

PRELIMINARY REPORT OF HEALTH EFFECTS AMONG OIL SPILL CLEANUP WORKERS AND VOLUNTEERS, THAILAND, 2013

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ABSTRACT:

On 27 July, 2013, there was a mishap of more than 50 tons of crude oil spill near Prao Bay, Samet Island, Rayong Province, in the Gulf of Thailand. More than 2,000 people participated in oil spill cleanup. The objective of this study was to evaluate health effects in these people, and to initiate the surveillance process. We obtained their information via self-response questionnaires. This included personal data, work and oil spill exposure, personal protection to reduce exposure, medical history, and symptoms during cleanup. We also collected their after-work urines to test for trans, trans-muconic acid (t,t-MA), one of the benzene metabolites.

The majority of 2,118 cleanup workers and volunteers consented to participate were male (90.2 %), and military (45.7 %), whereas 36.9 % of them were company employees and 17.4 % were volunteer citizens (civil defense volunteers, students, etc.). Their age ranged from 16 to 71 years. Their tasks included digging and collecting contaminated soil/sand (57.7%), collecting spilled oil (23.5%), and others (18.8%). Most of them (88.6%) wore personal protective equipment (PPE): gloves (58.6%), boots (44.9%), protective suit (42.3%), and mask (37.3%). Two-third of them wore the PPE all the time, whereas the others wore only some of the time. Medical history revealed that 5.5% of them had allergy and 3.9% had hypertension. Regarding symptoms during cleanup, we observed dizziness (11.5%), irritated/ dry throat (9.9%) and irritated eyes (9.1%). However, the most frequent symptoms were pulmonary. Regarding the examination of t,t-MA, 57.3% were not detected, 42.6% were lower than 500 µg/gCr, and only 1 subject (0.05%) had t,t-MA higher than 500 µg/gCr. We followed this individual and found that his urine t,t-MA returned to normal. Their cleanup practice, symptoms, and t,t-MA indicated that some of them had substantial exposure to crude oil and its constituents, and hence should be put under further surveillance.

Keywords: Oil spill, Health effects, Trans, Trans-muconic acid, Benzene biomarker

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INTRODUCTION

On 27 July, 2013, there was a mishap of crude oil spill near Phrao Bay or Ao Phrao, Samet Island, Rayong Province, in the Gulf of Thailand [1], depicted in Figure 1. The oil spill amount was later reported to be more than 50 tons (50,000 L). This was considered as tier 2 (20 - 1,000 tons, major spills) according to Tier Classification [2]. However, it was estimated to be as high as

108,000-190,000 L [1]. Since major oil spill rarely occurred in Thailand, the cleanup protocol and exercise were not well prepared. There were more than 2000 workers and volunteers participating in cleanup (Figure 2). Some of them were well protected, but most of them were not (Figure 3). Moreover, they were unaware of any exposure to the hazards of the crude oil and its constituents. Therefore, it was our objective to evaluate any health effects that might be caused by the oil spill among the cleanup workers and provide information and knowledge for undertaking the future incidence.

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Figure 1 Map showed locations of oil spill and Samet Island, Rayong Province, Thailand



Figure 2 Cleanup processes



Figure 3 Occupationally exposed to crude oil



Figure 4 Environmental contaminations

MATERIALS AND METHODS

Permission to conduct human subjects in this study was approved by the Ethical Committee of Rayong Hospital (RyhEC 12/2557).

Subjects

Eligible subjects were all workers and volunteers participated in this oil spill cleanup.

Exposure assessment

Self-response questionnaires were used in this study. Questions included personal data, work and oil spill exposure, personal protection to reduce exposure, and medical history. Medical investigation was also conducted in order to record any symptoms occurred during the cleanup process. Urine samples were collected 4 times; on 30 July-4 Aug, 6-9 Aug, 12 Aug, and 23 Aug, 2013, in order to test for trans, trans-muconic acid (t,t-MA) [3], one of the benzene metabolites.

Statistical analysis

The descriptive statistics - mean and standard deviation for continuous variables, and percent for categorical variables, were used to analyze the data.

RESULTS

There were 2,118 cleanup workers and volunteers consented to participate in this study (Table 1). Most of them were male (90.2 %). The majority was military professional (navy/marines/army) (45.7 %), 36.9 % of them were the company employees and 17.4 % were volunteers (civil defense volunteers, students, etc.). The age of workers/volunteers ranged 16-71 years, with mean of 31.9 years.

They (82.2%) performed the cleanup tasks from 27 Jul to 2 Aug, only 17.8% did that after 3 Aug, 2013. The cleanup tasks included digging and collecting contaminated soil/sand (57.7%), collecting spilled oil (23.5%), supporting and others (18.8%) (Table 2). Most (88.6%) of them wore personal protective equipment: gloves (66.1%), boots (50.7%), protective suit (47.8%), and mask (42.1%). However, 62% of them wore it all the time, whereas 34.6% wore only some time.

The data on medical history revealed that 5.5% of them had allergy, 3.9% had hypertension, and 1.1% had diabetes (Table 3).

Of the total of 2,046 who responded to the questionnaires on the medical history, only 72 subjects did not reply. 36.1% (739/2,046) admitted that they had at least 1 symptom - 11.5% dizzy, 9.9% irritated/ dry throat, and 9.1% irritated eyes. When grouping these symptoms into systems as Pruitt & Lawson [4], we found that pulmonary

Table 1 Characteristics of cleanup workers/volunteers

Characteristic	Number	Percent	Missing
Gender(n=2,071)			47
Male	1,869	90.2	
Female	202	9.8	
Occupation (2,118)			0
Soldiers/Marines/Navies	968	45.7	
Employees	782	36.9	
Volunteers	368	17.4	
Age (n=2,075)			43
Younger than 20	53	2.6	
21-30	1,086	52.3	
31-40	427	20.6	
41-50	372	17.9	
51-60	122	5.9	
Older than 60	15	0.7	
Mean 31.96, SD 10.992, Min 16, Max 71 years old			

Table 2 Cleanup tasks and personal protective equipment (PPE) use

Tasks and PPE use	Number	Percent	Missing
Period of cleanup (n=1,953)			165
27 Jul – 2 Aug	1,605	82.2	
3 Aug – 21 Aug	348	17.8	
Tasks (n=1,989)			129
Collecting spilled oil	467	23.5	
Digging and collecting contaminated soil/sand	1,147	57.7	
Directing/giving first aids	56	2.8	
Supporting/documenting	38	1.9	
Inspecting/environmental monitoring	15	0.7	
Others	266	13.4	
PPE use (n=2,001)			117
No	228	11.4	
Yes (could give more than 1 answer)	1,773	88.6	
Mask	747	42.1	
Protective suit	847	47.8	
Boots	899	50.7	
Gloves	1,172	66.1	
Others (goggles, apron, plastic bags to cover feet)	88	5.0	
Frequency of PPE use (n=1,863)			255
All the time	1,154	61.9	
Some time	646	34.7	
Not use	63	3.4	

Table 3 Medical history of cleanup workers/volunteers (n=2,046)

Pre-existing disease	Number	Percent
No	1,772	86.6
Yes	274	13.4
Atopy/allergy	113	5.5
Hypertension	80	3.9
Diabetes	23	1.1
Asthma	22	1.1
Anemia	17	0.8
Heart disease	10	0.5
Skin disease	10	0.5
Thalassemia	7	0.3
Hepatitis	3	0.14
Emphysema	2	0.1
Bronchitis	2	0.1
Epilepsy	2	0.1
Cancer	1	0.05
Alcoholism	1	0.05

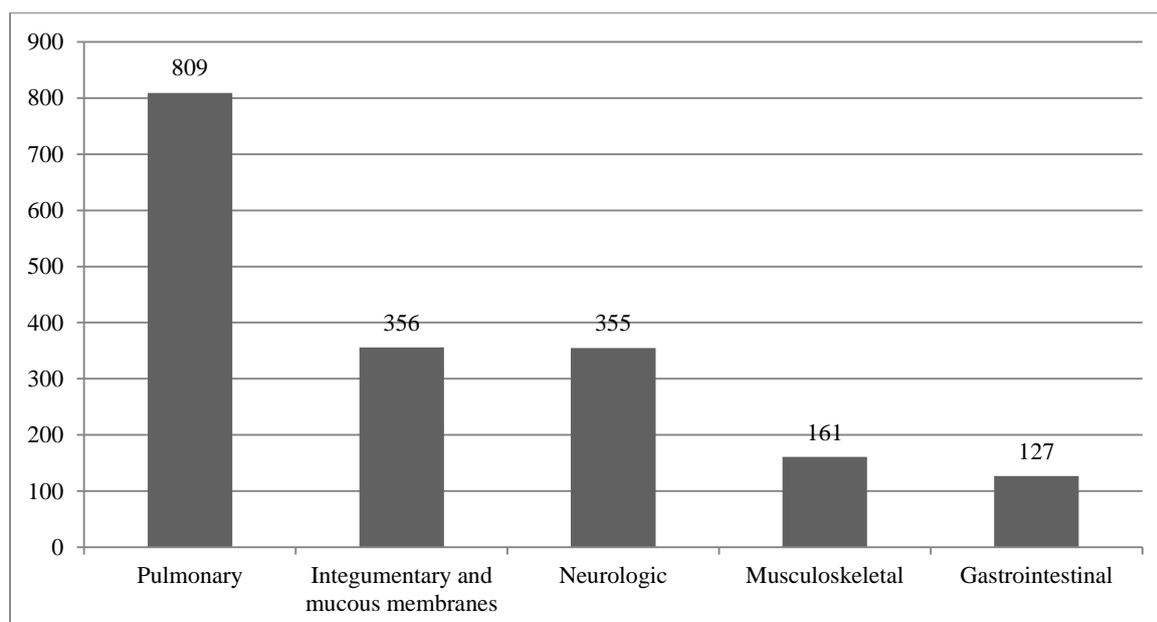


Figure 5 Frequency of symptoms grouped by systems

Table 4 Results of urinary t,t-MA in cleanup workers/volunteers (n=2,096), no urine for 22 subjects

Urinary t,t-MA ($\mu\text{g/gCr}$)	Number	Percent
Not detected	1,202	57.35
< 500	893	42.60
>500	1	0.05
Mean 32.741, SD 56.78, Min= not detected, Max 723.9		

symptoms were the most frequent to be expected (Figure 5).

We assessed benzene exposure by testing for urinary trans,trans muconic acid (t,t-MA), our result showed that the majority (57.3%) had no detectable t,t-MA in their urines, 42.6% had less than 500 $\mu\text{g/gCr}$, and only 1 above 500 $\mu\text{g/gCr}$ (Table 4).

DISCUSSION

This study revealed that crude oil spill cleanup workers/volunteers exposed to crude oil and its constituents to some certain degree. They experienced symptoms similar to previous report [4-6]. Those symptoms were pulmonary, integumentary and mucous membranes, neurologic, musculoskeletal and gastrointestinal. In addition, they also exposed to heat, physical stress, fatigue, psychosocial and work organization factors, and toxic chemical and physical agents [7]. International Agency for Research on Cancer (IARC) addressed that crude oil contains variable amounts of alkanes, cycloalkanes, aromatic hydrocarbons, and nonhydrocarbon compounds, such as sulfur, nitrogen, oxygen, metal-containing compounds, and miscellaneous contaminants. IARC classified crude oil as Group 3 (not classifiable as to its

carcinogenicity to humans) [8]. However, it is generally known that some mixture of hydrocarbons in petroleum crude oil may vaporize and release benzene into the air [5, 9]. This mishap has had and will have adverse effects on environment as depicted in Figure 4, since the spill occurred near a beautiful and popular tourist attraction beach. Fortunately, it occurred in an open space. The occupational exposure must have been higher if this had occurred in a closed space.

This study had several limitations. First, the study's design was done under the partial allowance from the authority to collect data and specimens. Second, we missed to collect data on duration of exposure of these workers/volunteers, which in-turn weakening our risk assessment. Third, the following questions: low back pain, heat-related symptoms and psychological distress or stress, were not asked as performed by other studies [5, 10-12]. Fourth, the personal air sampling was not collected as reported by Morita et al. in 1999 [10].

Nevertheless, this was a preliminary report of health effects on oil spill incidence. This study revealed that oil spill cleanup tasks put the workers/volunteers at risk of exposure to oil spill and its constituents, via inhalation, skin absorption,

and perhaps ingestion of some contaminated food and beverages. Our data on the medical symptoms and the urine analysis of t,t-MA clearly indicated that some of them had significant exposure to crude oil and its constituents, and hence should be put under further surveillance. Other exposures of concerned are mercury [13], dispersant [1], contaminated food and associated toxicants [14].

The Deepwater Horizon oil spill involved 55,000 workers and volunteers and was planned to follow up them for 5-20 years to see rare cancers [5]. Although this Ao Phrao mishap was much smaller than the Deepwater Horizon oil spill, we plan to follow up these 2,118 workers/volunteers for a long term health monitoring program.

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