PCBs, PBDEs and Thyroid Hormone Levels in Umbilical Cord Blood: A Feasibility Study

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Introduction

Recent studies have shown that human levels of polybrominated diphenyl ethers (PBDEs) are higher in North America than in Europe and are increasing exponentially over time [1-3]. Animal models indicate that perinatal exposure to polychlorinated biphenyls (PCBs) and PBDEs is associated with adverse outcomes, including neurodevelopmental effects [4-6]. Additionally there is some evidence in this region that PCB and PBDE levels are correlated in fish [7], whose consumption is a major route of exposure for humans To date, there have been no studies designed to measure PBDE exposure in an urban population on the east coast of the U.S. Nor have there been studies to examine the relationship between PCB and PBDE levels in urban populations. This paper evaluates the feasibility of collecting cord blood for thyroid and PCB/PBDE analysis in the context of a study of birth outcomes, including birth weight, gestational age, and thyroid hormone levels.

Methods and Materials

Study Population

Umbilical cord blood was collected from a cohort of 300 singleton-birth babies delivered at the Johns Hopkins Hospital between November 26, 2004 and March 16, 2005. Whenever possible, blood samples were collected by nursing and medical staff from all babies born during the above sampling period. These biological samples were collected anonymously with the approval of the Maternal and Fetal Research Committee and the Internal Review Board at the Johns Hopkins University School of Medicine. Medical records were abstracted for medical and demographic information. Hospital staff involved in the sample collection were interviewed to assess the factors that facilitated or inhibited sample collection activities.

Blood Collection and Analysis

Following the newborn delivery but prior to the delivery of the placenta, the umbilical cord was clamped and a segment of the cord was cleansed with antiseptic. Using a syringe with an 18-gauge safety needle, all obtainable blood was drawn from the umbilical vein. The blood was then transferred to five 10 ml silicon-coated vacutainer tubes containing no additives (for collection of serum) using a vacutainer transfer device. The samples were stored at 15^{o}C for a maximum of two hours before they were processed. Blood from the silicon-coated vacutainers was spun at 2400 x *g* for 15 minutes. The serum was then aliquotted and frozen at -80^{o}C in pre-screened, tinted containers for PCB and PBDE analyses and in clear tubes for thyroid measurements. For PCB and PBDE analyses, the samples were shipped to the Center for Disease Control and Prevention (CDC) in Atlanta, GA. Thyroid hormones (total thyroxine or TT4, free T4 or FT4 and thyroid stimulating hormone or TSH) were analyzed by Quest diagnostics laboratory (Baltimore, MD).

Feasibility Assessment

We used a qualitative questionnaire to assess the ability and the propensity of the medical staff in Labor and Delivery to collect umbilical cord blood for our study. The questionnaire took approximately 5-10 minutes to complete and was self-administered. Survey questions addressed the relative impact of factors that were likely to influence the collection of cord blood, from the perspective of those who were charged with collecting it.

Results and Discussion

Study Population

Table 1 describes a sub-sample of our study population. As compared to the overall population of newborns born at the Johns Hopkins Hospital, our study population is similar, except for the proportion of plural births, which were excluded by design of the study. In general, the mothers delivering at the Johns Hopkins Hospital represents an urban minority population, with a significantly higher proportion of adverse birth outcomes than found in the state of Maryland. Our study sample reflects these trends, indicating that we succeeded in recruiting a representative population sample.

Feasibility of Collecting Samples

Over the course of the study period, lasting approximately three and a half months, we were able to collect umbilical cord blood on approximately half of the deliveries occurring in the hospital during this time frame. Thirty-six surveys (out of approximately 50 distributed) were returned. These data are presented in Figure 1. The highest proportion of medical staff reported that the incentive (coupons for coffee in the hospital coffee bar), the amount of blood in or size of the placenta, and the quick response from the study team (who took custody of the cord blood within two hours of the delivery) influenced whether or not staff members were able or willing to collect blood. Similarly, these factors, plus complications during delivery and the availability of other labor and delivery personnel to assist, had the largest influence on whether or not blood was collected for this study.

Preliminary Outcome Distribution

Based on analysis of the first 114 samples, Table 2 describes the distribution of thyroid hormones and birth outcomes and the percentage of results outside the reference range. PCB and PBDE levels are currently under analysis by the CDC laboratory.

Discussion

We have been successful in assembling a cohort of births in Baltimore from whom we have collected umbilical cord blood samples for analysis of PCB and PBDE levels and thyroid hormones. The range of outcome variables is consistent with those reported in the literature. Preliminary assessments indicate that the thyroid indices vary with gestational age, as expected.

Our investigation has identified several factors influencing the collection of cord blood that are important for assuring success for the recruitment of a representative sample of the study population.

Future Steps

Laboratory analyses for PCBs and PBDEs are currently underway at the CDC and results are expected to become available within the next month. Measured concentrations of PCBs and PBDEs will be examined to identify (i) levels and patterns of exposure and (ii) whether PCB and PBDE levels are correlated in people in our area, as they are in fish. Subsequent analyses will examine relationships between thyroid hormone levels and birth outcomes.

Table 1. Study Population

Characteristics	This Study (%)	Johns Hopkins Hospital (%)*	Maryland (%)*
African-American	67.2	70.2	33.0
Maternal age <18	7.8	9.3	3.6
Plural births	0	4.9	3.6
Low birthweight (<2500 g)	12.2	20.5	8.9
Premature births (<37 weeks)	15.8	23.5	10.9

*****adapted from Maryland Vital Statistics, 1999-2001

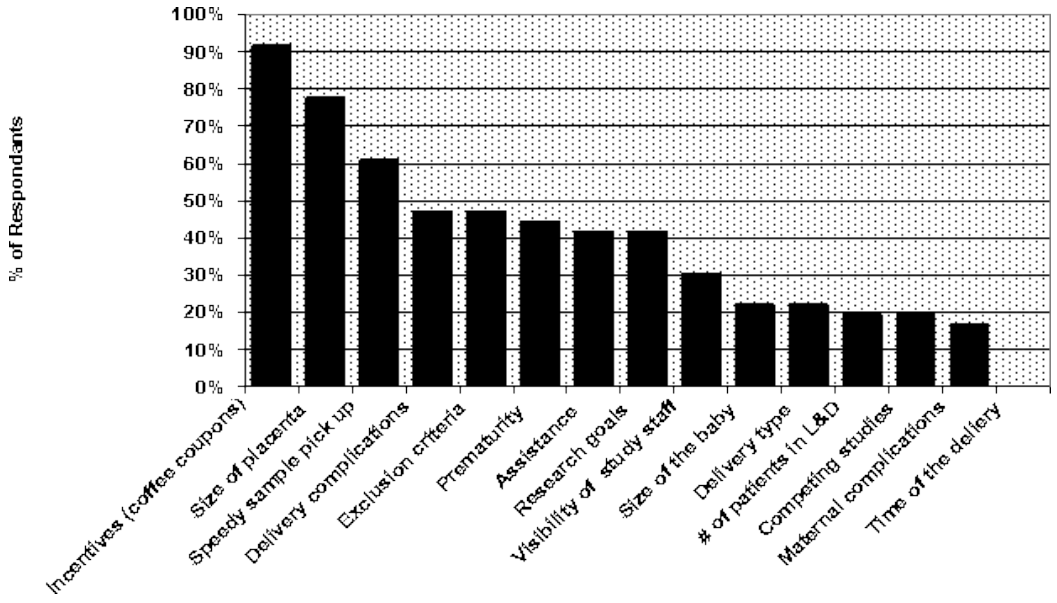
Table 2. Distribution of Outcome Data (N=114)

Outcome Measurement	Mean ± SD	Range	Percentage Outside Reference Range*
Birthweight (g)	3136 ± 558	1145 - 4738	12.2%
Gestational Age (days)	270.9 ± 15.1	206 - 293	15.8%
Total T4 (µg/dL)	11.0 ± 2.3	5.2 - 17.3	6.1%
Free T4 (ng/dL)	1.11 ± 0.18	0.61 - 1.70	0.9% (based on 95% CI)
TSH (µIU/mL)	8.0 ± 5.8	1.3 - 37.5	5.3%

* Birth outcomes: <2500 g defined as low birthweight; <259 days defined as premature birth.

Thyroid : 6.6–15.0 Total T4, 1.38 ± 0.35 Free T4, 1.0 – 20.0 TSH [8]

Figure 1. Factors influencing the collection of umbilical cord blood



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Note: The role of Andreas Sjödin, Donald G. Patterson Jr. and Larry L. Needham in this project was limited to providing the laboratory analyses and interpretation of the laboratory data

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