Is There a Need to Revise Health Canada's Human PCB Guidelines?

Eric N. Liberda, MES[1]
Leonard J.S. Tsuji, DDS, PhD[1]
Bruce C. Wainman, PhD[2]

ABSTRACT

Background: This article assesses if there is a need to revise Health Canada's polychlorinated biphenyl (PCB) guidelines for whole blood given that plasma is typically favoured over whole blood for analysis, technological advancements in analytical methods have occurred, and the congener profiles of PCBs in the environment continue to change due to degradation and re-compartmentalization.

Methods: Canadian epidemiological and exposure studies within the last 11 years were examined in order to determine the dominant method of PCB reporting and the human tissues or fluids analyzed.

Findings: In all but one study, PCBs were analyzed on a congener basis. In the cases where an Aroclor™ equivalency was reported, the result was calculated using an Aroclor™ estimation equation based on several PCB congeners. To date, a wide variety of tissues and fluids are still being analyzed; however, only one study performed the analysis using whole blood, the basis of Health Canada's guidelines. Additionally, congener profiles in the environment are changing due to degradation and re-compartmentalization; therefore, guidelines should reflect this change.

Conclusion: The reporting of whole blood PCB levels in Canada is a rare practice, and reporting PCBs solely as an Aroclor™ mixture can result in false non-detection; however, the Health Canada guidelines are based on Aroclor™ 1260 levels in whole blood. PCB congener analysis by gas chromatography/mass spectroscopy results in greater accuracy with greater sensitivity and limit of detection for the samples when compared to gas chromatography alone. Further, Aroclor™ equivalency can be estimated from congener analysis results. No other nation has yet prescribed PCB guidelines in human fluids or tissues; this is likely due to the uncertainty associated with PCB health risk assessment. Given the findings, whole blood PCB guidelines must be revised in order to reflect advances in the medical sciences.

MeSH terms: Polychlorinated biphenyls; Aroclor™; guideline

La traduction du résumé se trouve à la fin de l'article.

1. Department of Environment and Resource Studies, University of Waterloo, Waterloo, ON
2. Department of Obstetrics and Gynecology, McMaster University, Hamilton, ON
Correspondence: Dr. Leonard Tsuji, Department of Environment and Resource Studies, and the Institute of Health Informatics Research, University of Waterloo, 200 University Avenue West, Waterloo, ON N2L 3G1, Tel: 519-888-4567, ext. 32762, E-mail: ljtsuji@fes.uwaterloo.ca
Acknowledgements: We acknowledge support from the Canadian Institutes of Health Research and the University of Toronto/McMaster University Indigenous Health Research Development Program Graduate Scholarship to E. Liberda and the Ontario Ministry of Research and Innovation.

Polychlorinated biphenyls (PCBs) are among the most stable and ubiquitous of the organochlorine contaminants known to humankind. PCBs have been analyzed in a wide range of human tissues and fluids, including: plasma,[1] whole blood,[2] adipose tissue,[3] milk,[2] follicular fluid,[4] and serum.[4] Because PCBs are highly resistant to degradation, they will remain in the environment for many years and ultimately make their way to biota primarily through the food chain. Further, the propensity of PCBs to bioaccumulate and magnify means that all trophic levels will be contaminated and the upper levels of the food chain will bear a disproportionate burden of the contamination. PCBs are widespread, having been found in the most remote regions of the globe;[1] yet, to our knowledge, Canada is currently the only country with a government-mandated PCB health guideline for whole blood and breastmilk.[5]

In theory, there are 209 different PCB isomers, known as congeners, which can be formed with 1 to 10 chlorine atoms on a biphenyl molecule.[6] Commercial PCB mixtures, like the Aroclor™s, are composed of a mixture of congeners. Aroclor™ mixtures were used predominantly in North America as coolants and lubricants in electrical transformers, insulators, and other electrical equipment until their ban in the late 1970s.[6] The Aroclor™ mixtures are named by a four-digit number; the first two numbers representing the number of carbon atoms and the last two numbers representing the percent of chlorine by weight. PCBs, as Aroclor™ mixtures, enter the environment through routes, such as leakage (e.g., transformers), industrial discharges or accidental spills.[6]

A Health Canada PCB guideline of 50µg/L, measured as Aroclor™ 1260, is set for human milk while a range has been established for whole blood (Table I). The Health Canada guidelines are based on the toxicological evaluation of non-human primates with exposure to commercial Aroclors™ in combination with human toxicity exposure data from the 1968 Yusho PCB exposure in Japan.[7] In this paper, we determine whether the guideline for whole blood set by Health Canada in 1978 needs to be revised given changes in the tissue type analyzed, improvements in analytical methods and the changing congener profiles of PCBs in the environment.

It should be noted that we do not address lipid adjustment of PCB data as this issue is beyond the scope of this paper.

METHODS

Refereed journals with articles relating to PCB studies conducted on Canadians were acquired through database searches. Journal indexes such as PubMed, Scholarsportal, ProQuest and Ovid were used to locate studies that occurred in the 11-year period from January 1995 to October 2006, inclusive. Several studies from Health Canada were obtained in order to assess how PCBs were reported within the government and which biological tissues were measured.[9-11] The attached appendix presents the research databases and the search strings used to retrieve the articles for this report. Articles were retrieved based on titles and kept subject to inclusion criteria, which included exposure or epidemiological studies of Canadians occurring between January 1995 and October 2006. If articles met the inclusion criteria, they were used regardless of how PCB data were presented.

RESULTS

The analysis of PCB levels within Canada has changed drastically since they were initially investigated; there is a growing trend towards congener-specific analysis and reporting. Table II outlines 36 Canadian PCB studies published from 1995 to 2006 and tissues analyzed, as well as the method of reporting the contaminant load. All of these PCB studies, except for 3, report congener abundance; 18 studies report Aroclor™ levels and 34 studies individual congeners or the sum of congeners. It is important to note that in all but one study, the PCB analyses were conducted on a congener basis and not as an Aroclor™ analysis. The studies that conveyed results as Aroclor™ equivalency either required human fluid conversions to whole blood and/or Aroclor™ equivalency estimation from congener analysis results. For example, the Health Canada studies required conversion of blood serum to whole blood, while other studies estimated Aroclor™ content by the summation of PCB congeners 138 and 153 and multiplying by a predetermined factor (e.g. refs. 1, 12-16).

TABLE I

Health Canada Guidelines for PCB (Aroclor™ 1260) in Whole Blood[8]

Gender and Age Category	Normal Level (ppb*)	Concern Level (ppb)	Action Level (ppb)
Children (under 18 years)	Below 5	5 or above	20 or above
Pregnant and lactating women	Below 5	5 or above	5 or above
Adult women (18-45 years)	Below 5	5 or above	100 or above
Adult women (46 and above)	Below 20	20 or above	100 or above
Adult men (over 18 years)	Below 20	20 or above	100 or above

* ppb = part per billion = µg/L

It is clear from these human PCB studies that congener reporting is preferred over Aroclor™ reporting and that blood plasma is preferred over other human tissues.

Despite the fact that PCBs are persistent in the environment, congener profiles will ultimately change from the parent commercial mixture. The primary environmental mechanisms for alteration are degradation and re-compartmentalization.[17] It is likely that peak environmental loading for PCBs occurred during the 1950-1970s, and therefore the current human exposure patterns are likely to be different than the parent mixtures from that era. The loss of certain congeners (and/or analyzing for an Aroclor™ mixture different than the exposure source) makes it possible to report that a specific Aroclor™ mixture is undetectable in an organism even when other congeners are present. For example, in a game bird study where Aroclor™ 1260 and individual congeners were reported; the Aroclor™ 1260 results indicated 76% detection (n=100), yet congener analysis yielded 84% detection.[18] Similarly, in a cord blood plasma study (n=135), it was found that 89.6% of participants were reported as having detectable concentrations of PCBs as Aroclor 1260, while congener 153 was detected in 91.9% of cord blood plasma samples.[12] These examples clearly illustrate the chance of false non-detection of PCBs if Aroclor™ reporting is used alone, and as one author notes,[19] Aroclor™ analysis yields higher total PCB values than congener-specific analysis and provides limited information regarding the content of the PCB mixture.

Canadian studies continue to report PCB results as Aroclor™ equivalencies for several reasons. First, the results can be directly compared to the Health Canada guidelines. Second, the results can be used for historical comparisons. Finally, if human exposure to a known Aroclor™ mixture such as Aroclor™ 1260 is certain, then reporting as such is suitable (as done in Tsuji et al.[15]). Congener analysis using gas chromatography/mass spectroscopy yields advantages such as greater analytical sensitivity and lower detection and quantitation limits, but comes at a higher price per sample than gas chromatography analysis. The advantages of congener analysis are particularly important for ultra trace detection of persistent organic pollutants such as the PCBs which may exist at low levels in biota. Congener analysis also allows for the determination of the composition of weathered and degraded PCB mixtures whereas Aroclor™ analysis impedes this process. In addition, toxicity data such as toxic equivalency (TEQ) is congener-specific, and therefore measurement on an Aroclor™ basis may not represent valid toxicity results.[9]

DISCUSSION

On a national and international scale, health agencies have proposed tolerance guidelines for acceptable daily intake limits for PCBs in varying foodstuffs; most notably, this occurred in Canada for salmon.[44] Though food intake guidelines exist in other countries, only Canada currently has human tissue guidelines for PCBs. Implementing guidelines in the absence of adequate data can lead to under- or overprotective guidelines and legislation. The guidelines set by Health Canada are prescribed in order to provide an early warning signal that PCB body burdens have reached a level of concern. A false sense of security may arise from the knowledge that levels are in an acceptable limit set by the government.

While most epidemiology studies use the sum of congeners or individual congeners for cause and effect relationships, some studies do use Aroclor as well.[3] However, it is important to note that even if contamination is known to be from an Aroclor source, the chlorination process during PCB manufacturing results in varying congener profiles for different batches of the

TABLE II

Canadian Human PCB Studies

Author	Tissue or Fluid Measured						Reported As		
	Whole Blood	Tissue	Milk	Misc. Fluid	Serum	Plasma	Aroclor™	Σ PCB	PCB Congeners
Epidemiological Studies									
Saint-Amour et al., 2006[20]						x			x
Dallaire et al.,2004[21]						x		x	x
McCready et al., 2003[3]		x*					x		x
Demers et al., 2002[22]						x		x†	x
Pereg et al., 2002[23]		x‡				x			x
Wolfcott et al., 2001[13]		x*					x		x
Aronson et al., 2000[24]		x*					x		x
Demers et al., 2000[25]						x			x
Dewailly et al., 2000[26]			x					x	x
Lebel et al., 1998[27]						x	x	x	x
Exposure Studies									
Ayotte et al., 2005[28]						x		x	x
Jarrell et al., 2005[29]				x§	x			x	x
Tsuji et al., 2005[14]						x	x		x
Tsuji et al., 2005[15]						x	x		
Van Oostdam et al., 2004[1]						x	x	x	x
Ayotte et al., 2003[30]			x			x			x
Walker et al., 2003[12]						x	x	x	x
Cole et al., 2002[31]						x	x	x	x
Dallaire et al.,2002[32]						x		x	x
Nadon et al., 2002[33]						x	x		x
Sandau et al., 2002[34]						x	x	x	x
Younglai et al, 2002[4]				x||	x				x
Health Canada, 2001[9]					x		x		x
Health Canada, 2001[10]					x		x		x
Health Canada, 2001[11]					x		x		x
Muckle et al., 2001[35]						x		x	x
Muckle et al., 2001[36]			x			x	x	x	x
Longnecker et al., 2000[37]						x		x	x
Sandau et al., 2000[38]	x							x	x
Kearney et al., 1999[39]						x	x	x	
Newsome et al., 1999[40]			x					x	x
Muckle et al., 1998[41]						x	x		
Ayotte et al., 1997[42]						x		x	x
Ryan et al., 1997[19]						x		x	x ¶
Dewailly et al., 1996[16]			x				x		x
Newsome et al., 1995[43]			x					x	x

* Adipose tissue
† Σ PCB expressed in TEQ
‡ Placental tissue
§ Amniotic fluid
|| Follicular and seminal fluid
¶ Grouped sums

Appendix

Research Databases and Search Strings for Articles Used

Research Database and Search String	Search Results	Articles Retrieved	Articles Used
PubMed			
PCB AND Canad*	444	39	19
Polychlorinated AND Canad*	765	18	12
Scholars Portal			
PCB AND Canad*	579	7	1
Polychlorinated AND Canad*	406	1	0
ProQuest			
PCB AND Canad*	87	3	1
Polychlorinated AND Canad*	90	2	0
Ovid			
PCB AND Canad$	211	2	0
Polychlorinated AND Canad$	263	0	0

same commercial mixture.[45] Furthermore, Health Canada's guideline is set for Aroclor™ 1260; however, PCB contamination is not limited to one commercial mixture. Many Aroclor™ mixtures such as Aroclor™ 1254 and Aroclor™ 1242 were also used in North America and have differing congener profiles compared to that of Aroclor™ 1260. Additionally, degradation and re-compartmentalization of PCBs released into the environment have caused congener profiles to change, thus making the reporting of Aroclor™ alone misleading. Analysts have long abandoned whole blood as the biological matrix of choice and almost all exposure investigations of PCB contamination in Canada are now performed by congener analysis.

While progress has been made in the last three decades in an attempt to better understand PCB-induced human health effects, data gaps still exist and cloud the human health issue with uncertainty. A notable effort was put forth by Health Canada to create PCB guidelines; however, the guidelines were based on limited toxicological data. It is time to either incorporate the medical and analytical advances made thus far and revise Health Canada's PCB guidelines for whole blood or remove the guidelines altogether.

REFERENCES

1. Van Oostdam JC, Dewailly E, Gilman A, Hansen JC, Odland JO, Chashchin V, et al. Circumpolar maternal blood contaminant survey, 1994-1997 organochlorine compounds. *Sci Total Environ* 2004;330:55-70.
2. Schecter A, Ryan JJ, Päpke O. Decrease in levels and body burden of dioxins, dibenzofurans, PCBs, DDE, and HCB in blood and milk in a mother nursing twins over a thirty-eight month period. *Chemosphere* 1998;37:9-12.

3. McCready D, Aronson KJ, Chu W, Fan W, Vesprini D, Narod SA, et al. Breast tissue organochlorine levels and metabolic genotypes in relation to breast cancer risk Canada. *Cancer Causes and Control* 2004;15:399-418.
4. Younglai EV, Foster WG, Hughes EG, Trim K, Jarrell JF. Levels of environmental contaminants in human follicular fluid, serum, and seminal plasma of couples undergoing in vitro fertilization. *Arch Environ Contam Toxicol* 2002;43:121-26.
5. AMAP. AMAP Assessment Report: Artic Pollution Issues. *Artic Monitoring and Assessment Program (AMAP)*. Oslo, Norway, xii+859pp.
6. Position Paper of the American Council on Science and Health: Public Health Concerns about Environmental Polychlorinated Biphenyls (PCBs). *Ecotoxicology and Environmental Safety* 1997;38:71-84.
7. Health Protection Branch. Information Letter, Polychlorinated Biphenyls, Department of National Health and Welfare - Committee Report, March 31, 1978.
8. Health Canada. The Health and Environment Handbook for Health Professionals: Health and the Environment. Ottawa: Health Canada, 1998.
9. Health Canada. Assessment of PCBs among 17 Fort Albany First Nation Community Members. First Nations and Inuit Health Branch, August 2001.
10. Health Canada. Assessment of PCBs among 18 Moose Factory First Nation Community Members. First Nations and Inuit Health Branch, August 2001.
11. Health Canada. Assessment of PCBs among 21 Cochrane First Nation Community Members. First Nations and Inuit Health Branch, August 2001.
12. Walker JB, Seddon L, McMullen E, Houseman J, Tofflemire K, Corriveau A, et al. Organochlorine levels in maternal and umbilical cord blood plasma in Arctic Canada. *Sci Total Environ* 2003;302:27-52.
13. Woolcott CG, Aronson KJ, Hanna WM, SenGupta SK, McCready DR, Sterns EE, et al. Organochlorines and breast cancer risk by receptor status, tumor size, and grade (Canada). *Cancer Causes and Control* 2001;12:395-404.
14. Tsuji LJ, Wainman BC, Martin ID, Weber JP, Sutherland C, Elliott JR, et al. The Mid-Canada Radar Line and First Nations' People of the James Bay region, Canada: An evaluation using log-linear contingency modeling to analyze organochlorine frequency data. *J Environmental Monitoring* 2005;7:1-12.
15. Tsuji LJ, Wainman BC, Weber JP, Sutherland C, Katapatuk B, Nieboer E. Protecting the health of First Nation personnel at contaminated sites: A case study of mid-Canada Radar Line Site 050 in Northern Canada. *Arctic* 2005;58(3):233-40.
16. Dewailly E, Ayotte P, Laliberte, C, Weber JP, Nantel AJ. Polychlorinated biphenyl (PCB) and dichlorodiphenyl dichloroethylene (DDE) concentrations in the breast milk of women in Quebec. *Am J Public Health* 1996;86(9):1241-46.
17. Martin M, Richardson JB, Lam KP. Harmonisation of polychlorinated biphenyl (PCB) analyses for ecotoxicological interpretations of southeast Asian environmental media: What's the problem? *Marine Pollution Bull* 2003;46:159-70.
18. Fort Albany First Nation and Weenusk First Nations, Final Report. Mid Canada Radar Line and Contaminants Project (HQ0600227), May 2006.
19. Ryan JJ, Dewailly E, Gilman A, Laliberte C, Ayotte P, Rodrigue J. Dioxin-like compounds in fishing people from the Lower North Shore of the St. Lawrence River, Quebec, Canada. *Arch Environ Health* 1997;52(4):309-16.
20. Saint-Amour D, Roy MS, Bastien C, Ayotte P, Dewailly E, Despres C, et al. Alterations of visual evoked potentials in preschool Inuit children exposed to methylmercury and polychlorinated biphenyls from a marine diet. *Neurotoxicology* 2006;27(4):567-78.
21. Dallaire F, Dewailly E, Muckle G, Vézina C, Jacobson SW, Jacobson JL, et al. Acute infections and environmental exposure to organochlorines in Inuit infants from Nunavik. *Environ Health Perspect* 2004;112(14):1359-64.
22. Demers A, Ayotte P, Brisson J, Dodin S, Robert J, Dewailly E. Plasma concentrations of polychlorinated biphenyls and the risk of breast cancer: A congener-specific analysis. *Am J Epidemiol* 2002;155(7):629-35.
23. Pereg D, Dewailly E, Poirier GG, Ayotte P. Environmental exposure to polychlorinated biphenyl and placental CYP1A1 activity in Inuit women from Northern Quebec. *Environ Health Perspect* 2002;110(6):607-12.
24. Aronson KJ, Miller AB, Woolcott CG, Sterns EE, McCready DR, Lickley LA, et al. Breast adipose tissue concentrations of polychlorinated biphenyls and other organochlorines and breast cancer risk. *Cancer Epidemiol Biomarkers Prevent* 2000;9(1):55-63.
25. Demers A, Ayotte P, Brisson J, Dodin S, Robert J, Dewailly E. Risk and aggressiveness of breast cancer in relation to plasma organochlorine concentrations. *Cancer Epidemiol Biomarkers & Prevent* 2000;9:161-66.
26. Dewailly E, Ayotte P, Bruneau S, Gingras S, Belles-Isles M, Roy R. Susceptibility to infections and immune status in Inuit exposed to organochlorines. *Environ Health Perspect* 2000;108(3):205-11.
27. Lebel G, Dodin S, Ayotte P, Marcoux S, Ferron L, Dewailly E. Organochlorine exposure and the risk of endometriosis. *Fertility and Sterility* 1998;69(2):221-28.
28. Ayotte P, Dewailly E, Lambert GH, Perkins SL, Poon R, Feeley M, et al. Biomarker measurements in a coastal fish-eating population environmentally exposed to organochlorines. *Environ Health Perspect* 2005;113(10):1318-24.
29. Jarrell J, Chan S, Hauser R, Hu H. Longitudinal assessment of PCBs and chlorinated pesticides in pregnant women from Western Canada. *Environ Health* 2005;4:10.
30. Ayotte P, Muckle G, Jacobson JL, Jacobson SW, Dewailly E. Assessment of pre- and postnatal exposure to polychlorinated biphenyls: Lessons from the Inuit Cohort Study. *Environ Health Perspect* 2003;111(9):1253-58.
31. Cole DC, Sheeshka J, Murkin EJ, Kearney J, Scott F, Ferron LA, Webber JP. Dietary intakes and plasma organochlorine contaminant levels among Great Lakes fish eaters. *Arch Environ Health* 2002;57(5):496-509.
32. Dallaire F, Dewailly E, Laliberté C, Muckle G, Ayotte P. Temporal trends of organochlorine concentrations in umbilical cord blood of newborns from the Lower North Shore of the St. Lawrence River (Quebec, Canada). *Environ Health Perspect* 2002;110(8):835-38.
33. Nadon S, Kosatsky T, Przybysz R. Contaminant exposure among women of childbearing age who eat St. Lawrence River sport fish. *Arch Environ Health* 2002;57(5):473-81.
34. Sandau CD, Ayotte P, Dewailly E, Duffe J, Norstrom RJ. Pentachlorophenol and hydroxylated polychlorinated biphenyl metabolites in umbilical cord plasma of neonates from coastal populations in Quebec. *Environ Health Perspect* 2002;110(4):411-17.
35. Muckle G, Ayotte P, Dewailly E, Jacobson SW, Joseph JL. Determinants of polychlorinated biphenyls and methylmercury exposure in Inuit women of childbearing age. *Environ Health Perspect* 2001;109(9):957-63.
36. Muckle G, Ayotte P, Dewailly E, Jacobson SW, Jacobson JL. Prenatal exposure of the Northern Quebec Inuit infants to environmental contaminants. *Environ Health Perspect* 2001;109(12):1291-99.

...continues

RÉSUMÉ

Contexte : Dans cet article, nous cherchons à déterminer s'il y a lieu de mettre à jour les lignes directrices de Santé Canada sur les biphényles polycholorés (BPC) dans le sang entier, étant donné que l'on utilise d'habitude le plasma plutôt que le sang entier à des fins d'analyse, qu'il y a eu des progrès techniques dans les méthodes d'analyse, et que le profil des congénères de BPC dans l'environnement continue d'évoluer en raison de la dégradation et de la reconfiguration des BPC.

Méthode : Nous avons examiné les études épidémiologiques et d'exposition réalisées au Canada au cours des 11 dernières années afin de déterminer la méthode de déclaration la plus utilisée pour les BPC, ainsi que les tissus et liquides organiques humains analysés.

Résultats : Dans toutes les études sauf une, l'analyse portait sur des congénères de BPC. Lorsqu'un équivalent Aroclor[MD] était indiqué, le résultat avait été calculé à l'aide d'une équation d'estimation des Aroclor[MD] fondée sur plusieurs congénères de BPC. On semble encore utiliser des tissus et liquides organiques très divers pour ce type d'analyses, mais une seule étude portait sur le sang entier (le produit dont il est question dans les lignes directrices de Santé Canada). De plus, le profil des congénères dans l'environnement évolue en raison de la dégradation et de la reconfiguration des BPC, ce dont les lignes directrices devraient tenir compte.

Conclusion : L'analyse des concentrations de BPC dans le sang entier est une pratique rare au Canada, et la détection des BPC uniquement sous forme de mélange d'Aroclor[MD] risque de produire des résultats faussement négatifs; or, les lignes directrices de Santé Canada sont fondées sur les concentrations d'Aroclor[MD] 1260 dans le sang entier. L'analyse des congénères de BPC par chromatographie en phase gazeuse et spectroscopie de masse donne des résultats plus précis, avec une sensibilité plus grande et une limite de détection plus faible, que la chromatographie gazeuse utilisée seule. De plus, il est possible d'estimer l'équivalence Aroclor[MD] à partir des résultats d'analyse de congénères. Aucun autre pays n'a encore publié de lignes directrices pour la détection des BPC dans les liquides ou tissus humains, sans doute en raison de l'incertitude associée à l'évaluation du risque des BPC pour la santé. Sur la base de ces résultats, il faudrait revoir les lignes directrices sur la détection des BPC dans le sang entier en fonction des progrès de la science médicale.

37. Longnecker M, Ryan JJ, Gladen BC, Schecter AJ. Correlations among human plasma levels of dioxin-like compounds and polychlorinated biphenyls (PCBs) and implications for epidemiologic studies. *Arch Environ Health* 2000;55(3):195-200.
38. Sandau CD, Ayotte P, Dewailly E, Duffe J, Norstrom RJ. Analysis of hydroxylated metabolites of PCBs (OH-PCBs) and other chlorinated phenolic compounds in whole blood from Canadian Inuit. *Environ Health Perspect* 2000;108(7):611-16.
39. Kearney JP, Cole DC, Ferron LA, Weber JP. Blood PCB, p,p'-DDE, and mirex levels in Great Lakes fish and waterfowl consumers in two Ontario communities. *Environ Res* 1999;80(2 Pt 2):S138-S149.
40. Newsome WH, Ryan JJ. Toxaphene and other chlorinated compounds in human milk from northern and southern Canada: A comparison. *Chemosphere* 1999;39(3):519-26.
41. Muckle G, Dewailly E, Ayotte P. Prenatal exposure of Canadian children to polychlorinated biphenyls and mercury. *Can J Public Health* 1998;89(Supp.1):S20-S25.
42. Ayotte P, Dewailly E, Ryan JJ, Bruneau S, Lebel G. PCB and dioxin-like compounds in plasma of adult Inuit living in Nunavik (Arctic Quebec). *Chemosphere* 1997;34(5-7):1459-68.
43. Newsome WH, Darvies D, Dourcet J. PCB and organochlorine pesticides in Canadian human milk – 1992. *Chemosphere* 1995;30(11):2143-53.
44. Health Canada. Q's & A's on PCBs in salmon and food safety. 2004. Available online at: http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2004/2004_pcb-bpcbk1_e.html (Accessed January 15, 2006).
45. Frame GM, Cochran JW, Boewadt SS. Complete PCB congener distributions for 17 Aroclor mixtures determined by 3 HRGC systems optimized for comprehensive, quantitative, congener-specific analysis. *J High Resolution Chromatography* 1996;19:657-68.

Received: April 20, 2006
Accepted: November 27, 2006

Coming Events / Activités à venir

To be assured of publication in the next issue, announcements should be received by **September 30, 2007** and valid as of **October 31, 2007.** Announcements received after **September 30, 2007** will be inserted as time and space permit.
Pour être publiés dans le prochain numéro, les avis doivent parvenir à la rédaction avant le **30 septembre 2007** et être valables à compter du **31 octobre 2007.** Les avis reçus après le **30 septembre 2007** seront insérés si le temps et l'espace le permettent**.**

First Canadian Roundtable on Public Health and Ethics: Exploring the Foundations
La Première table ronde canadienne sur l'éthique en santé publique : explorons les bases
8-9 November/novembre 2007 Montréal, QC
Contact/contacter : info@ethics-ethique.ca
www.ethics-ethique.ca

Forum 11
Equitable Access: Research Challenges for Health in Developing Countries
29 October-2 November 2007 Beijing, China
Global Forum for Health Research
The annual Forum brings together decision-makers, funders and leaders in research and development to focus on reducing the massive underinvestment in health research for the needs of developing countries.
Contact: www.globalforumhealth.org

Symposium francophone de médecine
Une réalisation de l'Association des médecins de langue française du Canada
Du 31 octobre au 2 novembre 2007
Montréal, QC
Contacter :
Tél : 514-388-2228 ou 1 800 387-2228
www.amlfc.org

Politics, Policy & Public Health
135th Annual Meeting & Exposition of the American Public Health Association
November 3-7, 2007 Washington, DC
Contact: APHA
www.apha.org

14th Canadian Conference on International Health
"Global Change and Health: Who are the Vulnerable?"
Presented by the Canadian Society for International Health and the Canadian Coalition for Global Health Research
4-7 November 2007 Ottawa, ON
Contact: CSIH
conference@csih.org
www.csih.org/en/ccih/index.asp

CALL FOR ABSTRACTS
46th International Making Cities Livable Conference
True Urbanism: Designing the Healthy City
1-5 June 2008 Santa Fe, NM
Co-sponsored by The City of Santa Fe, Santa Fe County & NM Dept. of Transportation
Co-organized with the University of Notre Dame School of Architecture
Send a 250-word abstract to:
Suzanne H. Crowhurst Lennard Ph.D.(Arch.)
Program Committee Chair, IMCL Conferences
PO Box 7586, Carmel, CA 93921
Fax: +1-831-624-5126
E-mail: Suzanne.Lennard@LivableCities.org
www.LivableCities.org
Deadline for abstracts: 31 October 2007

5th World Conference on Breast Cancer
Heart, Soul, & Science: "It's a Small World After All"
4-8 June 2008 Winnipeg, MB
Contact: Tel: 204-480-4588
E-mail: mail@wcbcf.ca
www.wcbcf.ca

CALL FOR ABSTRACTS
18th World Conference on Disaster Management
Resiliency – Individual, Community, Business
The Canadian Centre for Emergency Preparedness
15-18 June 2008 Toronto, ON
Contact: www.wcdm.org
Deadline for abstracts: 2 December 2007

International Nursing Research Conference
Facing the Challenge of Health Care Systems in Transition
29 June-3 July 2008 Jerusalem, Israel
Contact: Diesenhaus Unitours – Convention Department
Tel: 972-3-5651313 Fax: 972-3-5610152
E-mail: meetings@diesenhaus.com
www.d-convention.com/israelnursing

Beyond the Horizon
74th Annual Educational Conference of the Canadian Institute of Public Health Inspectors
20-23 July 2008 St. John's, NL
Contact: www.ciphi.ca/events.htm

29th ICOH, International Congress on Occupational Health / 29e CIST, Congrès International de la Santé au Travail
Occupational Health: A Basic Right at Work – An Asset to Society / Santé au travail : un droit fondamental au travail – un atout à la société
22-27 March/mars 2009
Cape Town, South Africa / Afrique du Sud
Contact:
Congress Secretariat / Secrétariat du Congrès
Tel/Tél : +27(0)21-938-9238/9245/9082/9651
Fax/Téléc : +27(0)21 933 2649
E-mail/Courriel : admin@icoh2009.co.za
www.icoh2009.co.za