Historical and Current Trends in Dioxin Exposure – A Review

Lorber, M.

National Center for Environmental Assessment, Office of Research and Development, United States Environmental Protection Agency, 1200 Pennsylvania Ave, Washington, DC, USA.

Abstract
Empirical evidence suggests that exposure of Americans to dioxin-like compounds was low during the early decades of the 20th century, then increased during the 1940s and 1950s, reaching a peak in the 1960s and 1970s, and progressively decreased to lower levels in the 1980s, 1990s, and into the new century. Measured body burdens of dioxin-like compounds have been found to range from approximately 50 to 80 pg/g (ppt) lipid weight (lwt) on a Toxic Equivalent (TEQ) basis during the 1970s, 30–50 ppt lwt during the 1980s, and 10–20 ppt lipid in the 1990s into the 2000s (this summary based on data only on dioxin and furan congeners, not on dioxin-like PCBs, and the toxicity equivalency factors (TEFs) used in the generation of these ranges when originally published were the WHO 1998 TEFs). This mid-century rise in body burdens has been linked to the industrial revolution of the early decades of the 20th century and the rise of emissions of dioxin into the air from combustion and incineration associated with this rise in industrial activity. The decline over time has been the credited to air pollution controls mandated by the Clean Air Act which have significantly reduced dioxin emissions. This presentation reviews published blood measurement survey data showing these trends in body burdens, as well as studies measuring dioxins in environmental and exposure media[1]. Using a simple pharmacokinetic (PK) model, it was shown that these trends in body burdens could be replicated with an intake dose that peaked at above 6 pg TEQ/kg-day in the 1960s to then decline to below 1 pg TEQ/kg-day in the 1990s. The higher mid-century intakes are thought to be due to ingestion of animal food products, as dioxins are known to bioaccumulate in the lipids of animals. A limited sampling of historical, preserved meat samples by EPA show lipid concentrations 3-5 times higher in samples from the mid-century compared to meat concentrations taken today. The PK modeling exercise showed that older people in today's general population have body burdens that tend to be higher than those of younger people. However, this trend is not due simply to aging and accumulating more dioxins over time. Rather, as shown by the modeling, the main cause is high exposures in the middle decades of the previous century. While these dioxin residues continue to decline from individuals now comprising today's elder population, these past exposures are nonetheless the primary cause of their current higher dioxin body burdens. It is noted, of course, that this is a generalization that does not apply to all individuals in the general population; there are of course older individuals who did not experience high exposures in the past and have low body burdens today, and young people today with high exposures leading to higher body burdens.

The US EPA's *Draft Dioxin Reassessment* developed an estimate of general population exposures to dioxin-like compounds[2]. EPA combined concentrations of all dioxin-like compounds (dioxins, furans, and dioxin-like PCBs) in exposure media with contact rates (rate of inhalation, food consumption, and so on) to derive an adult background exposure rate of 61.0 pg TEQ/day. Assuming a 70 kg adult, this is less than 1 pg TEQ/kg-day, to place this in the perspective given above showing mid-20th century intakes that were greater than 6 pg TEQ/kg-day. This estimate was generated using mean exposure media concentrations calculated assuming non-detects were equal to one-half detection limit (ND = ½ DL) and using WHO-2005 TEFs. Mean exposure media concentrations were combined with average adult contact rates and average adult "per capita" food consumption rates (meaning the average of all individuals in a population, whether or not they were consumers of the food). These concentrations and contact rates were typical of the mid-1990s. Consumption of animal food products (beef, pork, poultry, dairy, milk, eggs, fish) comprise over 95% of the intakes, while soil ingestion (at an assumed soil concentration at 9.4 ppt TEQ) explained less than 1% of this total. In 2009, an update to this estimate was published at 40.6 pg TEQ/day (also at ND = ½ DL and WHO 2005 TEFs)[3]. This estimate was generated with updated concentration data, mostly from the

early 2000s. During this conference, a further update has been developed at 33.5 pg TEQ/day, again using newer concentration data, some of which are current as of 2007/2008 time frame[4]. It should be recognized that part of the differences between the estimates of the *Draft Dioxin Reassessment*, the 2009 update, and the update being presented at this conference, are due to use of food surveys of different designs and use of different laboratories with different capabilities (particularly as regards to the impact of the achieved detection limits; see Lorber et al[3] for an extensive discussion of this issue).

In summary, the preponderance of the available evidence, including body burden data as well as intake estimates, suggests that declines in exposure to dioxin-like compounds have occurred not only from the mid to latter decades of the 20th century decade, but also into the 2000s.

References

1. Lorber M. (2002) *Sci Tot Env* 288:81-95.
2. US EPA. 2003. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. United States Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. NAS Review Draft. December, 2003. EPA/600/P-00/001C(a-f). Available at, http://www.epa.gov/ncea/dioxin.htm.
3. Lorber M, Patterson D, Huwe J, Kahn H. (2009). *Chemosphere* 77: 640-651.
4. Lorber M, Huwe J, Rawn DFK. (2010) An Update to Estimates of intake of dioxin-like compounds for the general population of the United States. Presented at, Dioxin 2010, held Sep 12-17, 2010, at San Antonio, TX, USA