

ICOH 2012, Cancun

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Occupational burden of organic solvent in neurotoxicity

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Solvent, the Major Industrial Chemical

BACK GROUND

KOREA OCCUPATIONAL
SAFETY & HEALTH AGENCY

Occupational Burden of Neuropsychiatric disorder

- Solvent exposure
 - Well known risk factor of Neuropsychiatric disorder (NPD)
 - Most of solvent using at workplace may have effect on Nerve system
 - OR for NPD : 1.1 – 2.3 (Axelson, 1976; Baker, 1994)
 - OR for Neurosis : 5.5 (Lindstrom K, 1984)
- In Finland, 4% of mental Ds, 3% of Neurologic Ds reported as attributable to Occupation (Nurminen and Karjalainen, 2001)
- However, Occupational Attribution of Neuropsychiatric disorders due to Solvent Exposure rarely reported
 - Due to lack of 'exposure prevalence'



Research on Environmental Burden of Neuropsychiatric disorder

- Environmental burden
 - Reported by WHO as 13 (10 ~ 16) % (WHO, '06)
 - Insomnia, Migraine, PTSD, epilepsy (developing) : 10 ~ 20%
 - Depression, epilepsy (developed countries) : 5 ~ 10%
 - Others : less than 5%
- Risk factors
 - Depression : Occupational Stress
 - Insomnia : Noise
 - Parkinson Ds : Chemicals, head trauma
 - Loss of IQ : Lead
- **Attributable risk for Occupational Solvent Exposure ???**



Health effect of Solvent Exposure

- Acute effects
 - From Mild symptoms (headache, dizziness, light-headedness) to Unconsciousness, death
- Chronic Toxic Encephalopathy (CTE)
 - Affection, cognition, and neurologic system
- Peripheral Neuropathy
 - Specific Solvents (n-hexane, MEK, CS2, styrene, 111-TCE)
- Degenerative disorders (ALS, MS, PS)
 - Controversy



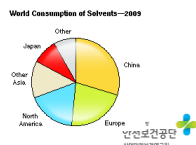
Solvent, Major Industrial Chemical

- Organic solvent : large, heterogeneous group of chemicals
 - alcohols, aldehydes, BTX, glycols, ketones, etc.
- Occupational Exposure
 - Surface coating(Paint, varnishes, removers)
 - Cleaning, degreasing, chemical production, mixing, transfer of chemicals



Solvent, Major Industrial Chemical

- Global consumption of Solvent
 - Annual global consumption of solvents is estimated at 30 billion pounds
 - http://www.solvent-systems.com/solvent.html#Blog_11.htm
 - Overall solvents market has been diminishing somewhat in the developed countries
 - <http://chemical.ihs.com/SSC/Public/greensolvents/>
- Developing countries
 - increasing solvent consumption
 - China, Korea



Purpose of the study

- Estimation of occupational attribution of Neurotoxicity of organic solvent in Korea
- Using
 - Existing information for solvent exposure
 - Reported relative risk of NPD and solvent
 - Prevalence of Subjective symptom

METHOD

Subjects

- Estimation of the Exposure Prevalence
 - **WCS** (Working Condition Survey) '06
 - Target population: '05 Economically active population
 - Household survey: Stratified random sampling of 10,000 houses among 14 million houses (proportional allocation method)
 - Estimation of the number based on **OES** (Occupational Employment Statistics) '05
 - **WES** (Working Environment Survey) '04
 - Target population: '04 manufacturing industries (≥ 5 workers) Complete enumeration : 73,884 industries
 - With randomized sampling of small sized industries : 6,156 industries (among 116, 784 industries)

Surveyed Items of WES & AWS

- Prevalence of Exposure & Subjective SX
- WCS '06
 - Interview, Household survey
 - Subjective Experience for solvent exposure
 - subjective symptom, and diagnosed Neurologic disease during 2005
- Estimation of the workers' number in particular JOB using OES '05
- WES '04
 - Inspection of semi-professionals on chemical usage by work-through survey
 - Amount, Kinds, number of exposed workers

Incidence of Neuropsychiatric Disease

- From National Health Insurance System (NHIS)
 - Rate of Patients get benefits from NHIS for Neuropsychiatric Disease during 2005 among aged 20 ~ 64
- Neuropsychiatric Disease (ICD10 code)
 - Dementia (F00 ~ F03)
 - Affective psychosis (F30 ~ F39)
 - Neurosis (F40-F48)
 - Alcoholism (F10)

Relative Risk / Odds Ratio

- Neuropsychiatric Disease **1.42** (1.04-1.94)
 - Dementia : 0.44 (0.18-4.79)
 - Affective psychosis : 2.41 (0.80-7.21)
 - Neurosis : 1.50 (0.89 -2.52)
 - Alcoholism : 1.20 (0.67 - 2.13)
- By Job or Industry
 - Construction Painters :**1.47** (1.07-2.02) ('90, Brackbill)
 - Painters, varnishers, carpet layers ≥ 30 years : **2.2**
 - Carpenters and cabinet-makers : **2.8**
 - always exposed* painters:**3.1**



Computation of Attributable Fraction

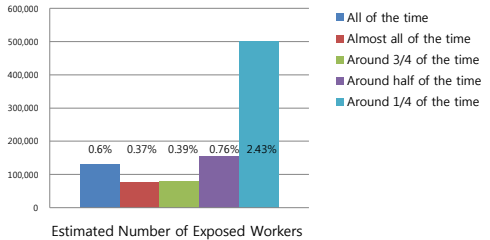
- Levin's equation :
 - $AF = \frac{Pr(E) * (RR-1)}{1 + Pr(E) * (RR-1)}$
 - RR = Relative Risk
 - Pr(E) = Prevalence of exposure
- Miettinen's equation :
 - $AF = \frac{Pr(E|D) * (RR-1)}{RR}$
 - Where Pr(E|D) exposure prevalence among patients



RESULTS

Prevalence of Exposure (1)

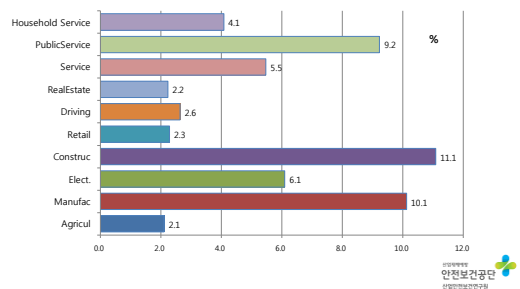
- Organic Solvent Exposure: 4.6%



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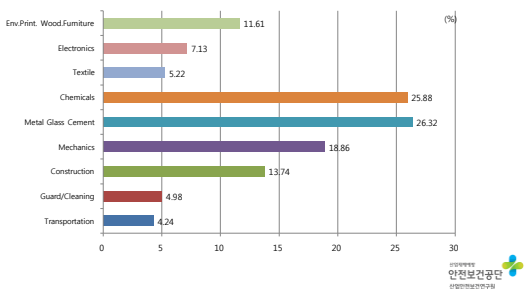
Prevalence of Exposure by Industry (2)

- Construction > Manufacturer > Public Service > Electronics



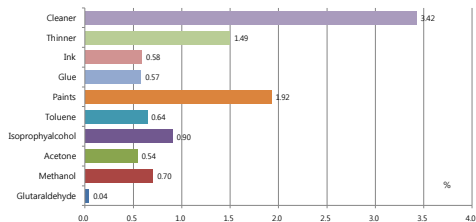
Prevalence of Exposure by Job (3)

- Materials (Metal Glass Cement) > Chemicals > Mechanics > Construction



Chemicals with exposure prevalence > 0.5%

- Based on WES on Manufacturing industry
- Total Exposure Prevalence of Solvent : 14%



Occupational Attributable Fraction (1)

- 1.9% of NPD is attributable to occupational solvent exposure
- Affective Psychosis > Neurosis >

	AF (%)
All NPD	1.90 (0.18 ~ 4.15)
Affective disorder	6.09 (-0.00 ~22.22)
Neurosis	2.25 (-0.00 ~ 6.54)
Alcoholism	0.91 (-1.54 ~ 4.94)



Occupational Attributable Fraction (2)

- Manufacturing Industries : 4~ 13% of NPDs
- Construction Industries : 1 ~13 % of NPDs

	AF (%)		
	Total Workers	Manufacturing	Construction
All NPD	1.90 (0.18 ~ 4.15)	4.10(0.40~8.67)	4.45 (0.44-9.45)
Affective disorder	6.09 (-0.00 ~22.22)	12.5 (-2.1 ~ 28.5)	13.5 (-2.3 ~40.8)
Neurosis	2.25 (-0.00 ~ 6.54)	4.81(-1.12~13.3)	1.98 (-3.45~10.24)
Alcoholism	0.91 (-1.54 ~ 4.94)	5.26(-1.24~14.4)	2.17(-3.8~11.15)



Expected Number of Occupational NPDs

- Occupational Attribution of
 - Affective disorder : 24,298 /Neurosis : 11,219/ Alcoholism: 401

	Total Number from NHIS	AF (%)	Estimated	
			Number	Disease Prevalence (% of Employed Worker)
¹¹⁶ Affective disorder	398,987	6.09 (-0.00 ~22.22)	24,298(0~88,654)	0.117
¹¹⁷ Neurosis	498,621	2.25 (-0.00 ~ 6.54)	11,219 (0~32,610)	0.054
¹¹³ Alcoholism	44,133	0.91 (-1.54 ~ 4.94)	401 (0~ 2,180)	0.002



Subjective Experiences of NPDs & Solvent Exposure

- Total prevalence of experience on
 - Insomnia (5.7%) Anxiety (4.7%) Depression (3.4%)
- In case of Medical Treatment
 - Insomnia (3.7%) Anxiety (2.0%) Depression (2.3%)

	Prevalence of Solvent Exposed (%)	Prevalence of not Exposed (%)	Odds Ratio	95% CI
Insomnia	10.1	5.4	1.96	1.45~1.63
Anxiety	9.2	4.4	2.21	1.63~3.00
Depression	6.5	3.3	2.06	1.45~2.95



DISCUSSION

Attributable fraction of NPDs (1)

- 1.9% of NPDs in Employed worker in 2005 was attributable to Solvent Exposure
 - Expected Medical const by NHIS : 8.6 Million \$

	Total Number from NHIS	AF (%)	Estimated	
			Number	Medical Cost (\$)
116 Affective disorder	398,987	6.09 (-0.00 ~ 22.22)	24,298(0~88,654)	7,220,964.51
117 Neurosis	498,621	2.25 (-0.00 ~ 6.54)	11,219 (0~32,610)	1,075,019.57
113 Alcoholism	44,133	0.91 (-1.54 ~ 4.94)	401 (0~ 2,180)	441,705.95

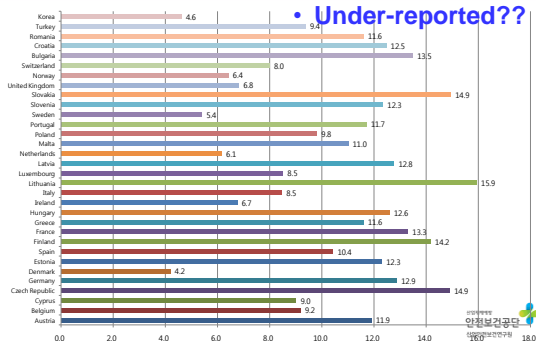


Attributable fraction of NPDs (2)

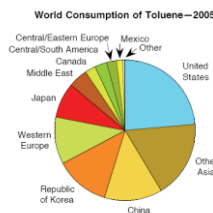
- Attributable fraction of Solvent in NPDs (1.9%) lower than,
 - Attributable fraction of Occupation : 3~ 4%
 - Attributable fraction of Environment : 13%
- NPDs in this study were restricted to
 - Affective Disorder, Alcoholism & Neurosis
 - RR for Other NPDs were not available
- Reported RR based on severe cases diagnosed by neurologist
 - Self reported (from WCS) prevalence of medical treated Depression, Anxiety & Insomnia (2~3%) was higher than AF



Prevalence of Solvent Exposure Korea vs. EWCS*



Possible Underestimate of Solvent Exposure in Korea



- Consumption of one of the most representative Organic Solvent, Toluene
 - USA > Other Asia ...
 - China ..Korea > Western Europe > Japan



CONCLUSION

First trial of Occupational Burden of Solvent Exposure

- 1.9% of some NPDs is attributable to Solvent Exposure
 - Based on RRs reported from previous studies from developed countries (USA & Europe)
- Possibility of under-estimation & over- estimation
 - Under-estimation of exposure prevalence of solvent
 - Over-estimation by applying RR or OR of previous studies to Korean Workers' data



Further needed studies

- Detailed studies on estimation of RR / OR regarding various NPDs
- Comprehensive and regular survey on working condition
- International Collaboration to communicate the information on solvent exposure & Diagnostic criteria

