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# Lung function in subjects exposed to crude oil spill into sea water

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**Abstract**

A Greek oil-tanker ran aground, resulting in a huge oil spill along the costal areas of Karachi, Pakistan. The purpose of this study was to assess the lung function and follow up change after one year in subjects exposed to crude oil spill in sea water. It was a cross sectional study with follow up in 20 apparently healthy, non-smoking, male workers, who were exposed to a crude oil spill environment during oil cleaning operation. The exposed group was matched with 31 apparently healthy male control subjects. Pulmonary function test was performed using an electronic Spirometer. Subjects exposed to polluted air have significant reduction in forced vital capacity (FVC), forced expiratory volume in first second ($FEV_1$), forced expiratory flow ($FEF_{25–75\%}$) and maximum voluntary ventilation (MVV) compared to their matched controls. This impairment was reversible and lung functions parameters were improved when the subjects were withdrawn from the polluted air environment.


*Keywords:* Lung function; Oil spill; Tasman Spirit

## 1. Introduction

Oil spills at sea are one of the most sensitive and high profile problems around the world. Major oil spill accidents have been recorded in the United Arab Emirates, Kuwait, Malaysia, India, Norway, Libya, Japan, America, England, Taiwan and Spain (Campbell et al., 1993; Lyons et al., 1999; Qiao et al., 2002; Chiau, 2005; Balseiro et al., 2005).

On the afternoon of July 27, 2003, a Greek oil tanker, the Tasman Spirit, carrying 67,535 ton of crude oil ran aground in the channel of Karachi port. The tanker was cracked and was unable to move. Over the next week an estimated 28,000 ton of crude oil spilled into the sea and started coming ashore. Air pollution was recorded between August 13 and 18 when approximately 11,000 ton of volatile organic compounds had entered the air as a result of the evaporated component of the crude oil. The polluted air contained volatile organic compounds ranging from 44 ppm to 179 ppm in different areas of the city. The pungent odor was reported and mist was perceptible even at a distance of 15–20 km from the coastline. The surrounding residents as well as workers were exposed to 40–170 ppm of volatile organic compounds for at least 15–20 days (Tasman Spirit oil spill assessment report, 2005).

Crude oil is a complex mixture of many chemical compounds, composed primarily of para-phenol, aromatic hydrocarbons (Smith, 1968; King, 1988). The aromatic hydrocarbons of toxicological interest are benzene, alkyl benzene (principally toluene and xylene) and poly cyclic aromatic hydrocarbons (PAHs) (Macfarland, 1988) along with traces of metals, notably nickel, vanadium, and less than 1% by weight of sulfur (Smith, 1968). The aromatic hydrocarbons showed high solubility and concentration in blood and low concentration in brain, liver and kidney and these have a tendency to accumulate in adipose tissues

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(Park and Holiday, 1999). The hydrocarbons possess distinctly different toxic properties which become a health risk. Crude oil spillage in the sea throws up many health hazards including coughing, shortness of breath, sore throat, runny nose and asthmatic attacks. It also results in death of wildlife surrounding the spills including fish, seabirds and marine mammals (Lyons et al., 1999; Moritam et al., 1999; Carrasco et al., 2006).

Very few studies have been designed to assess lung functions in the vicinity of major oil tanker accidents, and none of these studies was extensive. In general, results from earlier studies are insufficient to disclose the extent of health effects caused by oil spill (Crum, 1993). One of the main problems in the previous studies was that pulmonary functions were neither studied extensively nor explained by other factors which greatly influence the lung functions such as age, height, weight, smoking and socioeconomic status especially in such types of major pollution accidents. Moreover, the point that deserves to be discussed is that physicians should know the magnitude of health problems in general and pulmonary complications in particular in the aftermath of such major accidents. In view of these facts, the present study was designed to determine the lung function and follow up subjects exposed to crude oil spill into sea water.

## 2. Subjects and methods

This study was conducted during the period August 2003–2004. It was commissioned immediately after the incident; the principal investigator visited the costal areas of Karachi, Pakistan, and observed the situation, and interviewed approximately 115 subjects who were engaged for oil cleanup operation at the costal area. A comprehensive history was taken to ascertain whether they would be included in the study or not on the basis of the exclusion criteria.

Subjects with clinical abnormalities of the vertebral column, thoracic cage, neuromuscular diseases, known cases of gross anemia, diabetes mellitus, pulmonary tuberculosis, bronchial asthma, chronic bronchitis, bronchiectasis, emphysema and malignancy were excluded from the study. Drug addicts, cigarette smokers, tobacco chewers and those who had undergone abdominal or chest surgery as well as subjects exposed to any industry that generates smoke or dust were also excluded from the study.

All participants were questioned regarding their job, smoking and habits of chewing tobacco or betel-nut products. After the initial interview and clinical examination, 20 apparently healthy male workers were selected for lung function test. These workers participated in oil clean up operation for at least 8–10 h a day for six days a week, using self-protective measures (simple piece of cloth to cover the nose and mouth). The control group was selected in a similar way; approximately 80 subjects were interviewed, finally 31 matched healthy men, mean age $28.96 \pm 1.30$ years (mean $\pm$ SEM; range 20–60 years) were selected. The control group was composed of clerical staff, shopkeepers and salesmen. All subjects were matched for age, height, weight and socioeconomic status. During collection of data, a little temporary shelter was used as a camp office at the costal area, and the exposed group was invited to visit the camp office for general physical examination. A questionnaire was completed, including anthropometric data, and their consent was taken. After detailed interview and clinical examination of the subjects at the same camp office, the lung function test was explained to them. While performing Spirometry, the Electronic Spirometer was carefully calibrated. Some of the selected exposed subjects could not manage to achieve the test and recordings, therefore, the total number of exposed subjects were 20 while the controls were 31.

In August 2004, exactly after one year, a follow up study was conducted to determine the change in pulmonary function of the subjects, who had participated in the oil clean up operation in August, 2003. During follow-up examination, lung function test was again performed and compared with their previous lung function parameters obtained during the year 2003 (Table 2).

### 2.1. Methods

Spirometry is the basic, widely used pulmonary function test (PFT). Spirometric measurements typically assess lung volumes and flows and ideally suit to describe the effects of obstruction or restriction on lung function (Ruppel, 1997). Spirometry is essential to evaluate dyspnea, wheezing, orthopnea, cough, phlegm production, diminished breath sounds, overinflation, expiratory slowing, cyanosis, chest deformity, unexplained crackles, hypoxemia, hypercapnia, polycythemia, abnormal chest radiographs and has a key role in epidemiological studies investigating the incidence, natural history and causality of occupational and environmental lung disease. Spirometry is also vital to assess therapeutic interventions and to describe the course of diseases affecting lung function (American Thoracic Society: Statement on standardization of Spirometry, 1995). The essential parameters of lung function test are defined below.

Forced vital capacity (FVC): This is the maximal volume of air exhaled with maximally forced effort from a position of maximal inspiration expressed in liters at normal body temperature, ambient pressure, saturated with water vapor (BTPS).

Forced expiratory volume in first second ($FEV_1$): This is the volume of air exhaled during the first second of FVC, expressed in liters at (BTPS).

Forced expiratory ratio ($FEV_1$/FVC%): This is a ratio of the forced expiratory volume in one second and forced vital capacity recorded as a percentage.

Forced expiratory flow ($FEF_{25–75\%}$): The forced expiratory flow during the middle half of the FVC formerly called maximal mid-expiratory flow (MMEF) expressed in liters/second.