Epidemiology and Trends of ARDs
A Global Perspective

Ken Takahashi, MD, PhD, MPH
Professor of Environmental Epidemiology,
Director of WHOCC for Occupational Health,
University of Occupational & Environmental Health, Japan

1st International Conference on
Asbestos Awareness & Management
16-18 Nov 2014, Melbourne
Objective

1st International Conference on Asbestos Awareness & Management
"Working towards an asbestos free Australia"

What is important in the epidemiology and trends of ARDs which may contribute to conference aim?

What is important in the epidemiology and trends of ARDs from a global perspective?
potency of differences with respect to lung cancer or mesothelioma for fibres of various types and dimensions are debated, (but) the fundamental conclusion is that all forms of asbestos are ‘carcinogenic to humans’

NEW!

- Larynx & ovary
- Colorectum, stomach & pharynx
Epidemiology vs. Economy

World Asbestos Production by Type: 1900-2012 Total 200M tons*

By ~1960
- Robust Epi studies (scientific reasons) emerged
- Substitute materials, e.g., fiberglass, increasingly available

80% of Total World Production (>160M tons) was 1960+
Recent Consumption Dominated by Developing Countries & CHR Asbestos

Landmark EPI Studies

1. 1955 Richard Doll *(BJIM)*
   1st epidemiologic study on UK ASB factory workers on LC risk (O/E = 11/0.8)

2. 1960 Wagner JC *(BJIM)*
   33 cases of mesothelioma working/living near S African crocidolite mine

3. 1964 Selikoff *(JAMA)*
   American insulation workers at very high mortality risk for cancer of lung, GI tract and mesothelioma

* Virta, USGS
ARDs vs. Environmental Exposure

Conventional Knowledge

- Primary route of exposure is occupational
- Para-occupational, household and environmental exposure can cause ARDs

In Japan / Korea

- Environmentally induced MM legally compensated ("Relief" Law)
- Epi studies reporting environmentally induced lung cancer
# Usage vs. Asbestos-Specific-JEM

## Developed Countries

<table>
<thead>
<tr>
<th>Remaining (in situ)</th>
<th>Construction Material i.e., Asbestos-Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly Phased Out (Historically Yes)</td>
<td>Anti-friction / Heat Material i.e., Insulation, etc.</td>
</tr>
</tbody>
</table>

## Developing Countries

<table>
<thead>
<tr>
<th>Thriving</th>
<th>Continuing (Variable Degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity of Industries, Occupations &amp; Products Must Be Considered</td>
<td>Roadmap to Ban &amp; Control Measures During Transition</td>
</tr>
</tbody>
</table>

- Early Detection & Compensation
- Late Detection & Compensation
## Countries vs. Asbestos Situations

<table>
<thead>
<tr>
<th>Code</th>
<th>Major Occupations</th>
<th>Sub-major</th>
<th>Minor</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Managers</td>
<td>4</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>Professionals</td>
<td>6</td>
<td>27</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>Technicians and Associate Professionals</td>
<td>5</td>
<td>20</td>
<td>84</td>
</tr>
<tr>
<td>4</td>
<td>Clerical Support Workers</td>
<td>4</td>
<td>8</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>Services and Sales Workers</td>
<td>4</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Skilled Agricultural, Forestry and Fishery Workers</td>
<td>3</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Craft and Related Trades Workers</td>
<td>5</td>
<td>14</td>
<td>66</td>
</tr>
<tr>
<td>8</td>
<td>Plant and Machine Operators and Assemblers</td>
<td>3</td>
<td>14</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>Elementary Occupations</td>
<td>6</td>
<td>11</td>
<td>33</td>
</tr>
<tr>
<td>0</td>
<td>Armed Forces Occupations</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td><strong>10</strong></td>
<td><strong>43</strong></td>
<td><strong>130</strong></td>
</tr>
</tbody>
</table>

(Findings for occupations and industries were similar)

<table>
<thead>
<tr>
<th>Asbestos-related</th>
<th>Korea</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Japan</td>
<td>60</td>
<td>99</td>
</tr>
<tr>
<td>No</td>
<td>35</td>
<td>241</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>95</td>
<td>340</td>
</tr>
</tbody>
</table>

**Percentage agreement** between 2 countries is:

\[
Pr(a) = \frac{60 + 241}{435} = 69.2\%
\]

**Percentage inconsistencies** where

Japan (Y) and Korea (N) = \frac{99}{435} = 22.8%

Korea (Y) and Japan (N) = \frac{35}{435} = 7.6%
Chrysotile vs. Amphiboles

CHR is Carcinogen

Evidence Abundant

No Controversy

Amphibole

Carcinogen

biopersistence Amph>CHR

CHR Contaminated by Amph

Limits with epi Studies?!

Relative Potency

Evidence Inconclusive

Controversy Lingers
## Estimating ARLC Burden from MESO Mortality

(Based on 68 Risk Estimates from 55 Studies)

### Ratio: ARLC-to-MESO to 1

<table>
<thead>
<tr>
<th></th>
<th>Ratio: ARLC-to-MESO to 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CRO</strong></td>
<td>0.7 (0.5 to 1.0) to 1 [n=6 ]</td>
</tr>
<tr>
<td></td>
<td>Except for CRO, ARLC is larger than MESO</td>
</tr>
<tr>
<td></td>
<td>For CRO, MESO risk is high &amp; ARLC is just slightly lower</td>
</tr>
<tr>
<td><strong>CHR</strong></td>
<td>6.1 (3.6 to 10.5) to 1 [n=16]</td>
</tr>
<tr>
<td></td>
<td>For CHR, MESO risk is “due to amph exposure”</td>
</tr>
<tr>
<td></td>
<td>Based Quebec study and relies on bio-persistence theory</td>
</tr>
<tr>
<td><strong>AMO</strong></td>
<td>4.0 (2.8 to 5.9) to 1 [n=4]</td>
</tr>
<tr>
<td><strong>Mixed</strong></td>
<td>1.9 (1.4 to 2.6) to 1 [n=31]</td>
</tr>
</tbody>
</table>

### Notes:

1. Ratios show the low potential of CHR to produce MESO
2. MESO cannot be used (too low, too unstable) to estimate EXP
3. Major effect of CHR is LC (ARLC)
**Lemen vs. McCormack (BJC)**

**Omits Newer Data, Relies on Incomplete a/o Outdated Data**

**Uses Heterogeneous Datasets**
- Not adequately controlled for latency a/o exposure

**None of Raised Concerns Are Substantiated**
- Minimized CHR risk > misinterpretation
- Emphasized:
  - Lung cancer risk by CHR
  - Benefits of smoking cessation for formerly exposed workers

---

**Shortcomings Undermine Conclusions and Recommendations**

*Underestimates CHR Potency!*
### Original vs. Updated Study

**Hodgson & Darnton**

#### Original Study
- **Study Details**
  - Systematic Review (AOH, 2000)
  - Cohort: Textile workers in N. Carolina + Quebec Miners

<table>
<thead>
<tr>
<th>Risk (ratio) for LC</th>
<th>Meso Risk for CHR:AMO:CRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;less clear cut&quot;</td>
<td>1:100:500</td>
</tr>
</tbody>
</table>

#### Updated Study
- **Study Details**
  - Included Loomis study (OEM, 2009)
  - "meso risk by CHR is higher by a factor of 10"

<table>
<thead>
<tr>
<th>Risk (ratio) for LC</th>
<th>Meso Risk for CHR:AMO:CRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;less clear cut&quot;</td>
<td>1:10:50</td>
</tr>
</tbody>
</table>

#### Results
- Significant # revision*
  - "Risk by CHR exposure (N. Carolina textile) is much higher than (Quebec) mines"

* Criticisms emerged for omitting this revision
Chrysotile as Cause of Mesothelioma: Hill’s Criteria*

Global Consensus

Culminated in:
1. IARC Monographs from 1977 onwards

Supported by governmental agencies: EPA, OSHA, CDC, NIOSH, DHHS, PHS and FDA

- CHR per se can induce MESO when TREM or other amph are not detected
- As there is no 100% pure CHR, (arguing) meso carcinogenicity of CHR is academic at best

* Lemen: IJOEH, 2004
“It is prudent & in the public interest to consider all fiber types as having comparable carcinogenic potency in its qualitative assessment of meso risk. Engagement in argument has prevented timely and appropriate health protective actions.

– EPA, 1989

It is prudent & in the interest of developing countries... Argument will only prevent timely and appropriate protective actions!
Developing Countries vs. CHR Asbestos

### Public Health Argument Losing Against Economic Argument
- Middle of high growth
- Own burden not evident
- Failure to learn lessons

### Relative Potency Argument Used to Justify “Controlled Use”
- Lobbied by exporters
- Used by industry
- Believed by administrators

### Reasons

#### Empower Public Health Argument

#### Solutions

#### Demythologize Controlled Use Argument

### Role of Epi

+++
The most efficient way to eliminate ARD is to stop using all types of asbestos (WHO, 2006)

Recently Acknowledged by WHO

Evidence continues to show that national burdens of ARD are directly proportional to national consumption of asbestos
## Global Estimates of Mesothelioma

<table>
<thead>
<tr>
<th>Study</th>
<th>Estimated Deaths</th>
<th>Reported Deaths</th>
<th>DALY</th>
<th>Crude Death Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driscoll* (AJIM, 2005)</td>
<td><strong>43,000</strong> estimated deaths annually (world)</td>
<td></td>
<td><strong>564,000</strong> DALY (World)</td>
<td></td>
</tr>
<tr>
<td>Delgermaa* (Bull WHO, 2011)</td>
<td><strong>92,253</strong> reported deaths in 83 countries, 1994–2008</td>
<td></td>
<td><strong>Crude Death Rate = 6.2 per Million†</strong></td>
<td></td>
</tr>
<tr>
<td>Park* (EHP, 2011)</td>
<td><strong>38,900</strong> estimated deaths in 33 unreported countries, 1994–2008</td>
<td></td>
<td>From Ecological Relation</td>
<td></td>
</tr>
<tr>
<td>Lim (Lancet, 2012)</td>
<td></td>
<td></td>
<td><strong>Meso Mortality Used as Marker of Exposure</strong></td>
<td></td>
</tr>
<tr>
<td>Diandini* (AJIM, 2013)</td>
<td><strong>11,884</strong> reported deaths in 82 countries, 1994–2010</td>
<td></td>
<td><strong>215,000</strong> DALY (Reported Countries)</td>
<td></td>
</tr>
</tbody>
</table>

†Cross Verification

This equates to **38,000 estimated deaths annually** (world). We joined GBD 2014 Team

*Speaker is corresponding author
Our Update: Global Trend of ARDs

Methods*

- Source: WHO Mortality Database, 1994–2010
- Target: Mesothelioma (C45), Asbestosis (J61)
- Countries with total <10 cases or <3 reported years precluded from analysis
- Gender combined; mortality rates are age adjusted to the WHO world population of 2000
- PYLL = potential years of life lost; APYLL = average potential years of life lost

*Bull of WHO (2011); Environ Health Perspect (2011); AJIM (2013); paper in preparation
### Annual N* of Deaths: Mesothelioma

(Persons; 1994–2010)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country [years]</th>
<th>N*</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States [10]</td>
<td>2,448</td>
<td>20.6</td>
</tr>
<tr>
<td>2</td>
<td>United Kingdom [11]</td>
<td>1,827</td>
<td>15.4</td>
</tr>
<tr>
<td>3</td>
<td>Italy [5]</td>
<td>1,282</td>
<td>10.8</td>
</tr>
<tr>
<td>4</td>
<td>Germany [13]</td>
<td>1,133</td>
<td>9.5</td>
</tr>
<tr>
<td>5</td>
<td>France [10]</td>
<td>853</td>
<td>7.2</td>
</tr>
<tr>
<td>6</td>
<td>Japan [16]</td>
<td>849</td>
<td>7.1</td>
</tr>
<tr>
<td>7</td>
<td>Australia [8]</td>
<td>468</td>
<td>3.9</td>
</tr>
<tr>
<td>8</td>
<td>Netherlands [15]</td>
<td>406</td>
<td>3.4</td>
</tr>
<tr>
<td>9</td>
<td>Canada [10]</td>
<td>357</td>
<td>3.0</td>
</tr>
<tr>
<td>10</td>
<td>Spain [12]</td>
<td>294</td>
<td>2.5</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>9,917</td>
<td>83.4</td>
</tr>
<tr>
<td>World Total (61 Countries)</td>
<td></td>
<td>11,897</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Averaged over reported N of years

Other ranks: 20. Finland [15] 75
### Adjusted Mortality Rates*: Mesothelioma

(Person per Million Population; 1994–2010)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country [years]</th>
<th>Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iceland [13]</td>
<td>24.6</td>
</tr>
<tr>
<td>3</td>
<td>Bahrain [7]</td>
<td>20.5</td>
</tr>
<tr>
<td>4</td>
<td>United Kingdom [11]</td>
<td>18.4</td>
</tr>
<tr>
<td>5</td>
<td>Australia [8]</td>
<td>16.6</td>
</tr>
<tr>
<td>6</td>
<td>Netherlands [15]</td>
<td>15.9</td>
</tr>
<tr>
<td>7</td>
<td>New Zealand [9]</td>
<td>13.9</td>
</tr>
<tr>
<td>8</td>
<td>Luxembourg [12]</td>
<td>13.6</td>
</tr>
<tr>
<td>9</td>
<td>Italy [5]</td>
<td>10.4</td>
</tr>
</tbody>
</table>

**World Average (60 Countries)** | 5.2

*Age-adjusted to the world population

# Years Life Lost (APYLL)*: Mesothelioma

**(Years per Person; 1994–2010)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country [years]</th>
<th>Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Egypt [9]</td>
<td>29.9</td>
</tr>
<tr>
<td>2</td>
<td>Cuba [10]</td>
<td>26.2</td>
</tr>
<tr>
<td>3</td>
<td>Philippines [6]</td>
<td>25.6</td>
</tr>
<tr>
<td>4</td>
<td>Colombia [13]</td>
<td>25.2</td>
</tr>
<tr>
<td>5</td>
<td>Ecuador [12]</td>
<td>23.8</td>
</tr>
<tr>
<td>6</td>
<td>Moldova [15]</td>
<td>23.6</td>
</tr>
<tr>
<td>7</td>
<td>Mexico [13]</td>
<td>22.2</td>
</tr>
<tr>
<td>8</td>
<td>Venezuela [12]</td>
<td>22.1</td>
</tr>
<tr>
<td>9</td>
<td>Chile [13]</td>
<td>22.0</td>
</tr>
<tr>
<td>10</td>
<td>Brazil [15]</td>
<td>21.8</td>
</tr>
</tbody>
</table>

**World Average (59 Countries)** | 17.1


Global Deaths Due to Mesothelioma

Statistical Distribution of Data by Country, 1994-2010

- Skewed distribution likely reflects historical pattern of ASB use
- Rationality despite obscure validity of data from developing countries
Global Trends in ARDs

Preliminary Observations

1. Descriptive Statistics Depicted Both Accumulation and Spread of ARD Burden

2. Present Dependence on Asbestos Use Likely to Correlate with Future ARD Burden

3. Plausible Data Emerging from a Wide Range of Countries including Developing Ones
Conclusion

1st International Conference on Asbestos Awareness & Management

Global ARD trends warrant attention

Epidemiology prompted at all levels of prevention

Experience of developed countries should be better utilized to

Promote Asbestos & ARD Free World
Selected Bibliography


*Corresponding author*
From Research to Practice

The Asian Asbestos Initiative
IIES/UOEH, Japan
A WHO-CC for Occupational Health

Institute of Industrial Ecological Sciences (IIES), University of Occupational and Environmental Health (UOEH), Kitakyushu

1988 Designated as WHO-CC
Nov 2014 26th Year
July 2016
The Global Network of WHO-CC for Occup Health

53 in the World

9 in Western Pacific

China: 1
Korea: 2
Japan: 2
Vietnam: 1
Singapore: 2
Australia: 1
Global Master Plan 2012–17
to Implement Global Plan of Action

Priority 1
Regional and national programs on occupational non-communicable diseases with focus on cancer, silica and asbestos-related diseases

1.1 AMR Regional Product
Occupational cancer prevention program in the Americas

1.2 EUR Regional Product
National profiles and programs for the elimination of asbestos related diseases in the WHO European Region

1.3 SEA/WPR Regional Project
Asia Asbestos Initiative

1.4 AMR Regional Product
Asbestos Atlas for the Americas

1.5 AMR Regional Product
Program for the elimination of silicosis in the Americas

1.6 EMR Regional Product
Eastern-Mediterranean program for the elimination of silicosis

Priority 2
National programs and good practices for occupational health and safety of health workers

2.1 Global Product
WHO/ILO global framework and guidance for the development of national occupational health programs for health workers

2.2 Global Product
WHO Publication: Success Stories and Good Practices for Occupational Health of Health Workers

2.3 Global Product
WHO/ILO Tool for Work Improvement in Healthcare Facilities (Health WISE)

2.4 Global Product
Implementation of WHO-ILO-UNAIDS policy guidelines for improving health worker access to HIV and TB prevention, treatment, care and support

2.5 Global Product
Revision and dissemination of WHO Protecting Health Workers Toolkit

2.6 Global Product
Tools for identification and management of chemical hazards in health care settings

2.7 AMR Regional Product
Initiative for protecting the health of health care workers in the Americas

2.8 EMR Regional Product
Occupational health standards and indicators for use by country or institutional accrediting organizations in the Eastern Mediterranean

AAI was Recognized and Designated as an Official Activity of the GMP 2012–2017
What is AAI?

The Asian Asbestos Initiative (AAI) is the international collaborative effort aimed at the prevention & elimination of ARDs with primary focus on Asian countries but aspiring to provide model for the world.

Ultimate goal is consistent with existing efforts of the WHO, ILO and UNEP to globally eliminate ARDs.
## Development of AAI

<table>
<thead>
<tr>
<th>Year</th>
<th>Host / Venue</th>
<th>National Funds</th>
<th>International Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAI-1</td>
<td>2008</td>
<td>Initiated by IIES-UOEH</td>
<td>JSPS/IIES-UOEH</td>
</tr>
<tr>
<td>AAI-2</td>
<td>2009</td>
<td>Co-organized by MPH, Thailand and IIES-UOEH</td>
<td>JSPS/IIES-UOEH and MPH, Thailand</td>
</tr>
<tr>
<td>AAI-3</td>
<td>2010</td>
<td>Organized by IIES-UOEH</td>
<td>JSPS/IIES-UOEH</td>
</tr>
<tr>
<td>AAI-4</td>
<td>2011</td>
<td>Organized by PNU</td>
<td>MOE-Korea</td>
</tr>
<tr>
<td>AAI-5</td>
<td>2012</td>
<td>Co-organized by PNU and IIES-UOEH</td>
<td>MOE-Korea and JSPS/IIES-UOEH</td>
</tr>
<tr>
<td>AAI-6</td>
<td>2013</td>
<td>Co-organized by Gov of Philippines and IIES-UOEH</td>
<td>Gov of Philippines and JSPS/IIES-UOEH</td>
</tr>
<tr>
<td>AAI-7</td>
<td>2014</td>
<td>Co-organized by RCS-UNEP and IIES-UOEH</td>
<td>RCS-UNEP and JSPS/IIES-UOEH</td>
</tr>
</tbody>
</table>
### Asian Asbestos Initiative

<table>
<thead>
<tr>
<th>AAI-1 – Kitakyushu 2008</th>
<th>AAI-6 – Manila 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="AAI-1 Group Photo" /></td>
<td><img src="image2.png" alt="AAI-6 Group Photo" /></td>
</tr>
<tr>
<td>8 countries</td>
<td>22 countries</td>
</tr>
<tr>
<td>40-50 participants</td>
<td>224 participants</td>
</tr>
<tr>
<td>WHO-WPRO, ILO</td>
<td>WHO (HQ, WPRO, SEARO); ILO; IARC; UNU-IIGH</td>
</tr>
</tbody>
</table>

+ Concurrent Regional WHO-CC Meeting
Distribution to Countries of ARD Toolkit

- Commissioned by UNEP via WHO/ILO
- Distributed to administrators and academia in 30 countries
FEATURE: Japanese doctors helping stop-asbestos campaign in Asia

By Tetsuya Tsujimura
JAKARTA, Nov. 15, Kyodo

Japanese doctors are stepping up efforts to help Asia’s developing economies stop using asbestos, sharing knowledge bitterly learned in Japan about the serious and fatal illnesses caused by the material after it was used in abundance during the post-war economic boom through the 1970s.

Emerging economies continue using the affordable but hazardous silicate minerals “because they are still in the process of development and because the 30- to 50-year latent period of mesothelioma has prevented widespread recognition of future costs,” said Ken Takahashi, a professor at Japan’s University of Occupational and Environmental Health.

In October, Takahashi led an Asia-Pacific workshop in Jakarta on the sound management of industrial chemicals. The workshop was organized by the Asia Asbestos Initiative, a program Takahashi launched in 2008, in collaboration with the U.N. Environmental Program.
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