Biological Monitoring of Exposure to Benzene in Traffic Policemen of North India

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Abstract: Occupational health of traffic policemen employed at six major towns of north India was monitored during these investigations. Traffic controllers face the risk of exposure to benzene present in the ambient air as a component of fuel exhaust. Inhaled benzene is metabolized and excreted as phenol. Our observations on urinary phenol show much higher values than prescribed by ACGIH. Furthermore, social habits like alcohol consumption and cigarette smoke were found to modulate benzene metabolism. It was noticed that cigarette smoke synergizes the effect of benzene whereas antagonistic effects of alcohol were observed.

Key words: Benzene, Alcohol, Cigarette smoke, Phenol, Traffic policemen

Introduction

Benzene, a major monocyclic hydrocarbon is widely used as solvent in variety of industrial and commercial processes. It is also generated through processing, combustion and evaporation of gasoline. Gasoline used in European countries contains 5% benzene. In U.S.A, gasoline contains 1.5% benzene, whereas, in India, gasoline is known to contain 3% benzene. Thus automobile exhaust constitutes a potent source of atmospheric benzene. According to available reports, 85% of atmospheric benzene is produced from automobiles, higher concentration often present at places of high traffic density.

Long term exposure to auto-exhaust and other pollutant mixtures has been studied in man and animals. Effects on pulmonary function in beagle dogs were studied by Lewis and Moorman. McFarland established a correlation between carbon monoxide and driving performance. A study on policemen working in city streets has also been made in Boston and London. However, no such study has apparently been made in Indian cities. Verma and Rana (2001) while performing biological monitoring studies in petrol pump workers reported that gasoline is a potent source of occupational exposure to benzene. Like petrol pump workers, traffic policemen may also suffer from risk of occupational exposure to benzene. Therefore, a study using urinary phenol as the biomarker of benzene exposure was undertaken in traffic policemen of six cities covering three States of north India.

Materials and Methods

Six cities viz., Delhi, Dehradun, Haridwar, Saharanpur, Muzaffarnagar & Meerut of north India were selected for present investigations (Fig. 1). Six locations with high traffic density were identified in each city. Traffic policemen controlling these areas were registered and information like age, smoking habit, alcohol consumption and overall health condition was sought after personal interviews.

Thirty (five per city) healthy persons who had never been occupationally exposed to benzene and lived in clean surroundings were selected as controls.

The survey was made in the months of February and March 2002. Urine samples were collected in white sterile plastic bottles from all subjects at the end of work shift. These samples, were transported in liquid nitrogen container (Inox India Ltd., India) to the laboratory and stored frozen till analyses.
Specific gravity of urine samples was determined by an urinometer (Atago Company Ltd., Tokyo, Japan). Creatinine was determined by alkaline picrate method. Phenol, metabolite of benzene was estimated following the antipyrine method of Dannis. Pure liquid phenol (Central Drug House Pvt. Ltd., Mumbai) was used as the standard.

Statistical analyses of data was performed using Student’s “t”-test. Multiple comparisons were made applying one way analysis of variance (ANOVA) followed by Duncan’s post hoc test.

### Results

Three parameters viz., specific gravity, creatinine and phenol were considered for these investigations. Considerable variation in specific gravity was observed in the urine samples collected from cities, however, invariably higher values were registered than control subjects (Table 1).

Creatinine values were alarming in the policemen of Delhi. Values were found to be high in non alcoholics and non smokers. Similar trend was observed in the subjects of Dehradun and Haridwar. Non significant effects were observed in the subjects of Meerut and Saharanpur. However,
in traffic policemen of Muzaffarnagar creatinine values were low in nonsmokers and non alcoholics. Average values were significantly higher than control subjects (Table 2).

Urinary phenol was very high in policemen of Delhi and Meerut. However, it was lowest at Saharanpur. Significant differences in urinary phenol were observed between alcoholics and non alcoholics and smokers and non smokers (Table 3).

Finally the results were corrected to creatinine. Values were highest in the subjects of Muzaffarnagar. Non alcoholics excreted higher phenol than alcoholics. Smokers of this town had lower values than non smokers. Surprisingly alcoholics and smokers of Haridwar had higher values than nonalcoholic and nonsmoker subjects. In Dehradun also, smokers had higher values than nonsmokers. In all subjects, average values of phenol were higher in traffic policemen than control subjects (Table 4).

**Discussion**

Traffic policemen are directly exposed to auto-exhaust...
mixtures that mainly contain air pollutants like carbon monoxide, benzene, lead etc. Benzene is absorbed by inhalation. Almost one-third of retained benzene is excreted rapidly in urine as conjugate phenol and dihydroxy phenol\(^{(12,12)}\). The remainder is further degraded to be incorporated in tissues or exhaled as CO\(_2\)\(^{(13)}\). Phenol excretion has been treated as marker of benzene exposure\(^{(14)}\).

It is measured in relation to specific gravity and/or creatinine concentration in the urine. Specific gravity is a convenient indication of urine osmolality whereas creatinine indicates state of kidney function. The biological indicators used to monitor benzene exposure are metabolites such as phenol, S-phenylmercapturic acid and trans, trans-muconic acid. The biological exposure index (BEI) of phenol suggested by ACGIH until 1996 was 50 mg/g creatinine in the urine at the end of the work shift. The levels of exposure considered safe for exposed workers have progressively declined as the carcinogenicity of benzene have been established. Present results show that even the control subjects of five out of six cities excreted higher than prescribed limits of phenol. Only one of these six cities was found to be safer for citizens. Several workers have discussed the problem of phenol excretion in non-exposed subjects. Phenol concentration may vary with the method used. Van Haafien et al. (1965)\(^{(15)}\) found that phenol concentration may reach upto 160 mg/l if analyzed with the method of Theis-Benedict. In another report Walkley et al. (1961)\(^{(16)}\) established that phenol concentration may vary between 50–100 mg/l in non-exposed subjects. Cresol concentration might contribute in higher phenol concentrations. Cresols are normal constituents of urine and with higher phenol excretion, cresols become relative less important. The problem has been discussed by Docter and Zielhuis (1967)\(^{(17)}\).

Significant difference in the values of phenol between alcoholics and smokers was observed in comparison to nonalcoholics and nonsmokers. Similar results were recorded in our earlier study made in petrol pump workers\(^{(17)}\). The metabolism of chemicals may be modified by social habits\(^{(17)}\). Traffic controllers occupationally exposed to organic solvents consume alcoholic beverages occasionally or habitually. In view of the opposite effects of immediate and long term alcohol consumption, the net effect of concomitant alcohol use and xenobiotic exposure in a long term alcohol consumer is difficult to predict\(^{(18)}\). Ingestion of ethanol is therefore a noticeable source of error in biological monitoring of benzene uptake. Therefore, the history of ethanol intake was carefully evaluated in workers occupationally exposed to benzene. A decreased urinary phenol excretion has been reported after simultaneous exposure to benzene and ethanol\(^{(19)}\). These results support our observations.

Smoking appears to be a confounding factor in populations who are not professionally exposed to benzene. Blood benzene concentration has been ascertained not only in occupationally exposed individuals but also among non exposed controls, and has been found to increase significantly among smokers even in the control group\(^{(20)}\).

The effect of co-exposure to organic compounds on their metabolism depends on the specific metabolic pathways of each compound and on the degree of exposure. For example, occupational co-exposure to benzene and toluene reduces excretion of phenol and hydroquinone to a large extent than excretion of catechol\(^{(21,22)}\). It is the enzyme induction that accelerates the raising of biological levels of metabolites and thus accelerate the removal of parent compounds from the body\(^{(23)}\).

In brief, present study helps us to draw a few conclusions. Higher amounts of benzene are present in ambient environment of north Indian cities. An average concentration of benzene in the ambient environment of Delhi has been found to vary in different reasons. At traffic intersection, its concentration ranges from 70–163 µg/m\(^3\) in August and 271–540 µg/m\(^3\) in November\(^{(24)}\). This is confirmed by accelerated excretion of phenol in the urine of control subjects. Secondly, traffic policemen are facing a serious health hazard through occupational exposure to benzene. Lastly, social habits like alcohol intake and smoking potentiate the effects of benzene. Smoking is more dangerous than alcohol intake in subjects occupationally exposed to benzene.

### References


