Introduction

What are Dioxins?

- a group of aromatic chlorinated and lipophilic compounds
- potentially highly toxic to humans, as determined by leading international scientific committees
- widespread in the world as a result of industrial chemical processes and uncontrolled burning of waste
- persistent in the environment with low degradation rate
What are substances with dioxin-like activities?

- **PCDDs: Dioxins**
  Polychlorinated dibenzo-para-dioxins

- **PCDFs: Furans**
  Polychlorinated dibenzofurans

- **PCBs: Dioxin-like compounds**
  Polychlorinated biphenyls

Primary sources of dioxins
Chemicals or burning processes

- Old technology incineration
- Spraying of Agent Orange in Vietnam
- Burning of waste
- Fire at PVC plant, Canada
Path of dioxin exposure in humans

- Soil
- Water
- Air

Bioaccumulation in Food Chain

Human body tissue

Health effects of dioxins

- From laboratory animal studies:
  
  *The most sensitive effects are on the reproductive system of male offspring of rats*

- From studies on humans ~ occupational studies and accidents:

  *Increased risk of cancers, disruption of hormonal systems and other health effects*
Virtually every person in the world has some level of dioxins in their bodies, stored in fat.

Dioxin level in breast milk reflects the body load.

Aims

- To provide information on the concentration of dioxins and dioxin-like compounds in breast milk of mothers in Hong Kong.
- To identify factors associated with dioxin levels in humans in Hong Kong.
- To assess and compare levels of dioxins and dioxin like compounds in relation to worldwide data obtained by the 2003 World Health Organization (WHO) survey.
The Hong Kong Study
316 first time mothers recruited from 16 Maternal and
Child Health Centres, Department of Health

Methods of analysis for dioxin levels

1. *Chemical analysis* of pooled samples by Gas
   Chromatography/Mass Spectrometry
   (GC/MS) carried out in WHO reference
   laboratory in Freiburg, Germany.

2. *Bioassay* of individual samples by an
   independent laboratory in Amsterdam, the
   Netherlands
Study findings

Dioxin levels in Hong Kong mothers
Average levels (in 11 pools) by GC/MS

Level of PCDD/Fs of Hong Kong mothers among 26 countries/regions, 2002-03 WHO exposure study
Level of PCBs of Hong Kong mothers among 26 countries/regions, WHO exposure study

Dioxin body load is age dependent -- and increases for every year of mother's age
Guangdong born mothers showed higher dioxin-like activity in the bioassay

Higher seafood consumption was associated with higher dioxin-like activity in mothers older than 30 years.
Human PCDD/F exposure to background contamination

- About 90 to 98% of the average background contamination results from food intake
- About 90% of this intake can come from food of animal origin
  for example consumption habits in Germany:
  - 1/3 from milk and milk products
  - 1/4 from meat and meat products
  - 1/4 from fish
  - 1/20 from eggs
- Highest concentrations at the end of the food chain are in humans

WHO Exposure Study on levels of PCBs, PCDDs and PCDFs in human milk

1st Round 1987-1988  12 countries
2nd Round 1992-1993  19 countries
3rd Round 2002-2003  25 countries + Hong Kong SAR
Objectives of WHO study

- To monitor the overall dioxin exposure of local populations in countries worldwide

Standardised protocol

- At least two pooled (=mixed from 10 individuals) samples per country from expected high- and low-exposure groups
- Mothers should be having their first baby, be healthy, and reside in the area for about 5 years

Advantage of this WHO approach

(+ Cost-effective and useful non-invasive procedure
  - Rough estimate on the exposure with only very few samples
  - It is an alternative to determining the actual dioxin intake by analysing dioxin levels in many food samples

(-) Disadvantage: Lack of information about individuals
Analytical quality control of the WHO study

1. Quality assessment to identify a reference laboratory whose results can be accepted by WHO for exposure assessment studies (State Institute for Chemical and Veterinary Analysis of Food, Freiburg, Germany)

2. Very rigid and comprehensive quality programme during the study guarantees reliability and comparability of the results

Countries participating in the 3rd round of the WHO-coordinated exposure study

25 countries and Hong Kong SAR (100 pooled samples)

- Australia
- Italy
- Belgium
- Luxemburg
- Brazil
- New Zealand
- Bulgaria
- Norway
- Croatia
- Philippines
- Czech Republic
- Romania
- Egypt
- Russia
- Fiji
- Slovak Republic
- Finland
- Spain
- Germany
- Sweden
- Hong Kong SAR
- The Netherlands
- Hungary
- Ukraine
- Ireland
- USA
Median levels of dioxins and PCBs in human milk from different countries

Temporal trend of PCDD/F in human milk
EU strategy for PCDD/F and PCB (2001)

- Reduction of the dioxins in the environment
  **Source-directed measures**

- Reduction of the dioxins in feed and food
  **Measures to improve consumer’s protection**

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**Environmental controls**

- **Elimination of the manufacture and use of persistent organic pollutants**
  “The Dirty Dozen”

<table>
<thead>
<tr>
<th>STOCKHOLM CONVENTION, 2001</th>
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<tbody>
<tr>
<td>Intentional</td>
</tr>
<tr>
<td>Aldrin</td>
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<tr>
<td>Dieldrin</td>
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<tr>
<td>Endrin</td>
</tr>
<tr>
<td>Chlordane</td>
</tr>
<tr>
<td>Heptachlor</td>
</tr>
<tr>
<td>Hexachlorobenzene (HCB)</td>
</tr>
<tr>
<td>Mirex</td>
</tr>
<tr>
<td>Toxaphene</td>
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<tr>
<td>PCBs</td>
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Disposal of PCBs used in industry

Improper disposal of PCBs has been a major cause of contamination of feedstuff in other countries that has led to high levels of dioxins in meat, poultry, eggs and dairy products in several incidents.

General approach to waste management:
- Waste reduction
- Waste re-use
- Waste recycling
Closing down of old technology incinerators

Stockholm Convention, 2001

The old Kennedy Town incinerator is closed

Prohibition of the uncontrolled burning of waste e.g. tyres, asphalt and computer components

Computer parts for burning, China

Illegal Kiln in Wuhan, China, South China Morning Post Nov 2003
Monitoring of dioxins in foodstuff

- As >90% of dioxins in our body are ingested as contaminants in food, it is important to make sure that our food is safe from dioxin contamination.
- The Food and Environmental Hygiene Department performs regular tests for contaminants in different types of food in a comprehensive food monitoring programme.

Safety of Breastfeeding

WHO recommendation 2001

Ideal infant nutrition is exclusive breastfeeding for six months, and then the introduction of safe and appropriate complementary foods with continued breastfeeding for up to two years of age or beyond

Reference: World Health Organization. 54th World Health Assembly 2001
WHO recommendation concerning dioxins and breastfeeding 1998

Breastfeeding should be supported and promoted even though breastfed infants are exposed to higher intakes of dioxins compared to adults


Transfer of mother's dioxins to the infant already happens before birth

Adverse effect of dioxins from mothers are associated with transfer through placenta rather through breast milk
Breast milk has enormous beneficial effects

Benefits to infants, e.g.

- provides perfect infant nutrition
- better brain development
- provide immunity to diseases
- protect from possible harm from environmental chemicals

Conclusions:

- Breastfeeding is regarded as safe in Hong Kong and Mainland China
- Breastfeeding should be promoted and supported
- Enforcing strict regulations for dioxins and PCBs discharge
- Monitoring of dioxins in food
- To provide health protection for the Hong Kong population
Study findings
Dioxin levels among the thirteen pools

<table>
<thead>
<tr>
<th>Pool</th>
<th>Description</th>
<th>PCBs</th>
<th>PCDFs</th>
<th>PCDDs</th>
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</thead>
<tbody>
<tr>
<td>13 Mix</td>
<td>High Dairy/seafood</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>12 Mix</td>
<td>Low Dairy &amp; Seafood</td>
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<tr>
<td>11 OS</td>
<td>1-11 yrs</td>
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<tr>
<td>10 OS</td>
<td>1-10 yrs</td>
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<tr>
<td>9 CI</td>
<td>7 yrs+ in HK</td>
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</tr>
<tr>
<td>8 CI</td>
<td>2-6 yrs in HK</td>
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<td></td>
</tr>
<tr>
<td>7 ML</td>
<td>High Dairy/Seafood</td>
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<tr>
<td>6 ML</td>
<td>Low Dairy &amp; Seafood</td>
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<tr>
<td>5 HK</td>
<td>High Dairy/Seafood</td>
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<tr>
<td>4 HK</td>
<td>Low Dairy &amp; Seafood</td>
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<tr>
<td>3 HK</td>
<td>High Seafood</td>
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<tr>
<td>2 HK</td>
<td>High Dairy</td>
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<tr>
<td>1 HK</td>
<td>Smoking</td>
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0  5  10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  90  95  100
Sum WHO-TEQ (pg/g fat)