Exposure to Urban Pollutants and Plasma Vasopressin in Traffic Policemen

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Abstract: Objectives) The aim of the present study is to investigate whether traffic policemen of a big city exposed to urban pollutants may be at risk of alterations on plasma vasopressin (VP) concentrations compared with a control group. Material and Methods) Out of a population of 395 Municipal Police employees, the subjects with the principal confounding factors were excluded from the study. Traffic policemen and control subjects were matched by sex, age and working life. Plasma VP levels were determined in 82 subjects: 41 traffic policemen (18 men, 23 women) and 41 control subjects (18 men, 23 women). Results) Mean of VP values were found significantly lower in traffic policemen than in the control group both in men (P=0.010) and in women (P=0.015). We found high correlation between VP values and working life in traffic policemen of male and female sex (r=0.7; r=0.6). Discussion) The authors hypothesise an effect on plasma VP levels in traffic policemen exposed to chemical and physical stressors, according to plasma VP levels modifications found by other authors in studies on animals and human subjects.

Key words: Plasma vasopressin, Traffic policemen, Stressors, Urban pollutants, vasopressin (VP)

Introduction

The neurohypophyseal hormone vasopressin (VP) or antidiuretic hormone, was first isolated and characterized 40 yr ago. It is synthesized as a prohormone in magnocellular neurons in the posterior division of the paraventricular nucleus (PVN) and the supraoptic nucleus (SON) of the hypothalamus. From there it is carried by axonal transport via the internal lamina of the median eminence to nerve terminals in the neurohypophysis, where it is stored for later release. VP acts on a variety of target organs, including kidney, lung, liver and adenohypophysis and on a variety of cognitive functions such as memory and learning. The peripheral functions of VP are primarily oriented towards the regulation of the salt and water balance. This is mainly due to the capacity of this hormone to increase the permeability to water in the last portion of nephron in a regulated fashion, thus enabling the reabsorption of up to 10% of the filtered water. VP is secreted in response to either increases in plasma osmolality (very sensitive stimulus) or to decrease in plasma volume (less sensitive stimulus). In fact dehydration, water loading and haemorrhage produced small but significant changes in plasma VP concentration1, 2).

During the last two decades, it has become apparent that VP, in addition to play a role as peptide hormone, also acts as neurotransmitter3).

Studies on animals and human subjects have suggest that some urban pollutants, may decrease the normal synthesis, secretion and/or action of VP. These agents are: cadmium4), toluene5), lead6), and carbon monoxide7, 8). Besides these,
physical agents such as noise\textsuperscript{a,10}, and vibrations\textsuperscript{9} may modify VP levels.

The class of workers examined in this study were employees of the Municipal Police of the big Italian city, for whom we have already studied the environmental and biological levels of some urban pollutants\textsuperscript{11–14}. The levels of individual exposure to benzene, considered as an indicator of urban pollutants, were (mean 7 h) on average 10.7 µg/m\textsuperscript{3} for the group of traffic policemen and about three times lower (3.6 µg/m\textsuperscript{3}) in the control subjects\textsuperscript{11,13}.

In the period March-April 2001, the Municipality of the city in question monitored concentrations of particulate matter 10 micrometers in diameter and smaller (PM\textsubscript{10}), considered as an inhalable, in fixed stations located in districts with different intensities of traffic vehicle, registering average monthly values respectively of 60 µg/m\textsuperscript{3}, 45 µg/m\textsuperscript{3} and 30 µg/m\textsuperscript{3} in a Municipal park [http://www.comune.roma.it].

The aim of the study was to investigate whether traffic policemen of the big Italian city exposed to urban pollutants may be at risk of alterations on plasma VP concentrations compared with a control group.

**Materials and Methods**

Our research was conducted on a working population of 395 Municipal Police employees (200 traffic policemen and 195 administrative workers). Two groups were studied: traffic policemen who worked in shifts on parking, patrols, keeping passage-ways free, controlling traffic at crossings and on roads with intense flows of traffic; and subjects who carry out indoor activities of an administrative and bureaucratic nature, used as control group at lesser level of exposure. Traffic policemen and control group worked for seven hours a day at least five days a week.

For inclusion in the study, all workers were given a questionnaire in the presence of a physician which contained the following points: sex, age, working life, smoking habits (number of cigarettes smoked per day), drinking habits (how many glasses of wine, beer and spirits drunk per day), previous and/or current medical illness, recent use (and for six months previous to the taking of blood samples) of medicines able to alter plasma VP levels.

Were excluded from the study any worker who answered affirmatively to items related to the following: smoking habits (No. 59 traffic policemen and No. 42 controls)\textsuperscript{15,16}, drinking habits (No. 31 traffic policemen and No. 29 controls)\textsuperscript{17,18}, previous and/or current kidney disease (No. 3 traffic policemen and No. 2 controls)\textsuperscript{19,20}, use of diuretics (No. 2 traffic policemen and No. 1 controls)\textsuperscript{21}, antihypertensives (No. 31 traffic policemen and No. 29 controls)\textsuperscript{17,18}, oral contraceptives (No. 5 traffic policemen and No. 2 controls)\textsuperscript{23}, antidepressants and lithium medicines (No. 2 controls)\textsuperscript{24,25}, use of paints, solvents and pesticides during time-off (No. 4 traffic policemen and No. 3 controls)\textsuperscript{26}.

Women aged over 50 (No. 10 controls) were excluded from the study because of the menopausal and postmenopausal alterations on plasma VP levels\textsuperscript{27}.

The remaining 93 traffic policemen were matched with the remaining 101 control subjects by sex, age and working life by mean, SD and distribution into classes: 82 subjects remained included in the study: 41 traffic policemen (18 men, 23 women) and 41 control subjects (18 men, 23 women) (Table 1). All the traffic policemen and controls included in the study were none-smokers and non-alcohol drinkers. All the traffic policemen and controls worked for seven hours a day (daily working time from 8.30 AM to 3.30 PM) at least five days a week. No differences in working schedules (such as start time of work), no shift workers and/or night workers were present in this study.

All the subjects included in the study were asymptomatic.

The breakdown of the workers by sex was necessary in view of the greater sensitivity to physiological stimuli of the response of VP in women compared to men\textsuperscript{28,29}.

A 10 ml sample of venous blood was taken from each worker between 8 and 10 a.m., fasting. The blood samples were preserved at the workplace in a refrigerator at –4°C until they were transferred (by means of a container and at the same temperature) to the laboratory, where they were immediately centrifuged to obtain the serum which was kept at –20°C until the time when they were analysed (within 3 d). The samples were taken in the period from 14 March to 20 April 2001.

All the workers included in the study underwent RIA (radioimmunoassay) dosage of VP on the venous blood: the normal values of the test were the ones applied in our laboratory, 0.6–4.3 pg/ml for both sexes. The RIA method has a high specificity and accuracy, and has shown itself to be a convenient and useful system of quantifying plasma VP concentrations\textsuperscript{30–32}.

The laboratory did not know which samples came from the group of traffic policemen and which from the not exposed group, although both the physicians and the technicians knew how the study was being carried out.

All the subjects agreed to the processing of their personal data and declared that they were aware that those data came within the category of “sensitive data”, and consented that the data arising from the research protocol should be treated in an anonymous and collective way, with scientific methods.
and for scientific purposes in accordance with the principles of Helsinki Declaration.

**Statistical Analysis**

Statistical analysis of the data was based on the calculation of the mean, standard deviation (SD), distribution, range and frequency according to the nature of the single variables. The differences between group means were analysed using Student’s t-test for unpaired data.

The frequencies of the single variables were compared using the chi-square test with Yates’ correction setting up a four-way contingency table and Fisher’s exact test, setting up a four-way contingency table.

Fisher’s exact test was used when the total was less than 20 or between 20 and 40 and the smallest of the four expected values was less than 5.

The correlation (r) was calculated by Pearson correlation coefficient.

The differences were considered significant when the P values were < 0.05.

The statistical analysis was done using the statistical program Solo-BMDP™ Statistical Software.

**Results**

Mean VP values were significantly lower in traffic policemen compared with the control group both in men and in women (respectively P=0.010, P=0.015) (Table 1).

The frequency of traffic policemen with VP values outside the lower normal limit of our laboratory was not significant compared to controls of both sexes (Table 1).

Traffic policemen and controls of both sexes with VP values outside the higher normal limit of our laboratory were not present (Table 1).

The distributions of the VP values in male and female traffic policemen and control subjects are shown respectively in Fig. 1 (P=0.041) and in Fig. 2 (P=0.041).

We found an high correlation between VP values and working life in traffic policemen of male (r=0.7) and female sex (r=0.6). In the control group we found a little correlation between VP values and working life in traffic policemen of male (r=0.1) and female sex (r=0.2). There were a little correlation between VP values and age in traffic policemen and controls of male (respectively r=0.1 and r=0.2) and in traffic policemen and controls of female (respectively r=0.2 and r=0.3) sex.

**Discussion**

Considering that the subjects with the main confounding factors were excluded from the study, and that the subjects investigated were matched by sex, age and working life, the data suggest the possibility that occupational exposure to urban pollutants in traffic policemen may alter plasma VP concentrations.

The fact that the differences in mean VP levels between traffic policemen and controls of both sexes resulted significant and that there is an high frequency of traffic policemen of male and female sex with lower plasma VP levels (respectively 27.7% and 47.8%) than the normal limit for our laboratory, suggests that our results could have clinical validity. Besides,

<table>
<thead>
<tr>
<th>Table 1. Age, working life and VP concentrations in male and female workers</th>
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<tbody>
<tr>
<td>Male Workers</td>
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<tr>
<td>Traffic policemen</td>
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<tr>
<td>No = 18</td>
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<tr>
<td>Age (yr)</td>
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<tr>
<td>Mean (SD)</td>
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<td>min-max</td>
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<td>Working life (yr)</td>
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<td>Mean (SD)</td>
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<td>min-max</td>
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<tr>
<td>Plasma VP values (pg/ml)</td>
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<td>Mean (SD)</td>
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<td>min-max</td>
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<td>VP &lt; 0.6 pg/ml</td>
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*: P=0.010 with respect to controls. **: P=0.015 with respect to controls.
the level of VP in women was low compared to that in men according with studies in literature\textsuperscript{28, 29}.

The fact that there is a high correlation between VP levels and working life for traffic policemen induce us to hypothesize that occupational exposure to stressors decreases the VP levels. Besides these, the exhibition to hostile conditions such as warm and hot weather in outdoor workers could determine alterations of VP\textsuperscript{1, 2}.

Actually, the studies on human subjects, environmental pollutants and exposure time is about an acute intoxication by carbon monoxide\textsuperscript{6–8}.

It is well known that personal exposure to benzene, toluene and other aromatic hydrocarbons from direct exposure to traffic fumes, as experienced by some categories of outdoor workers, such as traffic policemen, may be considered higher than personal exposure of indoor workers (particularly in our cities\textsuperscript{33}). For this reason in our previous researches we have studied exposure dosage to benzene, toluene and other aromatic hydrocarbons in Municipal Police employees of the city in question. Time weighted average (TWA) exposure to benzene (mean 10.7 and 3.6 µg/m\textsuperscript{3}, respectively) and to toluene (mean 40.7 and 13.5 µg/m\textsuperscript{3}, respectively) was significantly higher among traffic policemen than among indoor workers\textsuperscript{15–18}. Since previous studies have already measured the environmental and biological levels in our working population and it is well known that traffic policemen’s exposure dosage is significantly higher than controls, we didn’t repeat the exposure dosage study in this work.

The action mechanisms of urban pollutants and able to modify VP levels, are still uncertain. Studies on laboratory animals\textsuperscript{4, 5} and human subjects\textsuperscript{6–8} have led to the hypothesis that exposure to chemical and physical agents (such as noise and vibrations) may decrease\textsuperscript{4–8} or increase\textsuperscript{9} VP levels probably in relation to the doses, modality and time of exposure.

In vitro Bentley, et al. (1975) have demonstrated that cadmium (Cd) on the mucosal and on the serosal side of the toad urinary bladder inhibits the hydro-osmotic effect of VP, but has no effect on the natriferic response to this hormone. These effects could be similar in human kidney\textsuperscript{4}.

A study on animals has shown that toluene administration could cause significant decrease of the neural numbers of VP in the preoptic and hypothalamic areas\textsuperscript{5}.

In literature a case of diabetes insipidus was described in a refinery worker frequently exposed to fuel with tetraethyl lead (Pb). In that case a toxic action by this compound on SON and PVN nucleus was supposed\textsuperscript{6}.

Central diabetes insipidus was reported after carbon monoxide (CO) poisoning\textsuperscript{7, 8}. In CO intoxication an increase of blood flow took place in the entire cerebral region except for the neurohypophysis\textsuperscript{8}.

Alterations of VP have been described among the extra-aural effects of noise and vibrations. Studies on animals have shown a strong inductive effect by noise and vibration on VP, in agree with the results of studies on hypertensive
effects following exposure to noise. The changes obtained in the structure of the neurohypophysis, in audio-vibratory stress, can be considered as a form of adaptive response to changed environmental conditions in order to maintain the neuroendocrine equilibrium of the organism\(^9\). On the contrary, Fruhstorfer and co-workers (1988) have evaluated industrial noise exposure effects on the release of pituitary hormones in human subjects: it has been impossible to ascertain a noise stress influence on VP secreting models\(^{10}\).

These data induce to suppose that a cumulative effect may exist for stressors of different nature able to determine lower or higher plasma VP concentrations with central or peripheral action mechanism.

In conclusion, the present study suggests that the specific working activity of traffic policemen of both sexes exposed to chemical and physical agents present in the city in question can reduce the plasma VP concentrations. Such changes might be regarded as early signs of risk for the general population exposed to environmental stressors also, even if the ways and times are different compared to working populations.

References


