

Blood Alcohol Levels for American Indian Mothers and Newborns

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KEY WORDS

alcohol dehydrogenase, American Indian, fetal alcohol metabolism, maternal and newborn blood alcohol levels

ABBREVIATION

FAS—fetal alcohol syndrome

The opinions expressed in this article are those of the authors and do not necessarily reflect those of the Indian Health Service or Sanford School of Medicine.

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abstract

Very little is known about the alcohol elimination rates of newborns who have had chronic alcohol exposure in utero. In these case reports, blood alcohol levels were taken immediately before delivery, at delivery, and postdelivery for 2 mothers who drank alcohol during their pregnancies and 3 single-birth newborns. Newborn A1 of Mother A had no physical characteristics of fetal alcohol syndrome (FAS). The initial blood alcohol level for this newborn was 38.4 mg/dL 129 minutes after birth, with a subsequent blood alcohol level of 5.5 mg/dL 304 minutes after delivery, resulting in an alcohol elimination rate of 11.3 mg/dL per hour. The blood alcohol level for Mother A was 87.4 mg/dL 66 minutes before delivery. Newborn A2 of mother A had FAS. Sixty minutes after delivery, the blood alcohol level for this newborn was 39.5 mg/dL, and the alcohol level of the mother was 42.1 mg/dL. Newborn B1 of mother B had FAS. At 67 minutes after birth, newborn B1 had a blood alcohol level of 246.5 mg/dL, which dropped to 178.7 mg/dL 302 minutes after birth, resulting in an alcohol elimination rate of 17.3 mg/dL per hour. This alcohol elimination rate is within the metabolism range (15–49 mg/dL per hour) of adults with alcoholism. The maternal blood alcohol level was 265.9 mg/dL 27 minutes before delivery. Blood alcohol levels drawn on both the mother and newborn at delivery and 2 or 3 hourly follow-up levels can provide evidence that fetal alcohol dehydrogenase activity is induced by chronic maternal alcohol use. *Pediatrics* 2012;130:e1015–e1018

Until the 1970s, some pregnant women who developed premature labor received ethanol infusions in an attempt to stop contractions. At delivery, the blood alcohol (ethanol) level of the mother and the newborn umbilical cord blood levels were nearly equal.¹ In two 1971 studies, the alcohol elimination rate in mothers who were treated with alcohol just before delivery was twice the rate found in their newborns. The slower rate of elimination by the newborns was attributed to low activity of alcohol dehydrogenase in the liver and higher water content of the tissues of newborns compared with their mothers.^{1,2} In both humans and animals, alcohol elimination for newborns was slower than the rate for their mothers.^{3,4} However, it is unknown what effect longer/chronic alcohol exposure in utero may have on the rate of newborn alcohol elimination. Late-term fetus/newborn alcohol metabolism rates for fetuses chronically exposed to elevated maternal blood alcohol levels have not been reported. This article reports maternal and newborn blood alcohol levels recorded in medical records of 3 singleton pregnancies of 2 Northern Plains American Indian mothers with a history of alcohol use during their pregnancies and with elevated blood alcohol levels at the time of their labor and deliveries.

CASE REPORTS

The data presented in this article were abstracted from the medical records for these mothers and newborns based on clinical observations rather than a research protocol. Both mothers had alcohol use documented before, during, and after each of these pregnancies. During these 3 pregnancies, both mothers had heavy alcohol use, including documented binge drinking of ≥5 drinks. Mother A was referred to an alcohol treatment program 9 times in 6 years, and Mother B was referred twice in an unknown time period.

Mother A experienced child abuse, child sexual abuse, and depression. Mother A also experienced 2 unintentional and 5 intentional (assault) injuries resulting in 1 hospitalization during the pregnancy with Newborn A1. Alcohol was involved in 5 of these injuries. During the pregnancy with Newborn A2, Mother A had 1 unintentional and 1 intentional injury, with alcohol involved in both injuries; however, these injuries did not require hospitalization. The medical record stated Mother A was clinically intoxicated at both deliveries. Mother A died at the age of 31 years (4 years after the delivery of Newborn A2) due to gastrointestinal bleed, portal vein hypertension, cirrhosis of the liver, and alcoholism.

Mother B had attempted suicide once (at age 18 years). Mother B died at age 42 years (10 years after the delivery of Newborn B1) of pneumonia, end-stage liver disease, and alcoholism.

Table 1 summarizes the outcomes of the 3 pregnancies, and Table 2 summarizes the maternal and newborn blood alcohol levels. Newborn A1 was Mother A's sixth pregnancy and had no physical characteristics of fetal alcohol syndrome (FAS) but had a poor suck

reflex. The blood alcohol level of Newborn A1 (38.4 mg/dL) was taken 129 minutes after birth whereas the mother's (87.4 mg/dL) was taken 66 minutes before delivery. This newborn's blood alcohol level was 5.5 mg/dL 304 minutes after birth. Newborn A1 had an average alcohol elimination rate of 11.3 mg/dL per hour (38.4 mg/dL to 5.5 mg/dL over 175 minutes). Newborn A1 was jittery and was placed in foster care.

Newborn A2 was Mother A's seventh pregnancy and was born at 34 weeks' gestation with the following characteristics: ear malformations; nonpendulous, poorly rugated, and nonpigmented scrotum; sole creases on anterior one-third of soles only; no breast tissue; only minimal areola pigmentation; and unspecified "facial features" characteristic of FAS. The maternal medical record stated Mother A was clinically intoxicated at delivery. Blood drawn 60 minutes after delivery on both the newborn and the mother found that the newborn's blood alcohol level (39.5 mg/dL) was very close to that of the mother's (42.1 mg/dL). This newborn had low birth weight (<2500 g), short birth length (<5th percentile), small

TABLE 1 Maternal and Newborn Characteristics

Variable	Newborn A1	Newborn A2	Newborn B1
Maternal age at delivery, y	26	27	32
Gender	Female	Male	Male
Weeks' gestation	40	34	40
Gravida	6	7	8
Parity	4	5	7
No. of living children	3	4	7
Birth weight, g	3470	2240	2450
Birth length, cm	48	43	50
Birth head circumference, cm	34.5	32	33.5
Apgar score at 1 minute	7	5	6
Apgar score at 5 minutes	8	8	8
Prenatal care	0	1	0
Other newborn observations	Poor suck reflex	Jittery	High-pitched cry, foul-smelling placenta and cord, jittery, floppy tone, transferred to area urban hospital

TABLE 2 Blood Alcohol Levels of Mothers and Newborns Before or After Delivery

Minutes ^a (Before [–]/After Birth)	Blood Alcohol Level, mg/dL	Blood Alcohol Level, mg/dL	Alcohol Elimination Rate, mg/dL per hour
Mother A, Newborn A1	Mother A	Newborn A1	Newborn A1
–66	87.4	—	—
0	Birth A1	Birth	—
129	—	38.4	—
304	—	5.5	11.3
Mother A, Newborn A2	Mother A	Newborn A2	Newborn A2
0	Birth A2	Birth	—
60	42.1	39.5	NA
Mother B, Newborn B1	Mother B	Newborn B1	Newborn B1
–27	265.9	—	—
0	Birth B1	Birth	—
67	—	246.5	—
302	—	178.7	17.3

^aBefore birth is indicated with negative numbers. Birth is indicated at zero minutes. After birth is indicated with positive numbers.

NA, not available.

head circumference (<5th percentile), a low 1-minute Apgar score of 5, and was jittery. Newborn A2 was placed in foster care outside the community.

Newborn B1 was Mother B's eighth pregnancy, had FAS, low birth weight (<2500 g), a low 1-minute Apgar score of 6, high-pitched cry, floppy tone, and was jittery. In addition, the placenta and cord were small and foul smelling. The FAS facial characteristics of the newborn included short palpebral fissures, flat philtrum, thin upper lip, and low nasal bridge. Additional characteristics suggestive of FAS included the following: irritability, high-pitched cry, feeding difficulties, hypotonia, cardiac problems, hirsutism, right foot upward compression, and neonatal teeth palpable on the left side of the gums. Mother B's medical record stated she was too intoxicated to provide information to the health care provider at delivery. The mother's blood alcohol level was 265.9 mg/dL, which was drawn 27 minutes before delivery. Newborn B1's blood alcohol level (246.5 mg/dL) was drawn 67 minutes after birth, with a subsequent blood alcohol level of 178.7 mg/dL drawn 302 minutes after delivery. This newborn had an alcohol elimination rate of 17.3 mg/dL

per hour (246.5 mg/dL to 178.7 mg/dL over 235 minutes). At birth, Newborn B1 went through alcohol withdrawal and was transferred to an area urban hospital. At 1 month of age, this newborn was hospitalized due to neglect.

DISCUSSION

This article presents maternal blood alcohol levels before delivery, at delivery, and postdelivery; newborn blood alcohol levels at delivery and postdelivery, and the blood alcohol elimination rates of the newborns. A previous report states that with a single drink of alcohol, the blood alcohol level of the fetus would not reach as high a peak as the mother.⁵ The report does not state the fetal age. The current case reports confirm that when mothers are in the later first order phase (initial absorption phase ended) of their alcohol metabolism (presumably they had not been drinking for at least a few hours before delivery), then mother and newborn can have roughly the same level of blood alcohol. This demonstration of newborn alcohol metabolic rates comparable to adult rates may explain the potential equivalency of newborn and maternal blood alcohol elimination rates in fetuses previously exposed to alcohol.

For people who do not drink alcohol on a regular basis, the alcohol metabolism rates range from 12 to 24 mg/dL per hour. People with chronic alcohol exposure have metabolism rates from 15 to 49 mg/dL per hour. The average metabolism rate used for the general population is 20 mg/dL per hour.⁶

The 2 newborn cases reported here metabolized alcohol at adult-comparable rates. One of the newborns metabolized alcohol at a slightly slower rate (11.3 mg/dL per hour) than the non-drinkers' range (12–24 mg/dL per hour); 1 of the other newborns metabolized alcohol at a rate (17.31 mg/dL per hour) that was within the range of adults with alcoholism. Given these findings that show adult rates of alcohol metabolism in 2 newborns, the authors speculate that alcohol dehydrogenase activity increases during gestation for a newborn who has had chronic fetal alcohol exposure.

Limitations of this study include the following: follow-up maternal blood alcohol levels were not conducted in the reported cases, which would have allowed for a determination of the maternal alcohol metabolic rates; and the newborn alcohol metabolism rates shown here could simply reflect individual variation.

Nevertheless, given the paucity of newborn/maternal blood alcohol reports in the literature, these case reports provide clues about the mechanics of fetal/newborn alcohol metabolism. In addition to the acquisition of new knowledge, a better understanding of fetal/newborn alcohol metabolism may have other benefits. Newborns found to have increased alcohol metabolism should have their liver function checked before prescribing any medications. Newborn metabolism of some drugs may be altered in a fashion similar to that seen in adults with alcoholism. Recognizing that a newborn has an elevated alcohol

metabolic rate also could be helpful in substantiating a history of maternal alcohol abuse.

A more accurate understanding of newborn alcohol metabolism will require the evaluation of larger numbers of newborns. Whenever maternal alcohol

use and/or intoxication is suggested during labor, blood alcohol levels drawn from both the mother and newborn at delivery and 2 or 3 follow-up levels drawn at hourly intervals can be used to calculate newborn alcohol elimination rates. Blood alcohol levels stored in

electronic medical records could be studied to gain a better understanding of newborn alcohol metabolism rates and the liver function of newborns with chronic fetal alcohol exposure, which could improve the care provided to these newborns.

REFERENCES

1. Idänpään-Heikkilä J, Jouppila P, Akerblom HK, Isoaho R, Kauppila E, Koivisto M. Elimination and metabolic effects of ethanol in mother, fetus, and newborn infant. *Am J Obstet Gynecol.* 1972;112(3):387–393
2. Seppälä M, Räihä NC, Tamminen V. Ethanol elimination in a mother and her premature twins. *Lancet.* 1971;1(7710):1188–1189
3. Brien JF, Loomis CW, Tranmer J, McGrath M. Disposition of ethanol in human maternal venous blood and amniotic fluid. *Am J Obstet Gynecol.* 1983;146(2):181–186
4. Kelly SJ, Bonthius DJ, West JR. Developmental changes in alcohol pharmacokinetics in rats. *Alcohol Clin Exp Res.* 1987;11(3):281–286
5. Rosett HL, Weiner L. *Alcohol and the Fetus.* New York, NY: Oxford University Press; 1984
6. Kleinschmidt KC. Ethanol. In: Shannon M, Borron S, Burns M, eds. *Haddad and Winchester's Clinical Management of Poisoning and Drug Overdose.* 4th ed. Philadelphia, PA: Saunders Elsevier; 2007:589–604

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