Health effects of oil spill: reflection of 5 years after the Hebei Spirit oil spill

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Global oil spills

Quantities of oil spilt over 7 tonnes, 1970 to 2010

Gulf of Mexico
>500,000 Tonnes
## Oil spills with health studies

<table>
<thead>
<tr>
<th>Accidents</th>
<th>Date of spill</th>
<th>Country</th>
<th>Amount/Oil species</th>
<th>Range of contamination (coastline, km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exxon Valdez</td>
<td>24 March 1989</td>
<td>Alaska, USA</td>
<td>37,000 ton/crude oil</td>
<td>4,800 km of coastline of land, headlands and bays</td>
</tr>
<tr>
<td>Braer</td>
<td>5 January 1993</td>
<td>Shetland, UK</td>
<td>85,000 ton/crude oil</td>
<td></td>
</tr>
<tr>
<td>Sea Empress</td>
<td>15 February 1996</td>
<td>Wales, UK</td>
<td>72,000 ton/crude oil + 360 ton/heavy fuel oil</td>
<td>200 km of coastline</td>
</tr>
<tr>
<td>Nakhodka</td>
<td>2 January 1997</td>
<td>Japan</td>
<td>6,000 ton/Bunker-C oil (number 6 heavy fuel oil)</td>
<td></td>
</tr>
<tr>
<td>Erika</td>
<td>12 December 1999</td>
<td>France</td>
<td>10,000 ton/ Bunker-C oil (number 6 heavy fuel oil)</td>
<td>400-500 km of coastline of mainland small islands</td>
</tr>
<tr>
<td>Prestige</td>
<td>11 November 2002</td>
<td>Galicia, Spain</td>
<td>67,000 ton/Bunker-C oil</td>
<td>900 km of coast line, from northern Portugal to southern France</td>
</tr>
<tr>
<td>Tasman Spirit</td>
<td>27 July 2003</td>
<td>Karachi, Pakistan</td>
<td>35,000 tone/ crude oil (Iranian light crude oil)</td>
<td>10 km of residential coastline</td>
</tr>
</tbody>
</table>

Source: Ha M et al., 2008
Hebei Spirit Oil Spill

- On December 7th, 2007
- The oil tanker *Hebei Spirit* collided with *Samsung crane barge*
- 5 miles northwest of Manripo beach, Taean (latitude, 36:52:13; longitude, 126:03:21)
- The spillage of approximately 12,547 kl (10,900 ton) of crude oil
- The largest oil spills that have occurred in Korea
M/V Hebei Spirit and Samsung crane barge

* Photos courtesy of Korea Coast Guard
Oiled shoreline map
(18 Jan 2008)

Source: KORDI
Human and the other living beings

Photos courtesy of Jungdoilbo, KFEM & Dr. Ok Hwan Yu
Number of cleanup work participants (~2008/6/30)

- Others: 48,809
- Public officers: 59,118
- Military personnel: 151,600
- Volunteers: 1,161,086
- Residents: 451,264

Total: 1,871,817

Drawn based on Taean County Report
Analysis of petroleum hydrocarbons

16 PAHs

Total Petroleum Hydrocarbons (TPH)

Unresolved Complex Mixture (UCM)

Akylated PAHs

Kuwait Export Crude

BTEX

Alkane
Evaporation Rate

- Evaporation rate of spilled oil with time; (a) representative toxic volatile organic compounds; (b) light components of crude oil

![Graph showing evaporation rate of spilled oil with time for different compounds.](image)

**Source:** Kim et al., 2012; TEHC
Exposure map for VOCs

Source: Kim et al., 2012; TEHC
Exposed population

• Repeated exposure through cleanup work
  – Residents 5,000-6,000
  – Military personnel 3,000

• Susceptible population
  – Pregnant women 80 (30 in high exposure area)
  – Infants and neonates
    • Exposed area 118
    • Non-exposed area 71
  – Children 1,100
  – Diseased
    • Asthma
    • CNS disorders
Pattern of metabolome before and after clean-up work

Before clean up

After clean up

Source: TEHC, 2008
Acute health effects

Children’s asthma

Source: TEHC, 2009
Distance from the coastline and somatic and psychiatric symptoms

Source: TEHC, 2008
Multiple route of exposures, multiple effects

Source: TEHC, 2009
Categorization of health effects of oil spill

- **Irreversible (Fatal)**
  - PTSD
  - Asthma
  - Allergic disease
  - MCS
  - Death
  - Cancer
  - Reproductive
  - Birth outcome

- **Acute effect**
  - Psychiatric (except PTSD)
  - Dermatologic
  - Neurologic
  - Nutritional change

- **Chronic effect**
  - Sexual precocity
  - Hematologic
  - Cardiovascular
  - Cell injury

- **Reversible (Non-fatal)**

Source: TEHC, 2010
The estimation level of environmental exposure

Source: Taean Environmental Health Center
Oxidative stress markers and clean-up workers

![Graphs showing oxidative stress markers (MDA, 8-OHdG) and their distribution by clean-up working days in the accident month. Log-log plots of Log 8-OHdG (μmol/kg Cr) vs. Distance from the oil spill site to the residence (km) and Log MDA (μmol/kg Cr) vs. Distance from the oil spill site to the residence (km).]

Source: TEHC, 2010
Long-term health effect study

• Governmental funding of 3 million USD by Ministry of Environment, 2008
• Establishment of *Taean Environmental Health Center (TEHC)*: Sep 2008
• Establishment of cohort
  • Residents and cleanup workers: 9,700
  • Intensive exposure cohort: 1,900
  • Biologically susceptible groups of residents:
    • birth cohort (n=70)
    • Infants and toddlers (n=750)
  • Local cancer registry
• Biorepository
• Follow up
  – 2 year interval
  – Clinical examination
  – Biomarkers
  – Exposure assessment
  – Mental health and MCS assessment
  – Cancer screening
Baseline health examination

• In Cohort I (n=1,900)
• As a part of community health promotion program

• Number of subjects
  • Adults 9,700, children 753

• Comprehensive questionnaire survey
  • Health behavior, PMHx,
  • Environment exposure status and history
  • Diet
  • Reproduction history(female)
  • Oil clean-up work history
  • Health belief
  • Fish/shellfish, food intake
  • Mental health (CES-D/ SAIC/TAIC/Anger)
  • Multiple chemical sensitivity (QEESI)
  • Occupational history
Summary of findings on long-term health effects studies

• *Elevated oxidative stress markers* in high exposure groups even after more than one year after the cessation of exposure

• Dose-response relationship between clean up exposure and various health indicators, including *cardiovascular, allergy, respiratory and metabolic system*, was demonstrated.

• *Psychiatric impacts and MCS* symptoms are declining, but still high.

• Long-term follow up with strengthened health promotion activities are needed.
Community Mental Health Center

Mental Health Screening Test
To identify

Risk Group
Secondary Clinical Interview
Clinical Group
Non Clinical Group

Non Risk Group
Outreach
Community Education
Counseling
Mental Health Mitigation Program

- Anger Management Program for Adult Group
- School Based Mental Health Promotion Program for Child
Proposal of new system with EH T/F
Legislative activity

- Special Act on Aid of Hebei Spirit Oil Spill Affected Area
  - March 2008: legislation
  - Nov 2011: revised
  - 2\textsuperscript{nd} revision in process
- Lawsuit on HSOS failed to prove Samsung’s responsibility.
- Compensation for Oil Pollution Damage Guarantee Act
  - 1993: legislation
  - Nov 2009: final revision
International collaboration

• Nov 2008: Symposium on HSOS health effects
  – Seoul and Taean, Korea
  – HSOS, Prestige, Exxon Valdez, Philippines
• Sep 2009: Minisymposium on oil spill and health
  – Dublin, Ireland (ISEE 2009)
  – HSOS, Prestige
• Aug 2010: Minisymposium on oil spill and health
  – Seoul, Korea (ISEE 2010)
  – HSOS, Prestige
  – MOU exchanged between TEHC and CREAL (Spain)
• Sep 2011: Workshop on oil spill and health
  – Barcelona (ISEE 2011)
  – HSOS, Prestige, BP oil spill
Conclusions

• Oil spill brings a disastrous impact on ecosystem and community.
• Oil is hazardous to human health and its effect can be manifested with a long delay.
• Health effect of oil spill is extensive over wide range of organ systems and time frame.
• Long-term follow up should be integrated with health promotion activities and community revival activities.
What did we learn from this accident?

• Prevention is much, much cheaper than treatment.
• Preparedness and contingency plan should be well made in advance.
• Victims are least benefited population associated with the accident-related activity.
• Good research activity on health effect is needed
  – Publication of peer-reviewed papers
• International collaboration with
  – Accumulation of scientific evidence
  – Sharing protocol
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