus has priority in the presence of an insufficient maternal supply.

Suboptimal nutritional status was suspected to exist among Navajo women of childbearing age, based on dietary patterns and clinical evidence [1]. Serum levels of nutrients thought to be at risk and related substances were analyzed in maternal and cord blood in order to determine the maternal status and the correlation between maternal and fetal levels.

Methods

Subjects

28 Navajo mothers and their infants participated in the investigation. The women were 16–33 years of age and their mean (± SD) gravidity was 2.4 ± 1.2. All pregnancies were of normal duration, 37–42 weeks. The women had uncomplicated vaginal deliv-

[1] Supported in part by USPHS grant AM07155A-03 and in collaboration with the Indian Health Service and USDA.

eries. Birth weight was 3,417 ± 400 g (range 2,560–3,262). The delivery record included Apgar scores and maturation ratings.

The mothers gave their informed consent to the protocol which was approved by the Navajo Tribal Health Council, Indian Health Service Research and Publications Committee, and the Committee for the Protection of Human Subjects of the University of California, Berkeley.

Collection and Preparation of Samples

Venous blood (20 ml) was drawn into a Monovette syringe from the mothers at the time of delivery. Blood from the umbilical cord was allowed to drain into a sterilized Monovette syringe. The samples were refrigerated until processed by the laboratory staff. The clotted blood was rimmed, serum was separated by centrifugation and portions were frozen at –20 °C for protein electrophoresis, vitamin A, carotene, retinol-binding protein (RBP), zinc, ferritin and folacin assays. The sample for folacin analysis was protected with 5 mg sodium ascorbate and adjusted to pH 6.0 with concentrated NaOH.

Analyses

Total serum protein was measured by a total-solids refractometer. Serum proteins were separated by cellulose acetate electrophoresis and quantified by densitometry. Serum retinol and carotene[2] were determined by the Carr-Price reaction utilizing trifluoracetic acid [2]. RBP[2] was determined by radial immunodiffusion (M-Partigen; RBP Accupak Kit, Behring Diagnostics, American Hoechst Corporation, Somerville, N.J.). Serum zinc[2] was determined by direct aspiration of a water-diluted sample into the Atomic Absorption Spectrophotometer. Serum ferritin[2] was analyzed by radioimmunoassay. Serum folacin was determined microbiologically by *Lactobacillus casei* (ATCC 7469) [3].

The data were analyzed by SPSS programs on a Control Data 6400 computer. Relationships were examined by the Pearson correlation coefficient and the paired t test.

[2] Analyses for retinol, carotene, RBP, zinc and ferritin were performed at the Human Nutrition Research Laboratory, USDA Nutrition Center, Grand Forks, N. Da. The authors are greatly indebted to Dr. *Harold Sandstead* for arranging for these analyses.

Results

Serum proteins of the maternal and infant cord blood are shown in table I. The level of total protein in the cord blood (5.4 ± 0.5 g/dl) was significantly ($p < 0.001$) lower than the maternal level (6.7 ± 0.6 g/dl). Mean concentrations of serum albumin in the maternal and cord blood samples were 3.3 ± 0.4 and 3.5 ± 0.4 g/dl, respectively. Except for γ-globulin, the serum globulins were significantly ($p < 0.001$) lower in the cord blood compared with maternal values. The level of RBP in the cord blood (22.2 ± 7.3 μg/dl) was significantly ($p < 0.001$) below that in the maternal blood (48.0 ± 13.0 μg/dl).

There was a significant ($r = 0.410$, $p < 0.02$) inverse relationship between maternal and cord blood levels of β-globulin. The level of RBP in the cord blood was positively ($r = 0.436$, $p < 0.02$) correlated to the maternal level. No other significant correlations were demonstrated between the protein levels in maternal and cord blood.

Serum indices of selected vitamins and minerals are presented in table II. Maternal serum retinol level was 37.7 ± 7.3 μg/dl, significantly ($p < 0.001$) higher than the average concentration (14.7 ± 4.4 μg/dl) found in cord blood. 7 of the 28 mothers (25%) had serum values of retinol in the marginal range (20–30 μg/dl); the corresponding cord blood levels of retinol were not significantly different from the rest. Similarly, serum carotene was significantly ($p < 0.001$) higher in the maternal blood compared with cord blood (150.7 ± 45.4 vs. 22.2 ± 16.7 μg/dl). No significant correlation was demonstrated between the serum and cord blood levels of carotene.

The level of serum folacin in the cord blood

Table I. Serum proteins of 28 Navajo mother-infant pairs

Parameter	Mean ± SD	Range	Pearson correlation	Paired t test
Total protein, g/dl				
Maternal	6.7 ± 0.6	5.6 – 7.7	−0.160 NS	7.17[1]
Cord	5.4 ± 0.5	4.6 – 6.7		
Albumin, g/dl				
Maternal	3.3 ± 0.4	2.6 – 4.1	−0.003 NS	−2.66[2]
Cord	3.5 ± 0.4	2.7 – 4.5		
α_1-Globulin, g/dl				
Maternal	0.41 ± 0.09	0.26 – 0.61	−0.126 NS	9.2[1]
Cord	0.19 ± 0.06	0.12 – 0.37		
α_2-Globulin, g/dl				
Maternal	0.85 ± 0.13	0.54 – 1.10	−0.064 NS	9.4[1]
Cord	0.41 ± 0.17	0.22 – 0.95		
β-Globulin, g/dl				
Maternal	1.24 ± 0.32	0.10 – 1.90	−0.410[3]	6.77[1]
Cord	0.56 ± 0.24	0.28 – 1.25		
γ-Globulin, g/dl				
Maternal	0.82 ± 0.32	0.07 – 1.51	−0.031 NS	0.86 NS
Cord	0.76 ± 0.33	0.11 – 1.28		
RBP, μg/dl				
Maternal	48.0 ± 13.0	24.8 – 81.6	0.436[2]	11.32[1]
Cord	22.2 ± 7.3	11.0 – 43.2		

[1] Significance level ($p < 0.001$).
[2] Significance level ($p < 0.01$).
[3] Significance level ($p < 0.02$).

(24.7 ± 12.4 ng/ml) was significantly ($p < 0.001$) higher than the level in the maternal samples (16.4 ± 13.1 ng/ml). There was a strong association ($r = 0.765$, $p < 0.001$) between maternal and cord blood levels. Low levels (3.0–5.9 ng/ml) of folacin were detected in 3 of the 28 women and deficient levels (< 3.0 ng/ml) in 2 of the women. The mean cord blood level (15.7 ng/dl) associated with the deficient mothers was lower than the others (26.5 ng/ml) but the difference did not reach statistical limits ($p = 0.10$).

The mean concentrations of serum ferritin were 23.4 ± 19.8 and 127.7 ± 87.3 ng/dl in the maternal and cord blood samples, respectively. The cord blood level was significantly ($p < 0.001$) higher than the maternal level, but demonstrated no dependence upon maternal level. Although the level of serum ferritin was substantially depressed (< 9 ng/dl) in 5 of the mothers, the corresponding cord blood values were not significantly lowered.

The average concentration of zinc in cord blood serum (73.8 ± 10.7 μg/dl) was significantly ($p < 0.001$) higher than the level in the maternal serum (51.6 ± 14.0 μg/dl). No significant correlation was demonstrated between the two compartments. Serum zinc

Table II. Serum indices of selected vitamins and minerals of 28 Navajo mother-infant pairs

Parameter	Mean ± SD	Range	Pearson correlation	Paired t test
Vitamin A, μg/dl				
Maternal	37.7 ± 7.3	23.4 – 51.7	0.103 NS	15.20[1]
Cord	14.7 ± 4.4	6.2 – 22.7		
Carotene, μg/dl				
Maternal	150.7 ± 45.4	72.2 – 239.0	0.178 NS	14.50[1]
Cord	22.2 ± 16.7	8.0 – 84.2		
Folacin, ng/ml				
Maternal	16.4 ± 13.1	2.2 – 42.6	0.765[1]	-4.46[1]
Cord	24.7 ± 12.4	8.9 – 45.5		
Ferritin, ng/dl				
Maternal	24.3 ± 19.8	6.4 – 73.1	-0.002 NS	-6.15[1]
Cord	127.7 ± 87.3	33.5 – 350.0		
Zinc, μg/dl				
Maternal	51.6 ± 14.0	27.0 – 85.0	-0.112 NS	-6.08[1]
Cord	73.8 ± 10.7	52.0 – 97.0		

[1] Significance level ($p < 0.001$).

was below normal (< 50 μg/dl) in 12 (43%) of the women, but their respective cord blood levels were unaffected.

Birth weight was not significantly correlated to any of the maternal or cord blood parameters. The Apgar scores averaged 8.46 ± 0.88 and 9.18 ± 0.48 after 1 and 5 min, respectively, on a scale of 1–10. The maturation rating ranked these infants at the equivalent of 39.8 ± 1.21 gestational weeks. None of these developmental indices were related to any of the maternal or infant biochemical parameters.

Discussion

Except for RBP, the levels of cord blood proteins were not positively correlated with maternal levels. Proteins are synthesized in the fetus from amino acids transported actively across the placenta, or derived from maternal sources, or from the placenta [4]. Some polypeptides and proteins, such as albumin and γ-globulin can cross the placenta by micropinocytosis [4].

It is known that 90% of the retinol found in fetal blood is bound to RBP in the form of a complex with prealbumin; 5–10% is associated with lipoproteins. The origin of RBP is undetermined; however, qualitative tests on RBP demonstrated chemical properties identical to the adult form [5]. The present findings suggest a direct transfer of maternal RBP across the placenta, but by no means exclude the possibility of RBP synthesis by the fetal liver or the placenta.

The concentration of retinol in cord blood is typically 50% lower than the maternal concentration [6]; the values reported in this

study were 60% lower. No correlation was demonstrated between maternal and fetal levels of retinol. Others have shown that supplementation with excessive amounts of vitamin A elevated the maternal retinol values, but had no effect on the fetal blood levels [6, 7].

Contrary to other reports [6, 7], there was no significant correlation in this study between maternal and cord blood levels of carotene. *Barnes* [7] proposed that the majority of fetal retinol was derived from the conversion of carotene which freely diffused across the placenta. He demonstrated that an increase in maternal carotene resulted in an increase in both fetal carotene and fetal vitamin A.

The cord blood level of folacin was similar to the mean concentration (24.5 ng/ml) reported by *Vanier and Tyas* [8], although in the latter study no relationship was seen between maternal and fetal levels. Folacin supplementation has been shown to increase the concentration of folacin in both maternal and fetal blood [9], but a significant correlation between maternal and cord blood levels was demonstrated only in the unsupplemented group. In this study we found a strong association akin to their unsupplemented group, even though our maternal serum levels were higher. *Baker* et al. [10] showed that serum folacin levels of low birth weight infants were less than those of normal-sized infants. No association with birth weight was demonstrated here.

The concentration of ferritin in these cord blood samples fell within normal limits. No relationship was demonstrated between the maternal and fetal levels. Several investigators [11, 12] have indicated that the maternal iron status has no influence on the amount of iron acquired by the fetus. Iron deficiency anemia, diagnosed by ferritin levels of less than 9 ng/dl, did not result in lowered cord blood levels of ferritin [11]. Iron supplementation augmented maternal ferritin, but did not alter fetal blood values [12]. In contrast, fetal iron and transferrin were significantly lower with maternal hypoferremia ($\leq$ 50 µg Fe/dl) [13]. It appears that the fetus is protected against iron overload and iron deficiency within certain limits.

The mean concentration of cord serum zinc was slightly below reports in the literature which range from 83 to 108 µg zinc/dl [14–17]. No significant correlation has been demonstrated between maternal and fetal zinc levels. Maternal zinc levels have no predictive value in terms of birth weight [17] and zinc levels among small-for-gestational-age infants did not differ significantly from normal neonates [14, 17].

References

1 Butte, N.F.; Calloway, D.H.; Van Duzen J.L.: Nutritional assessment of pregnant and lactating Navajo women. Am. J. clin. Nutr. *34:* 2216–2228 (1981).

2 Neeld, J.B.; Pearson, W.N.: Macro and micromethods for the determination of serum vitamin A using trifluoracetic acid. J. Nutr. *79:* 454–462 (1963).

3 Tamura, T.; Shin, Y.S.; Williams, M.A.; Stokstad, E.L.R.: *Lactobacillus casei* response to pteroylpolyglutamates. Analyt. Biochem. *49:* 517–521 (1972).

4 Timiras, P.S.: Developmental physiology and aging (Macmillan, New York 1972).

5 Ismadi, S.D.; Olson, J.A.: Vitamin A transport in human fetal blood. Am. J. clin. Nutr. *28:* 967–972 (1975).

6 Lund, C.J.; Kimble, M.S.: Plasma vitamin A and carotene of the newborn infant. Am. J. Obstet. Gynec. *46:* 207–221 (1943).

7 Barnes, A.C.: The placental mechanism of vitamin A. Am. J. Obstet. Gynec. *61:* 368–372 (1951).

8 Vanier, T.M.; Tyas, J.F.: Folic acid status in normal infants during the first year of life. Archs Dis. Childh. *41:* 658–665 (1966).
9 Landon, M.J.: Oxley, A.: Relation between maternal and infant blood folate activities. Archs Dis. Childh. *46:* 810–814 (1971).
10 Baker, H.; Thind, I.S.; Frank, O.; DeAngelis, B.; Caterini, H.; Louria, D.B.: Vitamin levels in low-birth-weight newborn infants and their mothers. Am. J. Obstet. Gynec. *129:* 521–523 (1977).
11 Rios, E.; Lipschitz, D.A.; Cook, J.D.; Smith, N.J.: Relationship of maternal and infant iron stores as assessed by determination of plasma ferritin. Pediatrics, Springfield *55:* 694–699 (1975).
12 Van Eijk, H.G.; Kroos, M.J.; Hoogendoorn, G.A.; Wallenburg, H.C.S.: Serum ferritin and iron stores during pregnancy. Clinica chim. Acta *83:* 81–91 (1978).
13 Singla, P.N.; Chand, S.; Agarwal, K.N.: Cord serum and placental tissue iron status in maternal hypoferremia. Am. J. clin. Nutr. *32:* 1462–1465 (1979).
14 Bogden, J.D.; Thind, I.S.; Kemp, F.W.; Caterini, H.: Plasma concentrations of calcium, chromium, copper, iron, magnesium and zinc in maternal and cord blood and their relationship to low birth weight. J. Lab. clin. Med. *92:* 455–462 (1978).
15 Henkin, R.I.; Marshall, J.R.; Meret, S.: Maternal-fetal metabolism of copper and zinc at term. Am. J. Obstet. Gynec. *110:* 131–134 (1971).
16 Alexiov, D.; Grimanis, A.P.; Grimani, M.; Papaevangelov, G.; Papadatos, C.: Concentrations of zinc, cobalt, bromine, rubidium and gold in maternal and cord blood serum. Biol. Neonate *28:* 191–195 (1976).
17 Prasad, L.S.: Zinc – a short review. Annls Nestlé *33:* 28–36 (1974).

Doris H. Calloway, PhD,
Department of Nutritional Sciences,
119 Morgan Hall, University of California,
Berkeley, CA 94720 (USA)