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Infants' exposure to aluminum from vaccines and breast milk during the first 6 months

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The success of vaccination programs in reducing and eliminating infectious diseases has contributed to an ever-increasing number of vaccines given at earlier ages (newborns and infants). Exposure to low levels of environmental toxic substances (including metals) at an early age raises plausible concerns over increasingly lower neuro-cognitive rates. Current immunization schedules with vaccines containing aluminum (as adjuvant) are given to infants, but thimerosal (as preservative) is found mostly in vaccines used in non-industrialized countries. Exclusively, breastfed infants (in Brazil) receiving a full recommended schedule of immunizations showed an exceedingly high exposure of Al (225 to 1750 μg per dose) when compared with estimated levels absorbed from breast milk (2.0 μg). This study does not dispute the safety of vaccines but reinforces the need to study long-term effects of early exposure to neuro-toxic substances on the developing brain. Pragmatic vaccine safety needs to embrace conventional toxicology, addressing especial characteristics of unborn fetuses, neonates and infants exposed to low levels of aluminum, and ethylmercury traditionally considered innocuous to the central nervous system.
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Introduction

Although vaccine safety is constantly reaffirmed in regard to its immunogenicity and rare adverse events, it is assumed that low doses of preservative (thimerosal) and adjuvant (aluminum salts) have the same innocuous effects across the large spectrum of those vaccinated — adults, children, infants, newborns, and unborn fetuses — and for the ever-increasing number of them given to young children. Despite low doses in vaccines, both Hg and Al are neuro-toxic; the higher toxicity of Hg is well recognized and it has been more studied and better understood than Al.

During early life, exposure to either mercury or aluminum that occur through breastfeeding depends on the maternal exposure (diet mainly). However, because of mammary-gland barrier, expected exposure for infants is greatly attenuated. The exposure to mercury or aluminum in breast milk is spread out through the course of a day's nursing with the very young or smaller (immature) baby absorbing proportionally smaller quantities. However, in intramuscular injections ethylmercury (in preservatives) and Al (as adjuvant) gain unimpeded access to body compartments. In this context, specific aspects of Hg exposure have been discussed elsewhere (Dórea, 2007). The American Academy of Pediatrics' revision of 1996 discussed aluminum in infant feeding but did not address the additional higher and acute exposure to aluminum in commonly used infants' vaccines (AAP, 1996).

Recent evidence based on cellular and animal studies indicates that both thimerosal at small concentrations (Baskin et al., 2003; Hornig et al., 2004; Ueha-Ishibashi et al., 2004; James et al., 2005; Parran et al., 2005; Geier et al., 2009; Hewitson et al., 2009; Olczak et al., 2009) and adjuvant-Al are neuro-toxic. In this regard, aluminum-adsorbed vaccines caused a transient rise in brain tissue of mice (Redhead et al., 1992). Indeed, *in vitro* work showed that adjuvant-Al at levels comparable to those administered to adults can kill motor neurons (Petrik et al., 2007). Toimela and Tähti (2004) showed the toxicity of both Al and Hg in neuro-blastoma cell line. The toxicity of Al is much lower than that of thimerosal (Deth et al., 2008). Nevertheless, Mutter et al. (2007) suggested that low levels of Hg could cause nerve cell deteriorations that could be aggravated by aluminum. Therefore, data to provide a non-observable adverse effect level for Hg and Al (inclusive combined) on the brain are sorely needed.

Vaccines represent an important strategic line of defense against infectious diseases; however, those containing mercurial

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