

Information provided by WHO on mercury in health care, related WHO activities, resources and risk assessment methodologies

The present document provides information from the World Health Organization on mercury in health care, related WHO activities, resources and risk assessment methodologies, in response to the request of the open-ended working group to prepare for the Intergovernmental Negotiating Committee on mercury.

I. WHO information on current uses of mercury in health care

A. Blood pressure measuring devices

1. Historically, blood pressure measurements have been conducted through the use of mercury column sphygmomanometers, which are both accurate and affordable. Many such devices are still in use in many parts of the world. Due to the toxicity of mercury, the potential breakage of mercury sphygmomanometers represents a significant hazard for users and/or health care personal and for the environment in general.
2. WHO recommends that, in light of the toxicity of mercury, mercury blood pressure measuring devices be gradually phased out in favour of affordable, validated, professional electronic devices as these become available.
3. WHO, through its Department of Chronic Diseases Prevention and Management, has explored and encouraged since 2002, in collaboration with relevant professional associations and industry, the development of an accurate and affordable mercury-free automated blood pressure measuring device suitable for low resource settings. An affordable solar-powered digital sphygmomanometer has recently been field tested and validated, following international protocols.
4. In certain low resource settings it may be difficult to replace all mercury devices with electronic devices within a short time frame. In addition, a long-term strategy for the safe disposal and recycling of mercury-containing blood pressure measuring devices is required.
5. WHO recommends that mercury sphygmomanometers be retained for calibration purposes in designated laboratories.

Information resources

6. Affordable technology: Blood pressure measuring devices for low resource settings (2005), WHO (<http://whqlibdoc.who.int/publications/2005/9241592648.pdf>)

This document is the report of a WHO expert meeting on accurate and affordable blood pressure measuring devices for office/clinic use in low resource settings that took place on 3 December 2003 in Geneva, Switzerland. It summarizes discussions, recommendations and technical specifications for a blood pressure measuring device for office/clinic use in low resource settings that were developed during the meeting.

7. "Recommendations for blood pressure measuring devices for office/clinic use in low resource settings." Parati G, Mendis S, Abegunde D, Asmar R, Mieke S, Murray A, Shengelia B, Steenvoorden G, Van Montfrans G, O'Brien E. Blood Press Monit. 2005 Feb;10(1):3-10 (http://www.dableducational.org/pdfs/spring05/BP_devices_for_low_resource_settings_BPMonit_Mar_2005.pdf)

This paper, which summarizes the conclusions of a WHO Expert meeting, proposes indications for the development of technical specifications for an accurate and affordable blood pressure measuring device for office/clinic use in low resource settings.

B. Thermometers

8. Mercury thermometers have been used for many years in health care and domestically, principally as "fever thermometers". Breakage of these thermometers and improper mercury waste management has resulted in significant human exposure of patients, health care workers, and individuals, and contributed to the global mercury release in the environment. Some countries have restricted the use of mercury thermometers or have banned them except on prescription.

9. WHO recommends the use of mercury-free thermometers in health-care and domestic settings. Affordable alternatives are available. Note that some alternatives require consumables. Proper disposal of mercury-containing thermometers must be ensured. (http://www.who.int/water_sanitation_health/medicalwaste/mercury/en/index.html) (<http://www.who.int/phe/news/Mercury-flyer.pdf>)

C. Dental amalgams

10. Dental amalgam is commonly used in dental restorative care. Its normal composition is 45-55% mercury, approximately 30% silver and other metals such as copper, tin and zinc. Amalgam restorations are durable, cost-effective and generally considered safe for the patient, although adverse biological reactions to the materials do occasionally occur. A potential health risk to oral health personnel from mercury exposure exists if working conditions are not adequate. Mercury used in dentistry may contaminate the environment during inappropriate use and via the disposal of waste products from dental clinics in the absence of appropriate collection and recycling technology. Mercury can also be released to the atmosphere during cremation. A few high-income countries have introduced a ban on use of dental amalgam as alternative mercury-free tooth restorative materials became available and accessible. As alternatives to dental amalgam become available their potential health and environmental impacts also need to be assessed.

11. Oral health is integral and essential to general health, and oral health is a determinant factor for quality of life. Access to affordable dental restorative materials is imperative for poor and disadvantaged populations. This is a particular challenge in low and middle-income countries. The WHO Global Oral Health Programme has been active for many years in the review and evaluation of the use and safety of dental amalgam. In 1997, a WHO Consultation on Dental Amalgams and Alternative Direct Restorative Materials unanimously approved a Consensus Statement on Dental Amalgam stating that there was no direct filling material that had the wide indications for use, ease of handling and good physical properties of dental amalgam. A subsequent update of WHO advice on the use of dental amalgam for restoration in 2009 (WHO Consultation on the Future Use of Materials for Dental Restoration - Scope and Purpose; see below) indicated that high quality alternatives have become available on the market in some high-income countries. In the vast majority of low- and middle-income countries, the use of dental amalgam remains, however, the only appropriate material for dental fillings or build-up material as the alternative materials are far too expensive. In addition, additional efforts are required to further reduce: i) occupational mercury exposure of dental personnel, and ii) environmental mercury contamination due to dentistry.

12. A WHO Meeting on the Future Use of Materials for Dental Restoration took place in Geneva on 16-17 November 2009. The objective of this consultation was to assess the scientific evidence available on the use of dental restorative material alternatives to dental amalgam, and the public health implications of using alternatives to amalgam in dental restorative care. WHO is currently preparing the report of this meeting, which will become available in the first half of 2010.

Information resources

13. Consensus Statement on Dental Amalgam, (1997), WHO.

This Consensus Statement summarizes the outcome of a WHO Consultation on Dental Amalgam and Alternative Direct Restorative Materials that took place in Geneva on 3-7 March 1997, and was unanimously approved by all participants. The statement highlighted that amalgam restorations were durable and cost effective and that there was no direct filling material that had the wide indications for use, ease of handling and good physical properties of dental amalgam. Components of amalgam and other dental restorative materials may, in rare instances, cause local side-effects or allergic

reactions. The small amount of mercury released from amalgam restorations, especially during placement and removal, had not been shown to cause any other adverse health effects. The statement further indicated that a potential health risk to oral health personnel from mercury exposure existed if working conditions were not adequate. Mercury used in dentistry may contaminate the environment during inappropriate use and via the disposal of waste products from dental clinics in the absence of appropriate collection and recycling technology. The statement concluded that the restorative materials then available as alternatives to dental amalgam significantly increased the cost of dental care.

14. WHO Consultation on the Future Use of Materials for Dental Restoration - Scope and Purpose (2009), WHO.

This document describes the scope and purpose of a WHO Consultation on the Future Use of Materials for Dental Restoration that took place in Geneva on 16-17 November 2009, and provides an update of WHO's policy on the use of dental amalgam for restoration. It highlights that the objective of the consultation is to assess the scientific evidence available on the use of dental restorative materials alternative to dental amalgam, and the public health implications of using alternatives to amalgam in dental restorative care. The report of this WHO Consultation will become available in the first half of 2010.

15. Oral health: action plan for promotion and integrated disease prevention (2007), Resolution WHA60.17, 60th World Health Assembly (http://apps.who.int/gb/ebwha/pdf_files/WHA60/A60_16-en.pdf)

This resolution, adopted by the 60th World Health Assembly, describes an action plan for promotion and integration of oral health into health prevention programmes.

D. Vaccine preservative

16. Thiomersal (sodium ethylmercurythiosalicylate), which contains 49.6% ethyl mercury, has been used as a vaccine preservative since the 1930s. It is used to prevent bacterial and fungal growth in some vaccines during storage, and especially during use of opened multi-dose vials. Thiomersal is also used by some manufacturers to inactivate bacterial cultures used in vaccine production, and to maintain sterile production lines. Some antivenom and antisera preparations also contain thiomersal. As ethylmercury does not accumulate and is actively excreted via the gut, the health risk from this exposure is low.

17. Concerns were raised in 1999 about the cumulative amount of mercury in infant immunization schedules. WHO's Department of Immunization, Vaccines and Biologicals established in 1999 the Global Advisory Committee on Vaccine Safety. The Committee's mandate is to enable WHO to respond promptly, efficiently, and with scientific rigour to vaccine safety issues. The Global Advisory Committee on Vaccine Safety (GACVS) first assessed the safety of thiomersal use in vaccines at a special meeting in August 2000. The Committee review has been ongoing since then, taking into account new evidence, including any epidemiological data that might emerge from ongoing studies.

18. The current position of the Committee is that there is no evidence of toxicity to infants, children or adults exposed to thiomersal (containing ethyl mercury) in vaccines. In addition, there is no reason on grounds of safety to change current immunization practices with thiomersal-containing vaccines, as the risks are unproven.

19. National pharmacopoeias require preservative for multidose package vaccines, except for live vaccines. There are a limited number of preservatives used in vaccine formulations and a selection is done on the basis of not affecting vaccine efficacy. Vaccines could be supplied in preservative-free single-dose vials, but this option requires a significant increase in manufacturers' filling capacity. Vaccines supplied in single dose vials are more expensive than a dose of vaccine from a multidose vial. In addition, single-dose vials require significantly larger cold storage space as well as increased transport needs, which is currently not feasible for the majority of countries.

20. Furthermore, vaccines developed and used in pandemic or epidemic situations will continue to have to be supplied as multidose preparations because single filling takes valuable time, i.e. release of vaccines to the market is delayed, and it imposes logistical problems.

Information resources

21. Statement on thiomersal from the Global Advisory Committee on Vaccine Safety (2006), WHO (http://www.who.int/vaccine_safety/topics/thiomersal/statement_jul2006/en/index.html)

This statement describes the position of the Global Advisory Committee on Vaccine Safety (GACVS) with regards to the use of thiomersal as preservative in some vaccines. The GACVS is a scientific advisory body established by WHO to provide a reliable and independent scientific assessment of vaccine safety issues in order to respond promptly, efficiently and with scientific rigour to such issues.

22. Thiomersal and vaccines: questions and answers (2006) WHO (http://www.who.int/vaccine_safety/topics/thiomersal/questions/en/index.html)

This document provides answers to some questions related to thiomersal and vaccines. It provides information on issues such as current uses of thiomersal in vaccines, typical thiomersal concentrations per vaccine dose, and challenges in formulating and licensing thiomersal-free vaccines. It highlights that, for vaccines used in multi-dose formulations, thiomersal offers better protection from contamination than other preservatives, while not affecting vaccine efficacy.

23. Weekly epidemiological records describing meeting outcomes of the Global Advisory Committee on Vaccine Safety (GACVS) (<http://www.who.int/wer/2008/wer8332.pdf>) (<http://www.who.int/wer/2005/wer8028.pdf>) (<http://www.who.int/wer/2005/wer8001.pdf>)

These weekly epidemiological records describe outcomes of meetings of the Global Advisory Committee on Vaccine Safety (GACVS) that took place in Geneva, Switzerland on 2-3 December 2004, on 9-10 June 2005, and on 18-19 June 2008. These meetings addressed different issues related to the use of thiomersal in vaccines.

24. Guidelines on regulatory expectations related to the elimination, reduction or replacement of thiomersal in vaccines (2004), WHO. ([http://www.who.int/entity/biologicals/publications/trs/areas/vaccines/thiomersal/Annex%20%20\(95-102\)TRS926thiomersal.pdf](http://www.who.int/entity/biologicals/publications/trs/areas/vaccines/thiomersal/Annex%20%20(95-102)TRS926thiomersal.pdf))

This guidance document discusses the general principles of evaluating a vaccine following the elimination, reduction, removal or replacement of thiomersal from an already licensed vaccine. Particular attention is given to the regulatory expectations for each of the above possibilities. It is not within the scope of these guidelines to discuss the policy of using or not using thiomersal, nor to discuss the effectiveness of reducing levels of thiomersal, or using a new preservative, in preventing microbial contamination.

25. Thiomersal in vaccines: A regulatory perspective (2002), WHO. (http://www.who.int/biologicals/publications/meetings/areas/vaccines/thiomersal/Thiomersal_WHO_Consult%20April%2015_16_April2002.pdf)

This document is the report of a WHO consultation that took place in Geneva, Switzerland, on 15-16 April 2002. The objective of the Consultation was to review, in a global forum, the experience of eliminating, reducing and/or replacing thiomersal in vaccines and to discuss the potential impact of these changes on the quality, safety and efficacy of vaccines. The review involved National Regulatory Authorities (NRAs) and vaccine manufacturers from developing and industrialized countries and the focus was on vaccines already licensed with thiomersal.

II. Cross-cutting WHO activities in relation to mercury

E. Mercury in Health Care

26. Mercury in Health Care: Policy Paper (2005), WHO.
http://www.who.int/water_sanitation_health/medicalwaste/mercury/en/index.html

WHO follows a holistic approach with regards to the use of mercury in health care. This policy paper describes WHO's position and recommendations, and presents a strategy based on short, medium and long-term steps to achieve the gradual substitution of mercury-based medical devices. This document is also available in Spanish, French and Arabic.

French: http://www.who.int/entity/water_sanitation_health/medicalwaste/mercureorientstrat.pdf

Spanish: http://www.who.int/entity/water_sanitation_health/medicalwaste/mercurio_es.pdf

Arabic: http://www.who.int/entity/water_sanitation_health/medicalwaste/mercury_ar.pdf

27. Mercury-Free Health Care - An Initiative to Substitute mercury-based medical Devices around the World. <http://www.mercuryfreehealthcare.org>

WHO co-leads, together with Health Care Without Harm (HCWH), the "Mercury-Free Health Care" initiative. It is a global initiative to achieve virtual elimination of mercury-based thermometers and sphygmomanometers and their substitution with accurate, economically viable alternatives. This initiative is a component of the UNEP's Mercury Products Partnership, which is led by the US Environmental Protection Agency. Relevant resources and reports of global, regional and local events and activities conducted under the auspices of this initiative are available on the Mercury-Free Health Care website.

28. "Demonstrating and Promoting Best Techniques and Practices for Reducing Health Care Waste to Avoid Environmental Releases of Dioxins and Mercury" Project <http://www.noharm.org/seasia/issues/waste/gef.php>

This Global Environmental Facility (GEF) funded initiative is being implemented by Health Care Without Harm together with WHO and UNDP. The project's overall objective is to reduce environmental releases of dioxins and mercury by promoting best techniques and practices for reducing and managing health care waste. This initiative has been developed primarily under the GEF mandate to assist developing countries in meeting the objectives of the Stockholm Convention on Persistent Organic Pollutants. Relevant resource material and reports of events and activities that took place at a global, regional or local level are available on the initiative website.

29. "Greening the health sector" initiative.

As part of a broader effort for "greening" the health sector, WHO is working, in collaboration with professional and nongovernmental organizations, on the development of information material and guidance documents on good practice for the health sector, including with regards to mercury use and management in health-care. A number of capacity building activities have taken place in a number of countries and more are planned..

III. Additional resources, technical information and guidelines

F. Health aspects, including risk assessment

30. Exposure to Mercury: A major public health concern (2007), WHO
<http://www.who.int/phe/news/Mercury-flyer.pdf>

This information note provides a summary of WHO's position, guidance and recommendations with regards to the assessment and management of health risk from mercury. It describes sources of mercury releases and human exposure, health effects, WHO guidance values, and WHO recommendations.

31. Concise International Chemical Assessment Document (CICAD) 50: Elemental mercury and inorganic mercury compounds: Human health aspects (2003), WHO/IPCS (<http://www.who.int/ipcs/publications/cicad/en/cicad50.pdf>)

This document provides an international review on the effects on human health and the environment of elemental mercury and inorganic mercury compounds. It characterizes the hazard and dose-response of exposure to mercury and provides examples of exposure estimation and risk characterisations for application at the national or local level.

32. Inorganic Mercury. Environmental Health Criteria Monograph (EHC) 118 (1997) WHO/IPCS (<http://www.inchem.org/documents/ehc/ehc/ehc118.htm>)

This monograph on inorganic mercury is designed for scientists and administrators responsible for the establishment of safety standards and regulations. It provides comprehensive data and basic scientific risk evaluation on inorganic mercury from scientific sources. This document is based on a comprehensive search of available original publications, scientific literature and reviews and examine: the physical and chemical properties and analytical methods; sources of environmental and industrial exposure and environmental transport, chemobiokinetics and metabolism including absorption, distribution, transformation and elimination; short and long term effects on animals (carcinogenicity, mutagenicity, and teratogenicity); and finally, an evaluation of risks for human health and the effects on the environment.

33. Mercury and Mercury Compounds. Summary and Evaluation, volume 58. (1993), International Agency for Research on Cancer, WHO (<http://www.inchem.org/documents/iarc/vol58/mono58-3.html>)

This monograph provides a critical review of data on carcinogenicity for mercury and mercury compounds. Data has been evaluated in terms of human risk with the help of international working groups of experts in chemical carcinogenesis and related fields.

34. Evaluation of certain food additives and contaminants (Sixty-first report of the Joint FAO/WHO Expert Committee on Food Additives) (2004), WHO Technical Report Series, No. 922. (http://whqlibdoc.who.int/trs/WHO_TRS_922.pdf)

This report gives a concise description of the toxicological and epidemiological evaluation and the derivation of a Provisional Tolerable Weekly Intake (PTWI) for methyl mercury. Dietary exposure assessments are also described.

35. Evaluation of certain food additives and contaminants (Sixty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives) (2007), [WHO Technical Report Series, No. 940](#). (http://whqlibdoc.who.int/trs/WHO_TRS_940_eng.pdf)

This report gives further consideration to the sensitivity of sub-populations to methyl mercury, and in consequence the applicability of the PTWI to different parts of the population.

36. Summary report of the seventy-second meeting of Joint FAO/WHO Expert Committee on Food Additives (JECFA) (2010) (<http://www.who.int/ipcs/food/jecfa/summaries/en/index.html>)

This document summarizes in brief the derivation of a PTWI for inorganic mercury.

37. Health risks of heavy metals from long-range transboundary air pollution (2007), WHO Regional Office for Europe. (<http://www.euro.who.int/document/e91044.pdf>)

This report, based on contributions from an international group of experts, reviews the available information on the sources, chemical properties and spatial distribution of environmental pollution with cadmium, lead and mercury caused by long-range transboundary air pollution, and evaluates the potential health risks in Europe.

G. Health risk management

38. Drinking Water Quality Guidelines 3rd Edition, Chapter 8: Chemical aspects (2006), WHO (http://www.who.int/water_sanitation_health/dwq/GDW8rev1and2.pdf)

WHO Guidelines for Drinking-water Quality are used by developing and developed countries worldwide as the basis for regulation and standard setting to ensure the safety of drinking-water. The third edition of the Guidelines includes a description of a “Framework for Drinking-water Safety” and discusses the roles and responsibilities of different stakeholders, including the complementary roles of national regulators, suppliers, communities and independent “surveillance” agencies. Chapter 8 specifically addresses chemical aspects, including mercury.

39. Air quality guidelines for Europe, 2nd edition - Chapter 6.9: Mercury (2000) WHO (http://www.euro.who.int/document/aiq/6_9mercury.pdf)

These guidelines provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or wellbeing. These guidelines are intended to provide background information and guidance to (inter)national and local authorities in making risk assessment and risk management decisions. In establishing pollutant levels below which exposure – for life or for a given period of time – does not constitute a significant public health risk, the guidelines provide a basis for setting standards or limit values for air pollutants. Chapter 6.9 specifically addresses mercury.

40. International Chemical Safety Cards (ICSCs) 0056, 0978, 0979, 0980, 0981, 0982 and 0984: Various mercury compounds, WHO/IPCS (<http://inchemsearch.ccohs.ca/inchem/jsp/search/search.jsp?serverSpec=bette.ccohs.ca%3A9920&SubColl=ICSC&inchemcasreg=0&QueryText=mercury>)

These cards summarize essential health and safety information on a number of mercury containing chemical substances in a clear way. They are intended to be used at the "shop floor" level by workers, but also by other interested parties in places of work.

41. Mercury - Assessing the environmental burden of disease at national and local levels. Environmental Disease Burden Series No. 16. (2008), WHO. (http://whqlibdoc.who.int/publications/2008/9789241596572_eng.pdf)

This document presents methods for assessing the environmental burden of disease of mercury at national and local levels. Disease burden estimates provide an indication to policy-makers of the health gains that could be achieved by targeted action and enable to prioritize actions and direct them to the population groups at highest risk. The method used is based on the general framework for global assessments described in the World Health Report 2002. This guide takes a practical, step-by-step approach and use numerical examples. The methods described can be adapted both to local and national levels, and can be tailored to suit data availability.

42. Guidance for Estimating Exposure to Mercury to Identify Populations at Risk (2008), UNEP and WHO (<http://www.who.int/foodsafety/publications/chem/mercury/en/>)

This guidance document, prepared jointly by WHO and UNEP, is intended to assist countries concerned about the potential national impacts of mercury pollution to identify specific populations

or subpopulations that may be at risk. It aims to provide guidance on estimating exposures to mercury through biomonitoring as well as exposures to methylmercury using data on dietary fish intake. It gives an overview of mercury toxicity, exposure pathways, health and environmental impacts, as well as available reference levels. It also provides an overview of assessments of mercury exposures for some specific exposure scenarios, including hot spots exposures. It can be used as reference for conducting research or investigations regarding mercury exposure.

43. WHO Guidelines for Assessing Quality of Herbal Medicines with Reference to Contaminants and Residues (2007), WHO (<http://apps.who.int/medicinedocs/en/m/abstract/Js14878e/>)

Herbal and traditional medicines, which are widely used around the world, can be contaminated by mercury as a result of inadequate production or processing. WHO, in line with World Health Assembly resolution on traditional medicine (WHA56.31), recommends that the safety, efficacy and quality of these products be ensured, including with regards to possible mercury contamination. These guidelines present general consideration on potentially hazardous contaminants and residues in herbal medicines, including mercury. It also provides guiding principles for assessing quality of herbal medicines and recommends analytical methods for qualitative and quantitative determination of major contaminants and residues, including mercury.

44. Mercury and children's health - Training Module of the WHO Training Package for the Health Sector (2008), WHO (<http://www.who.int/ceh/capacity/Mercury.pdf>)

This training module is meant to be used to train paediatricians, family doctors, nurses, primary health care workers and other health care personal on the health risk faced by children and adolescents from mercury exposure. This material aims at enabling health and other professionals dealing with children and adolescents' health to recognize, prevent, assess and manage diseases linked to, or triggered by mercury exposure.

45. Workshop Report and Plan of Action to Address Environmental Health Impacts from Metal Exposure - Inter Regional Workshop on Environmental Health Impacts from Exposure to Metals, Simla, India (2005). New Delhi, World Health Organization Regional Office for South -East Asia. (http://www.searo.who.int/EN/Section23/Section1001/Section1110_11588.htm)

This document is a report of a three-day deliberation held amongst 50 participants from 12 countries at an interregional and intersectoral workshop on heavy metals, including mercury, that took place in Simla, India in 2005. The objectives of the workshop were to: i) sensitize health professionals and policy-makers in South Asia on the public health dimensions of environmental and human health impacts of various metals; ii) To present regional case studies of human health exposure to metals in specific settings, iii) to present success stories in terms of reducing and preventing human exposure to metals, and iv) To identify a framework to develop and implement national and regional action plans for public health interventions and collaboration, addressing human exposure to metals. This report includes a Plan of Action to Address Environmental Health Impacts from Metal Exposure.

H. Risk assessment methodologies

46. Principles for the Assessment of Risks to Human Health from Exposure to Chemicals, Environmental Health Criteria 210 (1999), WHO (<http://www.inchem.org/documents/ehc/ehc/ehc210.htm>)

This Environmental Health Criteria monograph is aimed at furnishing a practical overview of chemical safety and at providing the framework of risk assessment for regulatory and research scientists, as well as risk managers. It is intended to assist in the interpretation of risk assessments on specific chemicals and to assist in characterizing risk in specific situations. It is not intended as a textbook on toxicology.

47. Human Exposure Assessment, Environmental Health Criteria 214 (2000), WHO (<http://www.inchem.org/documents/ehc/ehc/ehc214.htm>)

This monograph presents in one publication the concepts, rationale, and statistical and procedural methodologies for human exposure assessment. It presents the methodologies for surveying exposures, analyzing data and integrating findings with the ongoing national and global debate defining natural limits to human behaviour. This monograph is intended for the community of scientific investigators enquiring about the human health consequences of contaminants in the environment and for those professions involved in devising, evaluating and implementing policy with respect to managing the quality of environmental health.

48. Elemental Speciation in Human Health Risk Assessment, Environmental Health Criteria 234 (2006), WHO (<http://www.who.int/entity/ipcs/publications/ehc/ehc234.pdf>)

The purpose of this document is to assess, evaluate, and give guidance on the role of elemental speciation and speciation analysis in hazard and risk assessment, rather than to present a review of each element and its speciation. This document is directed at risk assessors and regulators to emphasize the importance of consideration of speciation in their deliberations.

49. Principles for Modelling Dose-Response for the Risk Assessment of Chemicals, Environmental Health Criteria 239, International Programme on Chemical Safety (2009), WHO (http://whqlibdoc.who.int/publications/2009/9789241572392_eng.pdf)

This EHC provides descriptive guidance for risk assessors in using dose-response modelling in hazard characterization. It also provides mathematical modellers with an appreciation of issues to be considered when modelling in the context of the risk assessment process. Risk managers will be able to obtain a general understanding of the applications and limitations of dose-response modelling.

50. Principles and Methods for the Risk Assessment of Chemicals in Food, Environmental Health Criteria 240, International Programme on Chemical Safety (2010), WHO (in print) (<http://www.who.int/ipcs/food/principles/en/index.html>)

This EHC provides a detailed guidance for risk assessors on the assessment of human health impact of chemicals, to which main exposure is through food (and drinking water). This extended and updated guidance document builds on the previous Environmental Health Criteria documents 70 and 104, taking new scientific knowledge into account. Large sections are covering the hazard assessment process, dietary exposure assessment, chemical characterization and analytical methods, and risk characterization. The purpose of this monograph is 2-fold: 1) to provide descriptive guidance for JECFA and JMPR to ensure the continuation of transparent and sound expert evaluations of scientific data for risk assessments of chemicals in food; and 2) to be informative for users of the outputs from JECFA and JMPR, such as risk managers and other risk assessment bodies.

51. WHO Human Health Risk Assessment Toolkit: Chemical Hazards (in preparation), WHO

The purpose of this toolkit is to provide its users with guidance to identify, acquire and use the information needed to assess chemical hazards, exposures and the corresponding health risks in their given health risk assessment contexts at local and/or national level. This toolkit provides road maps for conducting human health risk assessment, identifies information that must be gathered to complete an assessment, and provides electronic links to international resources from which the user can obtain information and methods essential for human health risk assessment. The toolkit has been developed for public health and environmental professionals, regulators, industrial managers, and other decision-makers with, at least, some training in the principles of risk assessment who are: (i) responsible for conducting human health risk assessments; and (ii) making decisions on whether to take action to manage human risks of chemicals.

52. Additional resources and guidance material on risk assessment methodologies (<http://www.inchem.org>)

IPCS INCHEM is a website produced and maintained through cooperation between the International Programme on Chemical Safety (IPCS) and the Canadian Centre for Occupational Health and Safety (CCOHS). It provides rapid access to internationally peer reviewed information on chemicals commonly used throughout the world, which may also occur as contaminants in the environment and food.