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Abstract

Environmental Chemicals in Cord Blood and Neonatal Blood Spots: Analytical Method Development & Validation, and Evaluation of the Efficacy of Extant NCS Sample Collection Protocols for Cord Blood

Martin Shafer[1], Joel Overdier[1], Marie-Noel Sandoval[2], and Maureen Durkin[2]
[1]University of Wisconsin-Madison & Wisconsin State Laboratory of Hygiene [2]University of Wisconsin-Madison & Wisconsin Study Center

Introduction: Neonatal/Dried blood spots (DBS) are collected from virtually every infant in the United States, and are also obtained as part of the current NCS Vanguard study protocol. With only a few of these spots being used by health departments to screen for newborn diseases, or by NCS, the remainder represents a unique and potentially valuable resource for exposure assessment in epidemiological studies. Perinatal exposures to both toxic inorganic elements (As, Cd, Cr, Ni, Pb, V) and persistent organic chemicals (e.g. perfluorinated compounds (PFC) & brominated flame retardants (PBDE)) may affect health, both early and later in life - therefore developing methods to measure specific contaminant exposures and/or variations in blood chemistry using DBS may prove valuable for studies of the developmental origins of disease. Cord blood also represents an important "archive" of perinatal exposures and chemical characterization of cord blood could potentially be used to validate emerging methods for DBS analysis. Cord blood is collected in the NCS protocol, though the efficacy of the collection method has not been evaluated for a broad range of inorganic and organic environmental contaminants.

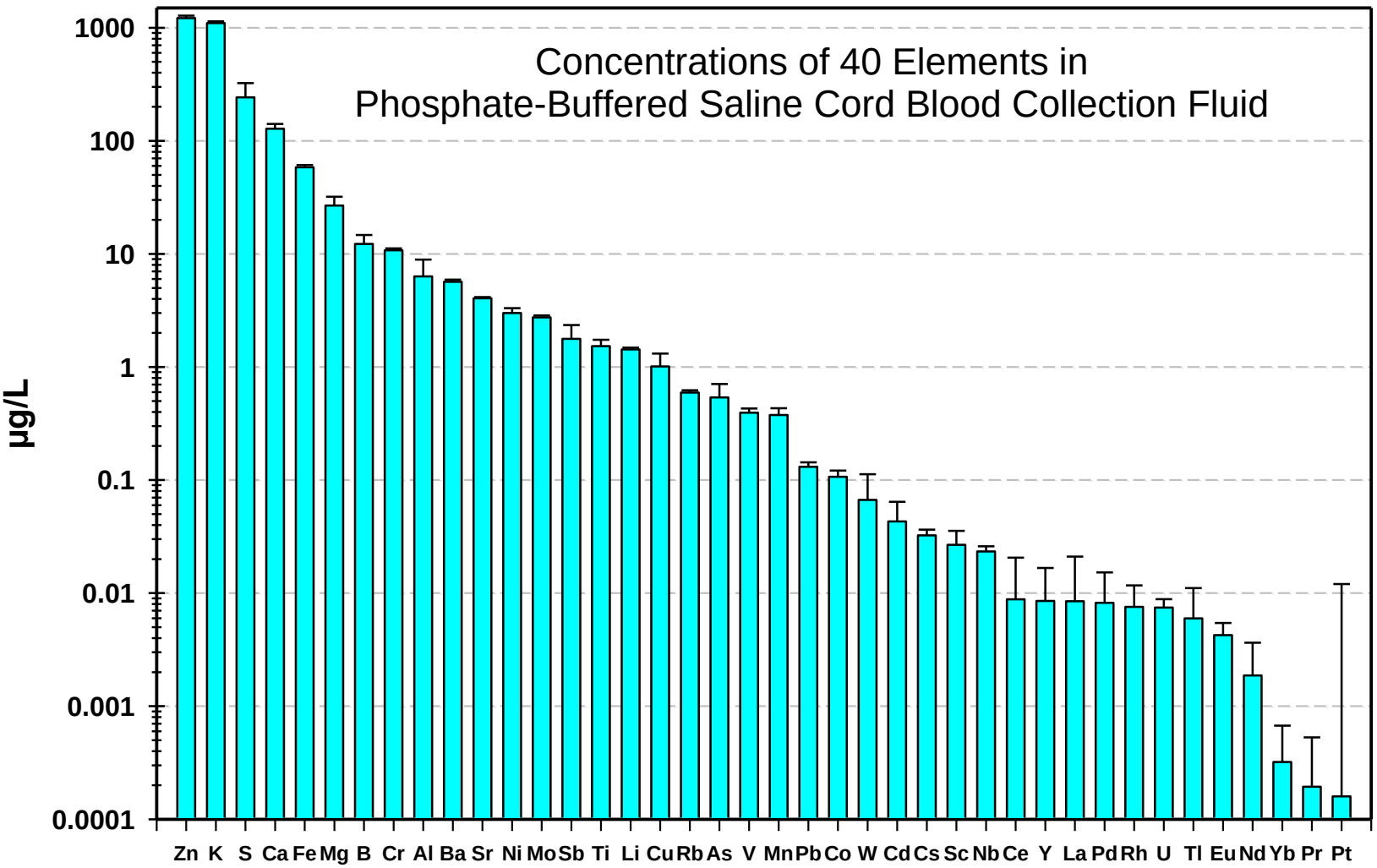
Objectives: Our overarching goal is to optimize and validate methods for a large (28) suite of trace metals, 16 PFC species, and 24 PBDE congeners in DBS. A key strategy of the study is a comparison of target species concentrations in co-sampled DBS and Cord Blood collections. In doing so, we hope to provide critical validation of the new DBS methods and importantly also ***address the utility of current NCS collection/storage protocols for these and similar environmental contaminants in Cord Blood***. The later is the focus of this report. Substantive effort is also being directed at optimizing analytical methods for PFC and PBDE analysis in Cord Blood.

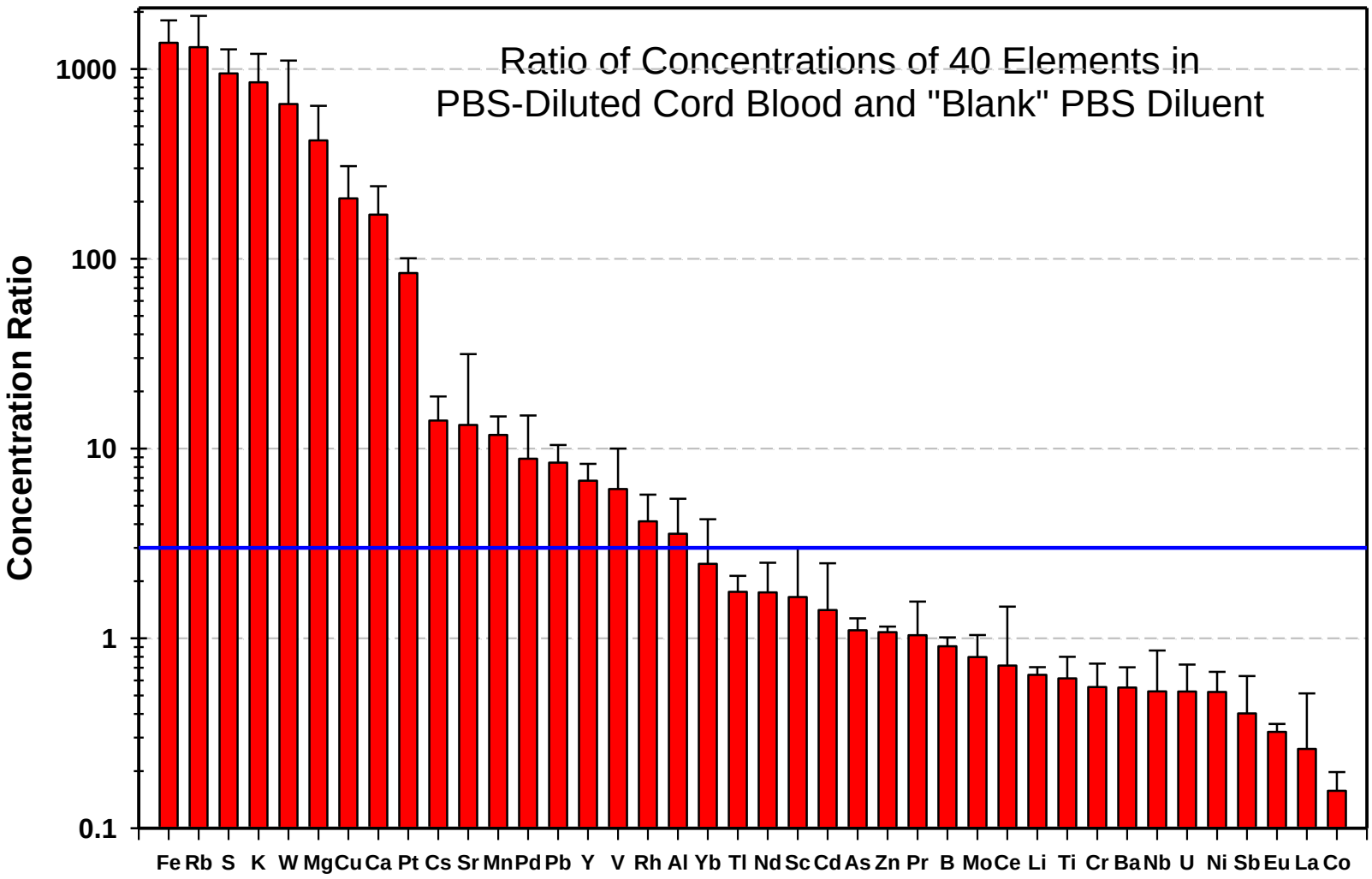
Methods: The elemental composition of representative samples of Cord Blood collected as per standard NCS protocols, along with 8 samples of “blank” Cord Blood bagged collection fluid (CPD), was determined using magnetic-sector (high resolution) ICPMS. Similarly, the concentrations of 16 PFC species in these samples were determined by HPLC-tandem mass spectrometry.

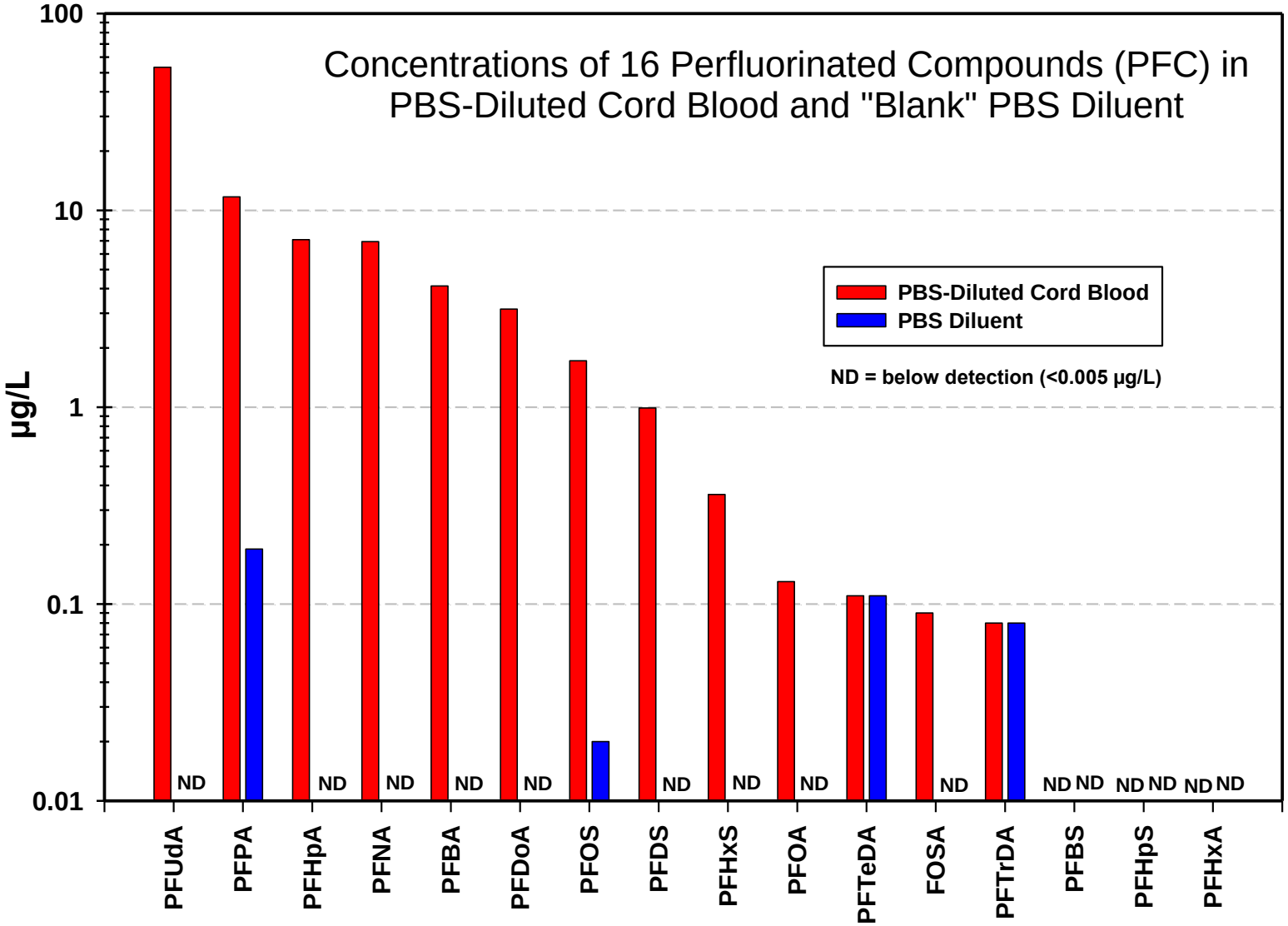
Results: Though the Cord Blood signal/background ratio was more than adequate for several trace metals (Fe, Rb, W, Cu, Pt, Cs, Mn, Pd, Pb) (Figs 1, 2); contamination in the CPD collection fluid/bag was at levels that would prevent accurate quantification of a large suite of important elements (Co, Sb, Ni, U, Cr, Ti, Mo, Zn, As, Cd, Tl, Al). Contaminant levels of PFCs in the CPD/bag were, with few exceptions, at or near detection limits, resulting in good signal/background ratios for most species (Fig 3).

Conclusions: The combined influence of the Cord Blood collection fluid and bag results in contamination levels that compromise the use of this collection protocol for a large suite of trace elements. In contrast, the protocol appears to be a viable approach for many PFC species. We developed and recommend an alternate Cord Blood collection protocol that involves sampling directly from the umbilical using a large plastic syringe and distribution of the sampled blood into appropriate “clean” storage tubes.

Figures:


Concentrations of 40 Elements in
Phosphate-Buffered Saline Cord Blood Collection Fluid
µg/L
1000
100
10
1
0.1
0.01
0.001
0.0001
Zn K S Ca Fe Mg B Cr Al Ba Sr Ni Mo Sb Ti Li Cu Rb As V Mn Pb Co W Cd Cs Sc Nb Ce Y La Pd Rh U Tl Eu Nd Yb Pr Pt


Ratio of Concentrations of 40 Elements in
PBS-Diluted Cord Blood and "Blank" PBS Diluent
Concentration Ratio
1000
100
10
1
0.1
Fe Rb S K W Mg Cu Ca Pt Cs Sr Mn Pd Pb Y V Rh Al Yb Tl Nd Sc Cd As Zn Pr B Mo Ce Li Ti Cr Ba Nb U Ni Sb Eu La Co


Concentrations of 16 Perfluorinated Compounds (PFC) in
PBS-Diluted Cord Blood and "Blank" PBS Diluent
PBS-Diluted Cord Blood
PBS Diluent
ND = below detection (<0.005 µg/L)
µg/L
100
10
1
0.1
0.01
ND
PFUdA
PFPA
PFHpA
PFNA
PFBA
PFDoA
PFOS
PFDS
PFHxS
PFOA
PFTeDA
FOSA
PFTrDA
PFBS
PFHpS
PFHxA