CLINICAL RESEARCH STUDY

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Health Consequences among Subjects Involved in Gulf Oil Spill Clean-up Activities

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ABSTRACT

BACKGROUND: Oil spills are known to affect human health through the exposure of inherent hazardous chemicals such as para-phenols and volatile benzene. This study assessed the adverse health effects of the Gulf oil spill exposure in subjects participating in the clean-up activity along the coast of Louisiana.

METHODS: This retrospective study included subjects that had been exposed and unexposed to the oil spill and dispersant. Using medical charts, clinical data including white blood cell count, platelets count, hemoglobin, hematocrit, blood urea nitrogen, creatinine, alkaline phosphatase (ALP), aspartate amino transferase (AST), alanine amino transferase (ALT), and somatic symptom complaints by the subjects were reviewed and analyzed.

RESULTS: A total of 247 subjects (oil spill exposed, n = 117 and unexposed, n = 130) were included. Hematologic analysis showed that platelet counts ($\times 10^3$ per μL) were significantly decreased in the exposed group compared with those in the group unexposed to the oil spill (252.1 ± 51.8 vs 269.6 ± 77.3, $P = .024$). Conversely, the hemoglobin (g per dL) and hematocrit (%) levels were significantly increased among oil spill-exposed subjects compared with the unexposed subjects ($P = .000$). Similarly, oil spill-exposed subjects had significantly higher levels of ALP (76.3 ± 21.3 vs 61.2 ± 26.9 IU/L, $P = .000$), AST (31.0 ± 26.3 vs 22.8 ± 11.8 IU/L, $P = .004$), and ALT (34.8 ± 26.6 vs 29.8 ± 27 IU/L, $P = .054$) compared with the unexposed subjects.

CONCLUSION: The results of this study indicate that clean-up workers exposed to the oil spill and dispersant experienced significantly altered blood profiles, liver enzymes, and somatic symptoms.

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KEYWORDS: Blood disorders; Chemical exposure; Crude oil spill; Dispersants; Health impact; Hematological toxicity; Hepatotoxicity; Somatic symptoms; Urinary phenol

Crude oil spills affect human health through exposure to inherent hazardous chemicals including para-phenols and volatile benzene.[1-3] The major health consequences of crude oil spill exposure include the abnormalities in hematologic, hepatic, respiratory, renal, and neurologic functions.[4,5] In addition, subjects exposed to oil spills often experience frequent asthmatic attacks, headache, diarrhea, dizziness, abdominal pain, back pain, and other symptoms.[4,6-9]

On April 20, 2010, the British Petroleum (BP) *Deepwater Horizon* offshore drilling rig located 50 miles off the Louisiana coast exploded and sank in the Gulf of Mexico (**Figure 1**).[5,10] Consequently over 200 million gallons of oil poured into the Gulf of Mexico,[11] thereby contaminating the Gulf coast. During the height of this disaster, BP used nearly 2 million gallons of dispersants such as COREXIT[12] (Nalco Energy Services, L.P., Sugar Land, Tex) to break down the oil slick.[11] This oil spill and use of massive amounts of dispersant has the potential to affect human health. It is estimated that up to 170,000 people worked in some capacity to clean up the Gulf oil spill.[13]

Previously, several studies have evaluated the health impact of other oil spills.[5,6,10,14-16] These studies primarily focused on physical effects and psychological sequelae. In addition, these studies point to potential adverse effects among oil spill clean-up workers. Earlier studies reported that benzene exposure is associated with hematological toxicity and increased cancer risk.[17-22] While such rare adverse outcomes may take years to develop, immediate health effects of

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oil spill exposure may be seen in hematological and hepatic parameters, indicating its toxic effects and potential for future health risk.[23]

To investigate the adverse health effects of the oil spill in the Gulf of Mexico, a retrospective analysis was performed on subjects participating in the oil spill clean-up activity along the coast of Louisiana. Specifically, we assessed the hematologic and hepatic markers in a cohort of oil spill clean-up workers, and the clinical findings were compared with the unexposed (control) subjects.

CLINICAL SIGNIFICANCE

- Human exposure to oil spill and dispersant use has a potential to alter both hematological and hepatic profiles.
- The hematological and hepatic alterations include decreased platelets and BUN, and increased creatinine, serum levels of ALP, AST, and ALT.
- The most reported somatic symptoms are headache, shortness of breath, skin rash, cough, fatigue, painful joints, and chest pain.

MATERIALS AND METHODS

Subjects

This study was approved by an Institutional Review Board. Using medical charts, demographic and clinical data were reviewed for the subjects who underwent clinical and laboratory evaluation between January 2010 and November 2012. The study was conducted according to the principles of the Declaration of Helsinki. The personal information of the subjects was redacted to maintain confidentiality.

Subjects included in this study were referred to the clinic for medical evaluation by the subjects' legal representatives. Written consent was obtained from the subjects' legal representatives. The subjects exposed to the oil spill and dispersant were identified as participants in the oil spill clean-up activities along the coast of Louisiana for a duration of over 3 months.

The unexposed subjects were living geographically at least 100 miles away from the Gulf coast of Louisiana. The unexposed subjects had visited the clinic for a routine wellness check-up. The subjects were selected randomly for the study by their primary care physicians.

Chart Review and Evaluation

Medical charts of exposed and unexposed subjects were reviewed by expert physicians and the data were processed for statistical analysis. Clinical data such as white blood cell (WBC) counts, platelet counts, hemoglobin, hematocrit, blood urea nitrogen (BUN), creatinine, serum beta-2-microglobulin, alkaline phosphatase (ALP), aspartate amino transferase (AST), and alanine amino transferase (ALT) levels were evaluated. Data on urinary phenol also was assessed as a benzene metabolite in oil spill-exposed subjects. Additionally, data on somatic symptoms were collected from the oil spill-exposed subjects and analyzed.

Statistics

Descriptive statistics were used to assess patient demographics and included means and standard deviations for each group. Variables included were WBC, platelets, hemoglobin, hematocrit, creatinine, BUN, ALP, AST, ALT, beta-2 microglobulin, and urinary phenol. Student's t test was used to assess the differences between exposed and unexposed groups. The significance level was predetermined at an alpha level of .05.

RESULTS

This study included a total of 247 subjects, 117 of which were involved in the clean-up activity of the oil spill. The outcomes of the oil spill-exposed subjects were evaluated and compared with the unexposed subjects (n = 130). The subjects' demographics are shown in **Table 1**. Among the oil spill-exposed subjects (n = 117), there were 104 (89%) males and 13 (11%) females. The median age of exposed and unexposed subjects was 34.0 (18-63) and 51.0 (15-90) years, respectively. The demographic characteristics such as sex and age groups differed significantly between the exposed and unexposed groups ($P = .000$).

The data in **Table 2** represents the differences in hematologic and hepatic markers between the subjects exposed to the oil spill and those unexposed. No significant differences were observed in the WBC count ($\times 10^3$ per μL) among those exposed to the oil spill and those unexposed (6.9 ± 1.9 vs 6.5 ± 1.9, $P = .11$). However, the platelet count ($\times 10^3$ per μL) in subjects exposed to the oil spill was significantly decreased compared with the unexposed subjects (252.1 ± 51.8 vs 269.6 ± 77.3, $P = .024$).

The hemoglobin (g per dL) levels were significantly increased among oil spill-exposed subjects compared with the unexposed subjects (14.9 ± 1.3 vs 13.6 ± 1.6, $P = .000$). The hematocrit levels were significantly elevated in oil spill-exposed subjects compared with the unexposed subjects (44.6 ± 3.4 vs 40.8 ± 5.0, $P = .000$). Similarly, serum creatinine levels (mg/dL) also were significantly higher in the oil spill-exposed subjects compared with the unexposed subjects (1.0 ± 0.2 vs 0.9 ± 0.3, $P = .000$). Conversely, the BUN (mg/dL) significantly decreased in the oil spill-exposed subjects compared with the unexposed subjects (13.4 ± 3.4 vs 15.4 ± 7.1, $P = .014$).

Compared with the unexposed subjects, subjects exposed to the oil spill showed significantly elevated levels of ALP (76.3 ± 21.3 vs 61.2 ± 26.9 IU/L, $P = .000$). The AST (IU/L) levels were significantly higher in the oil spill-exposed subjects compared with the unexposed subjects (31.0 ± 26.3 vs 22.8 ± 11.8, $P = .004$). Similarly, the ALT (IU/L) levels were marginally but significantly increased in the oil spill-exposed group compared with the unexposed group (34.8 ± 26.6 vs 29.8 ± 27, $P = .054$).