

Transfer of Lead during Lactation

Literature and Analysis

**Kathryn R Mahaffey, Ph.D.
Washington, D.C.**

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Basis for Concern

- ▶ CNS development in early post-natal life.
- ▶ *Neuro-endocrine impact of lead exposure during this period has not been investigated.*
- ▶ Documented transfer of lead from mother to infant. Source maternal bone lead.
- ▶ *Marginal evidence that the exposure to lead can be stopped as long as lactation continues.*
- ▶ In USA occupational lead exposures and elevated blood lead concentrations among recent immigrants to the country.

Issues Surrounding Benefits of Breast-Feeding Infants

- ▶ Benefits are very well established. Feeding infant formulas is immediately dangerous to the infant in circumstances where the water supply is not safe, refrigeration is not reliable, or use of infant formulas in highly diluted forms.
- ▶ *Are contraindications to breast feeding. Include transfer of some drugs in breast milk (e.g., lithium, concern over modern antidepressives). Maternal illness.*
- ▶ Questions have been raised regarding transfer of environmental chemicals – of known developmental toxicity – to the young infant.
- ▶ **Issue: risks and benefits.**

Establishing Dose

- ▶ Comparative concentrations of lead in milk sources.
- ▶ Concentration of lead x volume of milk consumed.

Source of Lead Transferred during Lactation

- ▶ Combination of current environment and maternal body stores of lead; i.e., bone lead.
- ▶ Current dietary habits – Greek data (Leotsinidis et al., 2005); Chinese data (Chien et al., 2006);

Studies with women and their infant showing transfer of lead from bone stores to the infant

- ▶ Have established that bone lead is mobilized and transferred into breast milk.
- ▶ *Multiple studies including Osterloh and Kelly (1999) based on changes in bone density, Gulson et al., (2004) based on stable lead isotope ratios, Ettinger et al. 2004 and 2006) based on measurement of bone lead concentration, Berglund et al. (2000).*
- ▶ Most definitive studies were those of Gulson et al. from Australia based on changes in stable lead isotope ratios indicating mobilization of "old" lead from bones. "Old" lead had the stable lead isotope ratios of the country of origin of the women – Yugoslavia.
- ▶ *Subjects of Osterloh and Kelly (1999) and Gulson et al. (1999 through 2004) had blood [Pb] generally less than 5 ug/dL.*
- ▶ Ettinger et al. reported on subjects with blood Pb averaging $\mu\text{g/L}$ at the geometric mean (range 1.8 to 29.9 $\mu\text{g/dL}$). Geometric mean 8.4 $\mu\text{g/L}$.
- ▶ *I have not looked for reports at "high" maternal blood [Pb].*

Can additional dietary Ca stop/reduce bone mobilization during lactation?

- ▶ Clearest results from Gulson et al. based on stable lead isotopes. Post-partum increases in maternal blood Pb increased an average of 65% geo mean (range 30% to 95%). Blood Pb at end of pregnancy < 6 ug/dL.
- ▶ *Ca provided post-partum (i.e., during lactation) did not affect the stable lead isotopic ratio – i.e., did not alter total bone lead mobilization. Ca supplementation did delay the mobilization of lead from bone. Calcium addition by supplement 900 to 1200 mg added to 400 to 600 mg in diet.*
- ▶ Total lead mobilized from bone was 145 ug Pb (geometric mean). Range 50 to 380 ug Pb. Appears that women experience a new loss of 1% to 5% of bone and a decrease in bone density post-partum.
- ▶ *One woman experienced a dramatic increase in blood Pb post-partum increasing from 5.6 ug/dL to 43 ug/dL.*
- ▶ Nonetheless, at maternal blood [Pb] < 5 ug/L transfer of lead during lactation is low.
- ▶ *Several investigators maintain that bone mineral changes during lactation are endocrine based and independent of dietary calcium (Cross et al., 1995; Kalkwarf 1999; Kolthoff et al., 199; Laskey et al., 1998, Prentise, 2000).*

Can additional dietary Ca stop/reduce bone mobilization during lactation?

- ▶ Alternately two sets of investigators have pointed to benefits from calcium supplementation during pregnancy and lactation in reducing lead mobilization (Hernandez-Avila et al, 2003; Janakiraman et al., 2003).
- ▶ Ettinger et al. (2006) showed that Ca supplements decreased lead transfer over the course of lactation by 5% to 10%
- ▶ Absent stable isotopes unclear on the mixture of bone lead and current environmental lead.

Lead Concentrations in Breast Milk

- ▶ Breast milk. **Greece** in 2005 (Mean +/- SD 0; .48 +/- 0.60 ug/dL); **Mexico** in 2006 (range for 310 women <0.05 to >0.40 ug/L), **Mexico** 2004 (range 0.2 to 8.0 ug/L geo mean 1.1 ug/L); **USA** 2002 (4.3 to 6.1 ug/L depending on month of lactation; mean maternal blood < 2.0 ug/dL), **Nigeria** 2001 (15 of 34 milk samples > 0.46 ug/L; median [Pb] of all 34 samples 0.67 ug/L (range 0.46 to 13.0 ug/L). **Austria**, 2002, in nonindustrial areas ~ 1.2 ug/L Twice as high in industrial areas. Mean for all 1.63 ug/L.
- ▶ Normal range provided by ATSDR (1997) was 2 to 5 ug/L.

- ▶ At maternal blood [Pb] less than 10 ug/dL, breast milk is in range of ~ 2 – 6 ug/L.
- ▶ Blood Pb and bone Pb can predict breast milk [Pb]. Breast milk [Pb] predicts ~ 12% of variance in infant's blood [Pb] in addition to the contribution of maternal blood [Pb] which predicts newborn blood [Pb].
- ▶ Questions about the shape of the distribution at higher blood Pb levels.

Levels of Lead in Infant Formulas

- ▶ Current infant formula contain no detectable quantities of lead – FDA data as recent as 2003/2004.
- ▶ If reconstituted in the home, water [Pb] important consideration.