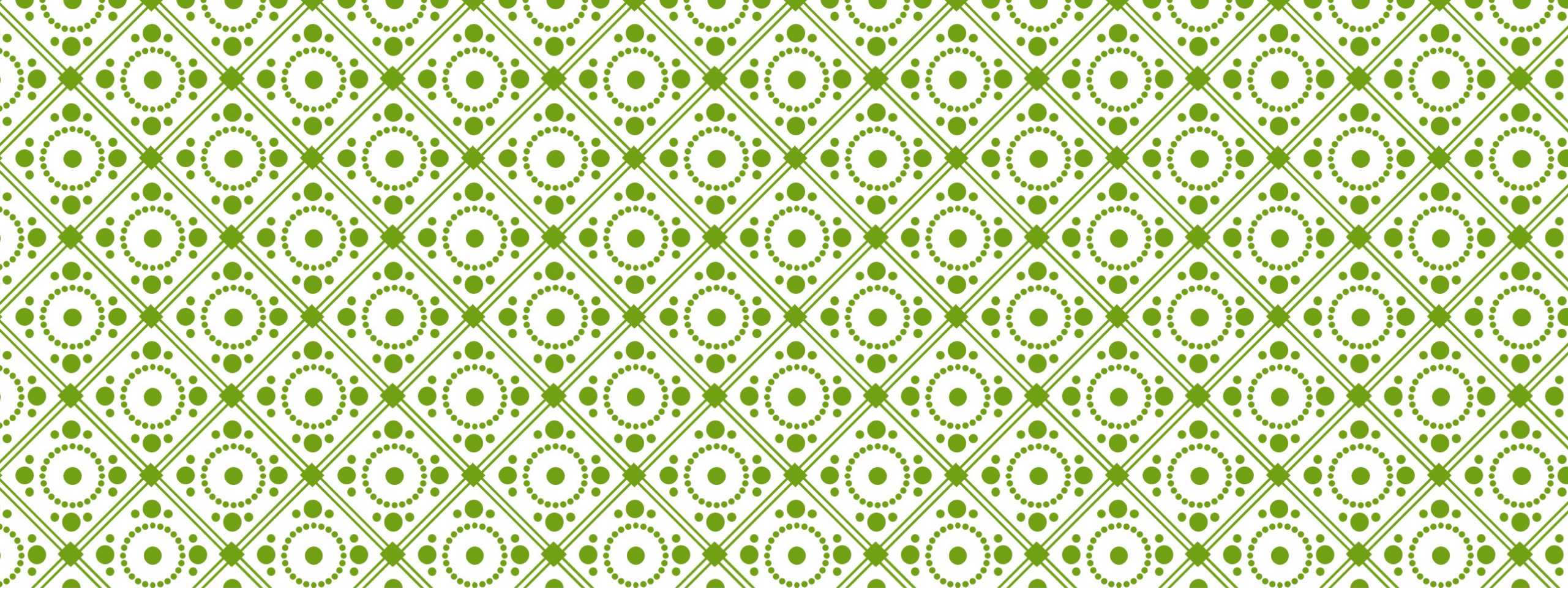




MERCURY AND HEALTH

Engr. Ana Trinidad F. Rivera, MSc

Director IV

Center for Cosmetic Regulation and Research

Food and Drug Administration

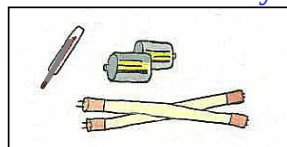
Philippines

WHAT IS 'MERCURY' ?

Mercury has been widely used in our life. Mercury is roughly divided into three chemical forms: metallic mercury, inorganic mercury, and organic mercury (R-Hg⁺). Methylmercury (MeHg) is considered to be an exclusive organic mercury generated in the natural environment. The three chemical forms are inter-converted in the natural environment.



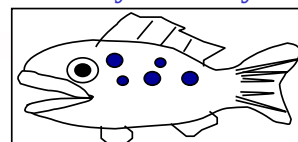
Metallic mercury



Metallic mercury is liquid, and easy to vaporize. It has been used for clinical equipment and fluorescent lamps, etc. It is also used in artisanal small-scale gold mining operation.



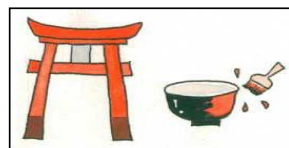
Methylmercury



Methylmercury is naturally generated from inorganic mercury by certain bacteria in the water environment, and accumulates in fish and mammals through the food web.



Inorganic mercury



Inorganic mercury includes mercuric oxide, mercuric sulfide, etc. Mercuric sulfide had been used as a pigment cinnabar and as a germicide since ancient times.



WHAT IS MERCURY?

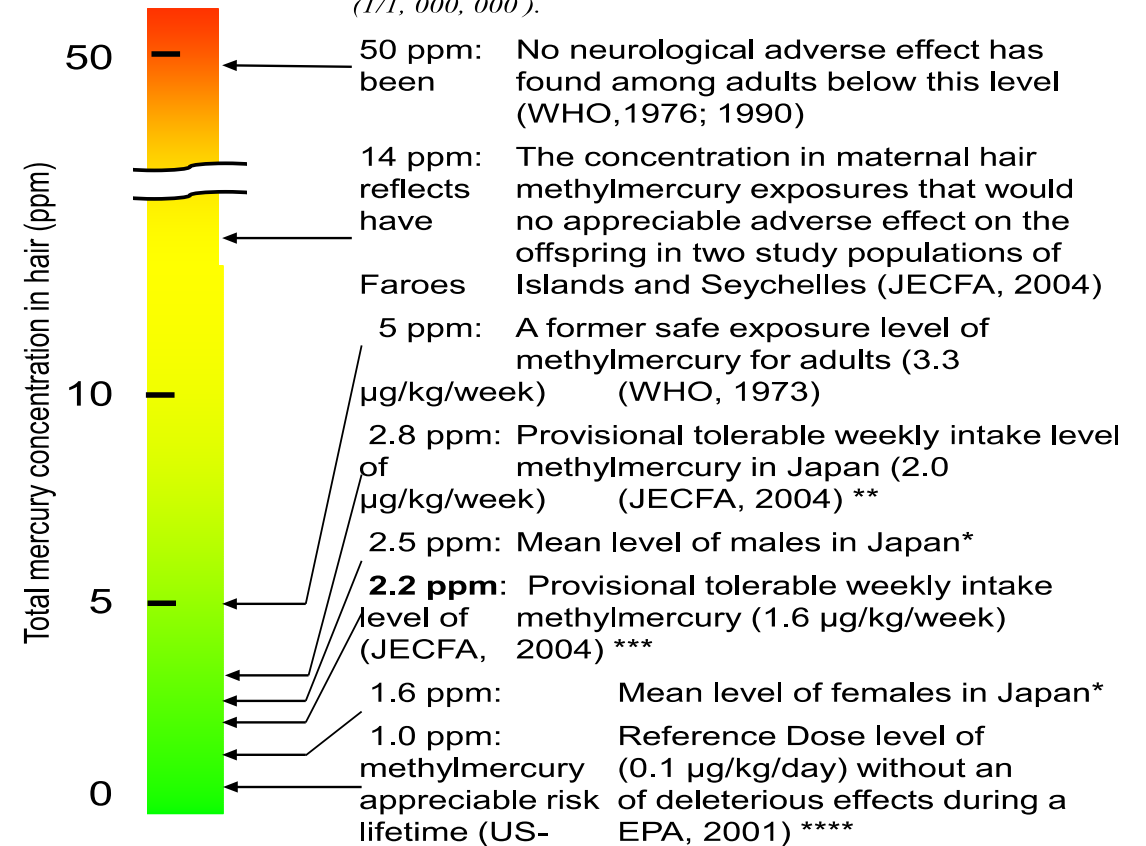
Mercury is a naturally occurring metal. When released into the environment, it can be toxic.

How mercury gets into the environment:



REFERENCE FOR HAIR MERCURY CONCENTRATION

1 ppm mercury means that 0.001 g mercury is contained in 1,000 g (1/1, 000, 000).



* Multi-site survey in Japan (NIMD, 2000-2004)

** The domestic provisional tolerable weekly intake (PTWI) is 2.0 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) /benchmark dose (BMDL) level, 11 ppm in maternal hair on the fetus development and uncertainty factor 4 (Food Safety Committee of Japan, 2005).

*** The provisional tolerable weekly intake (PTWI) is 1.6 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) /benchmark dose (BMDL) level, 14 ppm in maternal hair on the fetus development and uncertainty factor 6.4 (JECFA, 2004).

**** The Reference Dose (RfD) is 0.1 µg/kg body weight/day, and was derived from benchmark dose (BMDL) level, 46-79 ppb in maternal blood and uncertainty factor 10 (NRC, 2000, US-EPA, 2001)

MERCURY EXPOSURE IMPACTS HEALTH

HEALTH EFFECTS

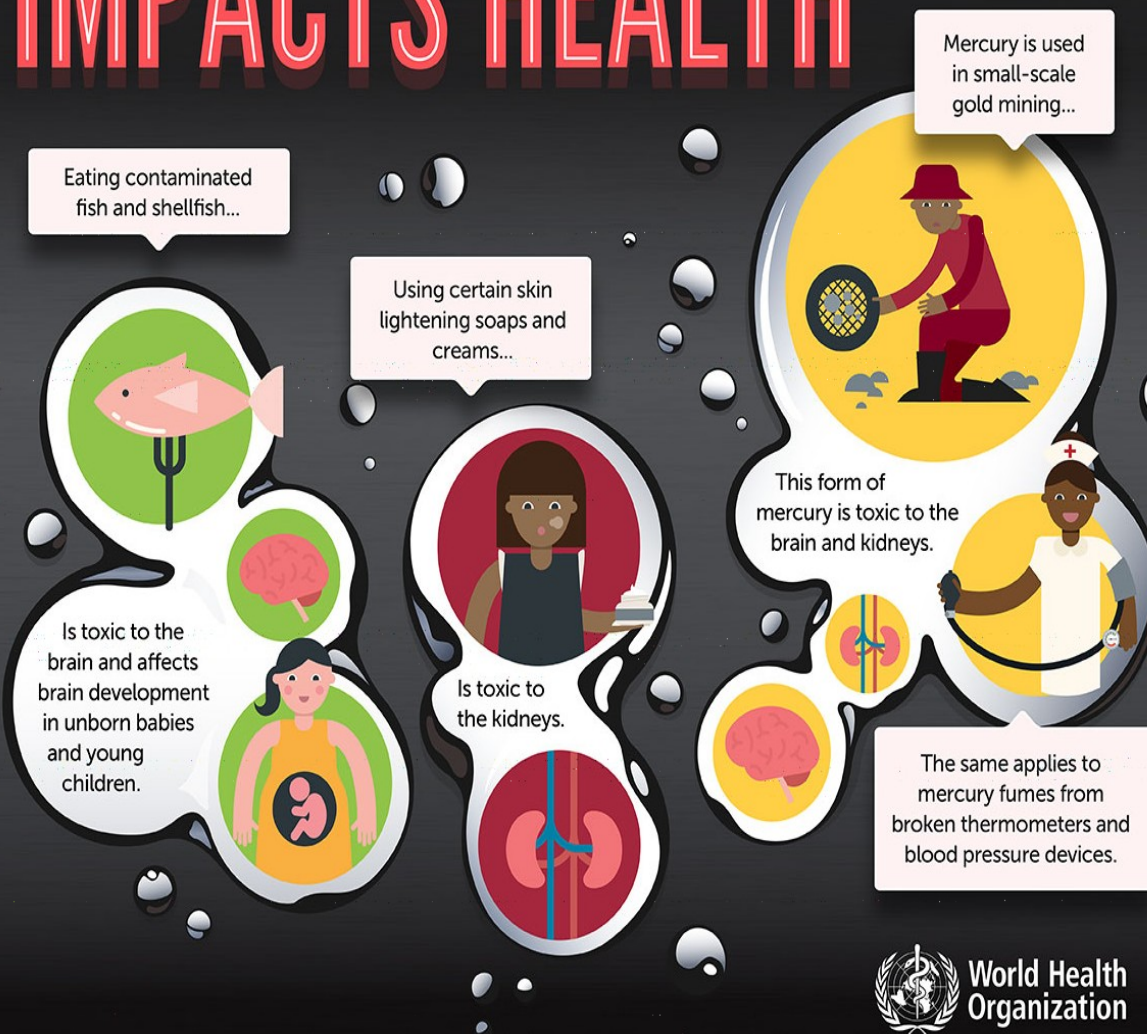


Table 1. The Major Clinical Toxicologic Features of Mercury.*

Variable	Mercury Vapor	Inorganic Divalent Mercury	Methyl Mercury	Ethyl Mercury
Route of exposure	Inhalation	Oral	Oral (from fish consumption)	Parenteral (through vaccines)
Target organ	Central nervous system, peripheral nervous system, kidney	Kidney	Central nervous system	Central nervous system, kidney
Local clinical signs				
Lungs	Bronchial irritation, pneumonitis (>1000 µg/m³ of air)			
Gastrointestinal tract	Metallic taste, stomatitis, gingivitis, increased salivation (>1000 µg/m³ of air)	Metallic taste, stomatitis, gastroenteritis		
Skin		Urticaria, vesication		
Systemic clinical signs				
Kidney	Proteinuria (>500 µg/m³ of air)	Proteinuria, tubular necrosis		Tubular necrosis
Peripheral nervous system	Peripheral neuropathy (>500 µg/m³ of air)	Acrodynia		Acrodynia
Central nervous system	Erethism (>500 µg/m³ of air), tremor		Paresthesia, ataxia, visual and hearing loss (>200 µg/liter of blood)	Paresthesia, ataxia, visual and hearing loss
Approximate half-life (whole body) (days)	60	40	70	20†
Treatment‡	Meso-2,3-dimercaptosuccinic acid	Meso-2,3-dimercaptosuccinic acid	Chelators not effective§	Chelators not effective§

Minamata Disease is a disorder of the CNS. Various signs and symptoms include sensory disturbance in the distal portions of four extremities, ataxia, concentric contraction of the visual field, etc. At the end of March 2001, 2,955 MD patients have been certified, of which 2,265 patients have been located on Yatsushiro Sea coast.

Mercury and children's environmental health

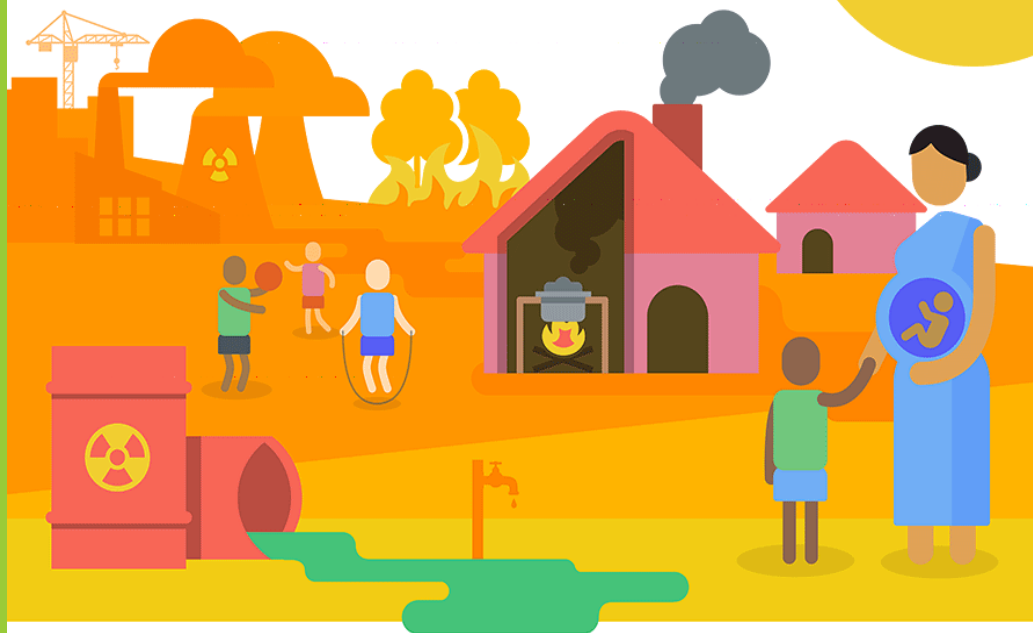
- ▲ Mental retardation
- ▲ Ataxia' & cerebral palsy
- ▲ Seizures
- ▲ Vision & hearing loss
- ▲ Delayed developmental milestones
- ▲ Language disorders
- ▲ Deficits in fine motor function
- ▲ Visual, spatial disabilities
- ▲ Memory problems
- ▲ High blood pressure, low cardiac rate variability

DOSE

HG AND ITS EFFECT ON VULNER GROUPS

PROTECTING CHILDREN FROM THE ENVIRONMENT

Environmental exposures start in the womb, and can have effects throughout life.



World Health Organization

Children, including adolescents, are exposed to a variety of hazards from the environments in which they live, learn and play.

8 months					
Sits alone steadily	Begins to take solid foods	Turns head when called by name, makes eye contact	Explores objects by biting or holding	Enjoys friendly handling	
4 months					
Holds head steadily	Sucks and swallows liquid	Turns head toward sound	Gazes slowly at moving objects	Smiles and lifts arms to greet caregiver	

Ensure the best possible start in your child's life. Monitor your child's development

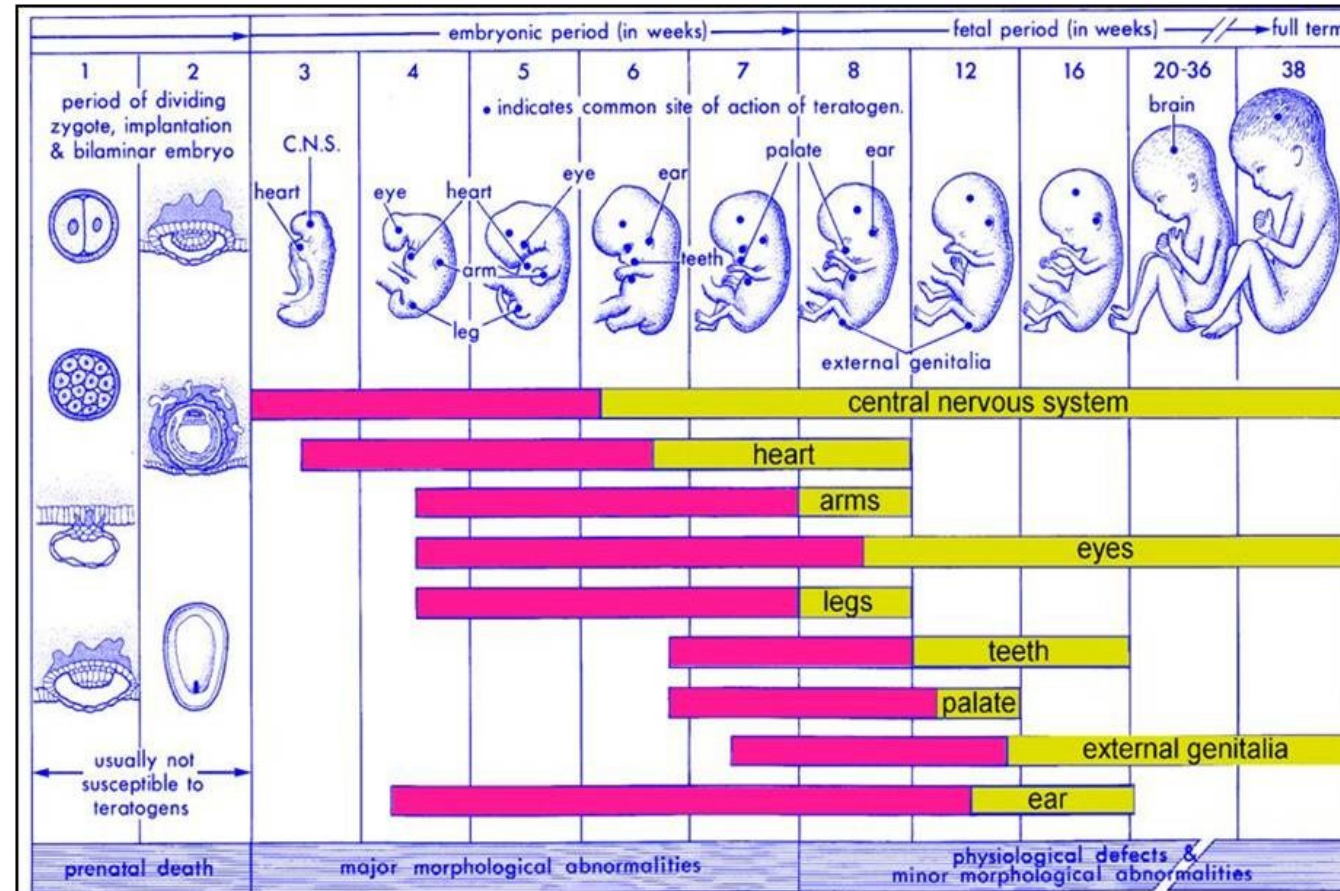
Any child with an identified problem should immediately see the health worker or visit the health center nearest you.

Source: ECCD Checklist, DSWD, 2005

Core Developmental Milestones of Filipino Children

	MOTOR	SELF-HELP	LANGUAGE	COGNITIVE	SOCIO-EMOTIONAL
60 months 5 years	 Throws ball overhead with direction	 Bathes unassisted	 Recounts recent experiences in order of occurrence using past tense	 Matches upper and lower case letters	 Uses cultural gestures or greeting without prompts (e.g. mano, bless, kiss)
48 months 4 years	 Draws a human figure or house	 Uses toilet with occasional accidents	 Asks "WHAT", "WHO", and "WHY" questions	 Arranges objects according to size from smallest to biggest	 Plays organized group games fairly
36 months 3 years	 Runs without tripping	 Pulls down gartered shorts	 Speaks grammatically correct 2-3 word sentence	 Matches objects and pictures	 Imitates adult activities (e.g. cooking, washing)

WINDO OF DEVELOPMENT



Schematic illustration of the sensitive or critical periods in human development. Red denotes highly sensitive periods; yellow indicates stages that are less sensitive to teratogens.

Moore KL. The Developing Human: Clinically Oriented Embryology. Philadelphia: W. B. Saunders Company, 1973.

SYMPTOMS AND SIGNS OF METALLIC Hg EXPOSURE

- ❖ Tremor
- ❖ Ataxia
- ❖ Coordination problems
- ❖ Excessive salivation
- ❖ Metallic taste



Courtesy of Dr Stephen Bossa-O'Reilly (2009)

- **Neurotoxicity**
- **Nephrotoxicity**
- **Teratogenicity: MeHg is a teratogen (Minamata disease)**
- **CVS: elevated risk of heart attack, hypertension**
- **Carcinogenicity: MeHg is a possible human carcinogen**
- **Mutagenesis: Hg seems not to be mutagen**
- **Reproduction: no clear evidence of effect**
- **Immunotoxicity: under scientific discussion**



- ❖ Mothers often asymptomatic!
- ❖ Microcephaly
- ❖ Cerebral palsy/spasticity
- ❖ Mental deficits
- ❖ Malformation of ears, heart, skeleton, eyes

Uncommon syndrome "Pink disease":

- ❖ Pain in the extremities
- ❖ Pinkish discoloration and desquamation
- ❖ Hypertension
- ❖ Sweating
- ❖ Insomnia, irritability, apathy

Considered as idiosyncratic reaction.



Mercury



Courtesy of Professor Muhândah



HEALTH STUDIES ON MERCURY

Integrated Surveillance of the Health and Environmental Impacts of Mercury Exposure in Gold Processing (Maramba, N, et.al, 1988)

- 26% (60/230) of the workers use some form of protective device such as facial cover or masks, boots and gloves
- 47%(106/230) showed gray or focal deposits in the gingiva upon PE
- 16% (36/230) had decreased breath sounds
- 11%(24/230) had thyroid enlargement
- cross-sectional survey revealed that blood mercury levels were elevated in 13 of the workers examined
- Showed statistically significant association of blood mercury levels with the duration of work, eosinophil count and serum glutamic amino transferase



UPDATES

Mercury levels in hair, blood, fish, water, soil/sediment and water samples were analyzed at National Institute for Minamata Disease-Japan.

Samples were collected among 100 residents of the mining community in Mt. Diwalwal, Monkayo, Compostela Valley in collaboration with the regional and local health unit.



SUMMARY OF THE RESULTS ARE AS FOLLOWS:

Five out of 100 residents from Mt. Diwalwal are recommended to undergo further health examination, for possible detoxification.

These residents have blood mercury levels $> 75 \text{ ug/ml}$ (permissible limit: 15 ug/ml).

39 more residents with blood mercury levels $> 15 \text{ ug/ml}$ will also have to be examined.

39/92 (42.39%) persons examined have total hair mercury levels $> \text{NV}$ of 4 ug/g .



Summary of Blood and Hair Total and Methylmercury Levels, Mt. Diwalwal, 2005

	Total mercury	Methyl mercury	% Methyl mercury
Blood (N=100)			
Mean $\pm$ SD	21.44 $\pm$ 27	7.2 $\pm$ 4.61	46.41 $\pm$ 26.23
Range	3.61 – 239.99	1.04 – 24.60	8.54 – 100%
Hair (N=92)			
Mean $\pm$ SD	13.34 $\pm$ 39.92	1.84 $\pm$ 1.12	52.06 $\pm$ 31.02
Range	0.66 – 289.21	0.52- 5.99	1.46 – 100%

MERCURY VAPOR* LEVELS IN BARANGAY PALANAS, CAMARINES NORTE FEBRUARY 25, 2010

Area	(Hg levels), ng/m ³	Remarks
Ambient environment (near the barangay hall, 4:55 pm)	153 - 1262	Outside the barangay hall
Gold Processing Area – House 1	7044 – 28,890	Ballmilling and panning operations
Gold Processing Area – House 1	50,000	Blowtorching area; no activity was prevailing during the monitoring
Gold Processing Area – House 2	429 – 27,200	Ballmilling and panning operations
Threshold Limit Value (TLV)	50 ug/m ³ or 50,000 ng/m ³	Occupational standards were exceeded in the workplace in the blowtorching area
Ambient air monitoring guidelines in residences, USEPA	200 ng/m ³	Levels were exceeded in the households/residences where the monitoring was done.

* Air Monitoring using Lumex Mercury Vapor Analyzer

RESULTS OF THE BLOOD MERCURY MONITORING, PARACALE, CAMARINES NORTE, 2010

Name of Patient	Blood Mercury levels* (ug/L)	Remarks
1. NS	82.7	Elevated, blood Hg level 17 yo, 2mos as small-scale miner
2. RD	51.3	Elevated Hg blood level 53 yo, housewife, residence with SSGM operations
3. VD	39.4	Elevated Hg blood level 51 yo, 20 years-oversee SSGM operation)
4. AA	36.4	Elevated Hg blood level 20 yo, 6 mos as small-scale miner
5. WT	35.9	Elevated Hg blood level 27 yo, 5 mos as small-scale miner
6. MV	23.1	Elevated Hg blood level 25 yo, 1 yr. as small-scale miner
7. AE	19.2	Elevated Hg blood level 16 yo, 2 yrs as small-scale miner
8. EG	18.6	Elevated Hg blood level 34 yo, 10 yrs as small-scale miner
9. PH	5.2	60 yo, 20 years as small-scale miner
10. MD	ND:DL=1	21

HEALTH STUDIES ON MERCURY

Health Impact of Mercury Among Small-scale Gold Miners in Camarines Norte (1991)

- 7 out of 99 (7%) were found to have elevated mercury blood levels
- 4 miners detoxified

Health and Environmental Impact of Mercury Among Schoolchildren in Apokon, Davao del Norte (2000)

- Blood and hair samples from 162 schoolchildren aged 5-17 years were collected and analyzed at the NIMD
- Summary of physical examination results showed that predominant findings include underheight, gingival discoloration, adenopathy, underweight and dermatological abnormalities among children examined

HEALTH STUDIES ON MERCURY

- Mercury as a health hazard due to gold mining and Mineral processing activities in Mindanao/Philippines (UNIDO, 2001)
 - Clinical symptoms among those examined showed that a fair amount of workers from Diwalwal showed severe symptoms that could be very well related to the classical picture of mercury intoxication
- Symptoms include fatigue, tremor, memory problems, restlessness, loss of weight, metallic taste and sleeping disturbances
- Intentional tremor, mainly fine tremor of eye lids, lips and fingers, ataxia, hyperreflexia and sensory disturbances as well as bluish discoloration of the gums
- More than 70% (73 /102) of the occupationally-burdened population suffer from chronic mercury intoxication
- Higher percentage among amalgam smelters (85.4%)
- 1/3 of the non-occupationally burdened is intoxicated

HEALTH AND ENVIRONMENTAL MONITORING

Mercury levels in hair, blood, fish, water, soil/sediment and water samples were analyzed as part of the continuing collaboration with the National Institute for Minamata Disease-Japan.

Samples were collected among 100 residents of the mining community in Mt. Diwalwal, Monkayo, Compostela Valley in collaboration with the Center for Health Development for Southern Mindanao and the local health unit.

Samples were analyzed February-March, 2005

Split sampling analysis with the EOH Collaborating Center

Summary of Blood and Hair Total and Methylmercury Levels, Mt. Diwalwal, 2005

	Total mercury	Methyl mercury	% Methyl mercury
Blood (N=100)			
Mean $\pm$ SD	21.44 $\pm$ 27	7.2 $\pm$ 4.61	46.41 $\pm$ 26.23
Range	3.61 – 239.99	1.04 – 24.60	8.54 – 100%
Hair (N=92)			
Mean $\pm$ SD	13.34 $\pm$ 39.92	1.84 $\pm$ 1.12	52.06 $\pm$ 31.02
Range	0.66 – 289.21	0.52- 5.99	1.46 – 100%

SUMMARY OF THE RESULTS ARE AS FOLLOWS:

The results of the laboratory tests showed that inorganic/elemental mercury is the predominant mercury specie in the blood samples and this is indicative of the environmental and occupational exposure of residents to the small-scale gold mining operations in the area rather than their dietary intake from contaminated fish.

WHAT IS THE MINAMATA CONVENTION?

It is an international agreement that aims to protect people and the environment from mercury.

The health sector is working to:



1. Phase out thermometers and blood pressure devices that contain mercury
2. Promote oral health and reduce dental amalgam use
3. Implement strategies to protect small-scale gold miners and other vulnerable groups
4. Monitor mercury exposure and provide health advice

Everyone can contribute:



Dispose of mercury-containing products safely.



Choose mercury-free products when possible.



World Health Organization

Highlights of operational articles

- Controls on all lifecycle stages of mercury covered by different articles of the Convention
- Controls on supply and on international trade in mercury (Article 3)
- Phase-out and phase-down for mercury use in products and processes (Articles 4, 5 and 6)
- Controls on artisanal and small scale gold mining (Article 7)
- Control measures on air emissions and releases to water (Articles 8 and 9)
- Storage, waste and contaminated sites (Article 10, 11 and 12)