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Anesthetic gases and occupationally exposed workers

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ABSTRACT

The aim of this study is to estimate whether the occupational exposure to low dose anesthetic gases could cause alterations of blood parameters in health care workers. 119 exposed subjects and 184 not exposed controls were included in the study. Each worker underwent the complete blood count test (CBC), proteinaemia, leukocyte count, serum lipids, liver and kidney blood markers.

The liver blood markers show statistically significant differences in health care workers compared with controls ($p < 0.05$), a statistically significant decrease in neutrophils and an increase of lymphocytes in health care workers compared with controls ($p < 0.05$). The prevalence of values outside the range for GPT, GGT, total bilirubin, lymphocytes and neutrophils was statistically significant in health care workers compared with controls ($p < 0.05$). The results suggest that occupational exposure to low dose anesthetic gases could influence some haematochemical hepatic and hematopoietic parameters in exposed health care workers.

1. Introduction

Several epidemiological studies suggested that even serious health effects may result from chronic exposure to low levels of anesthetic gases inhalation (Gwak et al., 2011; Kugel et al., 1989).

According to Obata et al. (2000), the main volatile anesthetics currently used in health care are degraded into potentially toxic products (Obata et al., 2000). The enflurane, the isoflurane and the desflurane generate carbon monoxide and are a potential cause of poisoning (Wallin et al., 1975). The halothane and sevoflurane generate difluoroethylene, aloalchene and trifluoromethyl vinyl ether (commonly known as "compound A"). In individuals chronically exposed compound A and the other products listed above may cause hepatotoxicity, nephrotoxicity, carcinogenesis, immune deficiency, impairment of fertility and negative effects on the fetal development (Burm, 2003; Nilsson et al., 2005; Sahin et al., 2011).

Kharasch et al. (2001) showed that the damage to target tissues occur after the administration of general anesthesia with all types of anesthetics, both inhaled and intravenous (Kharasch et al., 2001), with the consequent increase of organic enzymatic markers and the development of organic

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alterations detectable with clinical and instrumental examinations (Suttner et al., 2000).

In their research Hoerauf et al. (1997) showed that inhaled exposure to trace of anesthetic gases can affect the health of operating room personnel (Hoerauf et al., 1997) and several authors suggested that the chronic exposure to these gases has the power to cause variations in the genome of the target cells of exposed workers (Chandrasekhar et al., 2006; Szyfter et al., 2004).

The exposure measurements taken in operating rooms during the clinical administering of inhalational anesthetics indicate that these gases from the different components of the machinery for anesthesia may start to circulate in the environment coming. In addition, some techniques of anesthesia and the use of improper practices can actually favor the escape of anesthetic gases in the operating room (Chandrasekhar et al., 2006).

The scientific literature is still controversial in establishing a cause–effect link between adverse health effects and occupational exposure to anesthetic gases. However, the potential risk of adverse effects due to occupational chronic exposure to these compounds has led public health authorities to publish standards for occupational exposure to minimize the possible health effects (Huber, 1994). The American Conference of Governmental Industrial Hygienists (ACGIH, 2011) recommends as a global standard for occupational exposure (TLV-TWA) to halogenated anesthetic gases, 50 ppm for halothane and nitrous oxide (N_2O) and 75 ppm for enflurane and isoflurane.

The National Institute for Occupational Safety and Health (NIOSH, 1977) instead recommended stricter occupational exposure limits: 25 ppm for N_2O and 2 ppm for all halogenated anesthetics used alone, and 0.5 ppm, when in combination with N_2O.

Health authorities have also developed technical procedures (e.g., sampling methods, active air treatment systems, maintenance procedures and leak test of the machinery used for anesthesia, medical surveillance of exposed workers, etc.) to minimize the concentrations of anesthetic gases and to improve the healthness of the operating rooms (Hoerauf et al., 1997).

However, in the literature it was demonstrated that despite the implementation of these measures (Tonn and Whitcher, 1980; Whitcher et al., 1975) and despite the improvement of anesthetic techniques and instrumentation (Christensen et al., 1985; Hallonsen, 1982; Henry et al., 1992; Jacobs and Middendorf, 1986) the risk of exposure to anesthetic gases is still present in operating rooms (Chang et al., 1997; Chandrasekhar et al., 2006; OSHA, 2000). Also the use of masks for induction of anesthesia, the use of tracheal uncuffed tubes and of laryngeal mask during surgical operations may increase exposure to anesthetic gases since all instruments are subject to uncontrolled losses of gas (Hoerauf et al., 1999; Li et al., 2002). Some epidemiological studies showed that the chemicals contained in anesthetic gases may contaminate the air of operating rooms with the risk of potentially hazardous chronic exposure for exposed workers (Bruce et al., 1974; Cohen et al., 1971, 1980; Guirguis et al., 1990; Vessey and Nunn, 1980).

The results of the analysis of some research focused on these topics identified an increase of hepatic markers (AST, ALT, GGT and bilirubin) among the major effects of chronic exposure to low doses of anesthetic gases (Bito and Ikeda, 1994; Eger et al., 1997; Kharasch et al., 1997, 2001; Obata et al., 2000; Sahin et al., 2011). According to several authors in the literature chronic exposure to low doses are also capable to generate alterations of the immunological parameters (Ahlers et al., 2008; Caciari et al., 2012c; Chandrasekhar et al., 2006; Liu et al., 2011; Urner et al., 2011).

To date, the CBC blood is the most accessible and widely used test to evaluate the blood chemistry in these alterations (Sokolov et al., 1985; Dainiak et al., 2003).

The purpose of this research is to assess the health condition of a group of workers exposed to anesthetic gases compared to a control group of non-exposed workers.

2. Materials and methods

The research was carried out from an initial sample of 235 workers exposed to anesthetic gases and vapors in operating rooms and 302 workers not occupationally exposed (controls).

Health care exposed workers were assigned to tasks of anesthesiologists, surgeons, operating room doctors, nurses, and attending the surgery for longer than 20 h per week.

The anesthetic gases mainly used in the operating rooms of our study were: halothane, enflurane and isoflurane mixed with N_2O and oxygen.

The control group was composed of blood donor volunteer workers employees, housewives, teachers, businessmen, medical personnel not exposed to anesthetic gases and blue collar with various qualifications.

In the presence of a physician, a clinical medical questionnaire was given each worker on the same day of the blood sampling. The questionnaire included information on age, medical history, physiological history (especially focused on diet, alcohol consumption and exposure to tobacco smoke), remote and recent occupational, patological and pharmacological history. The questionnaire included items on headache, fatigue, arrhythmias, allergic reactions, gastritis, rhinitis, laryngitis, mouth herpes and menstrual disorders in order to identify the presence of liver diseases, past or current use of potentially hepatotoxic drugs, family history of liver disease and abitual use of solvents, paints or pesticides during spare time or in previous jobs.

All studied workers underwent to diagnostic protocols for the research of B and C hepatitis markers, for the research of possible infection, of vaccine covering and for the control of antibody title due to past infection.

In order to avoid the influence of the main confounding factors, all workers positive for B and C hepatitis markers, positive for medical history of hepatic, renal and hematic diseases, those who had not completed medical preventive checks of vaccine covering, those who reported taking chemotherapeutic and antiblastic drugs and those who reported the use of solvents, paints or pesticides during spare time or in previous jobs were excluded from the study.

The remaining exposed workers and controls were then made comparable for age and working life.

A final sample of 303 workers was studied: 119 professionally exposed workers and 184 not professionally exposed controls.