The use of simple diffusion tube samplers for the measurement of nitrogen dioxide in an operating room using nitrogen oxide as an anaesthetic (July – November 1999)

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Summary

Estimates have been made of the amounts of nitrogen dioxide (NO_2) in the operating room of University of Benin Teaching Hospital (UBTH) where nitrous oxide (N_2O) a potential source of NO is used as an anaesthetic agent. Measurements were made using palmes diffusion tubes, a device which is capable of taking samples of NO_2 gas from the atmosphere through diffusion or permeation of this compound to the interior and subsequently trapping it by means of adsorption on reactive material, but which does not involve the active movement of the gas through the sampler.

Results obtained indicate a low concentration of NO_2 in the operating room with a minimum of 5.83µg/m³ and a maximum concentration of 6.22 µg/m³ NO_2. This result therefore suggests that the use of nitrous oxide in the operating room does not contribute significantly to the concentration of NO_2.

Key words: ***Operating room, Indoor environment, Outdoor environment, Nitrogen dioxide, Nitrous oxide.***

Résumé

On avait calculé la quantité d'azote dioxyde(NO_2) dans la salle d'opération du centre universitaire de l'enseignement hospitalier du Benin (UBTH) ou l'azote oxyde (N_2O) qui est la source la tente de NO était utilisée comme agent de l'anasthésique. On avait pris la mesure tout en utilisant les palmes tubes diffusion, une méthode à travers laquelle on pourrait prendre des échantillons de NO_2 gaz dans l'atmosphère à travers la diffusion ou la filtration de ce composé chimique dans l'intérieur et finalement le gas est pris à travers le processus de l'absorbtion sur un matériel réactif; toutefois, ceci ne provoque pas le movement actif du gaz à travers le modèle. Il en résulte que la concentration de NO_2 est en baisse dans la salle d'opération avec 5.83µg/m3 au minimum et la concentration de 6.22µg/m3 No_2 au maximun. Par suite de cette conclusion on peut dire que l'utilisation de nitreux oxyde dans la salle d'opération n'a pas assez d'influence sur la concentration de NO_2.

Introduction

Several pollutants from indoor sources affect human health. The spectrum of effects ranges from mild irritation of nasal and mucous membranes to irreversible toxic and carcinogenic effects. The evaluation of indoor exposure to air pollution in the workplace is therefore essential for realistic health effects assessment. An average adult breathes approximately 10 to 15m³ of air each day and has little choice whether or not to take the air in the vicinity.

Association between air pollution and the spread of disease has been established. Indoor air pollution is a definite factor in human and animal morbidity and mortality. Nitrous oxide has been used as an anaesthetic in medical practice in Nigeria for many years and although the administration of general anaesthetic in medical practices in countries such as the United States and United Kingdom has decreased over the last few years the use of nitrous oxide continues in relative analgesia or inhalation sedation.

Nitrous oxide which was hitherto regarded to be inert can no longer be seen from this perspective as it produces hazardous effects which have been reviewed recently[1]. Apart from its deleterious effect such as its reaction with metal complexes, in particular those involving cobalt, where it oxidises reduced vitamin B_{12} (cobalamin)[2], N_2O a greenhouse gas[3] is considered to be an important source of NO[4,5] which is of significance for the production and distribution of NO_2 in the atmosphere[6]. Nitrogen dioxide is an oxidant gas that at high concentrations causes lung injury. Toxicologic studies have shown that it reduces the efficacy of lung defense mechanisms against infection[7]. Some studies suggest that short-term exposure may exacerbate asthma[8]. Thus, the potential health effects of exposure to nitrogen dioxide indoors include increased respiratory tact infection from effects of defence mechanisms, increased respiratory tract symptoms and reduced lung function from direct inflammation, and deterioration of the health status of persons with chronic respiratory diseases, particularly asthma.

The Federal Environmental Protection Agency (FEPA) standard for NO_2 is presently 75-113 µg/m³ (daily average of hourly values range). The US National Ambient Air Quality Standard for NO_2 is presently 100µg/m³ annual average while the World Health Organization[9] has recommended a short-term standard of 320µg/m³ (1 hour average) not to be exceeded more than once per month. The continuing concern about health effects of exposure to NO_2 has prompted us to measure the level of NO_2 in the operating room of UBTH where N_2O a possible source of NO_2 is used as an anaesthetic agent.

Materials and method

The measurements were performed in the main operating room of the University of Benin Teaching Hospital and an outdoor site created by pharmacy department of the hospital to act as a control.

To measure NO_2 concentration, we used passive diffusion samplers developed and used by Palmes[10-13] and others[14-18]. These are small, 3 inches long, 3/8 in diameter acrylic tubes with stainless steel wire mesh coated in triethanolamine inserted and protected in one end. When open to the atmosphere, NO_2 molecules diffuse at a rate proportional to the ambient concentration. The tubes were prepared as described in the literature and mounted vertically at a height of approximately 2.0m above the ground surface on the supporting stands at each sampling point.

Two-week sampling period was used to allow a reasonable quantity of NO_2 to be adsorbed. The monitoring was done continuously from July to November 1999. The analytical finish was accomplished using a clean visible spectrophotometer at zero extinction to determine the extinction of the air samples at a wavelength of 540mm and NO_2 concentration was calculated from the amount adsorbed.

Results

Results available from the series of measurements carried out between July and November 1999 to evaluate the level of NO_2 in the operating room of the University of Benin Teaching Hospital are shown in Tables 1 – 5. A cursory look at the tables reveal that throughout the sampling duration, very low concentration of NO_2 were recorded with a minimum of 5.8µg/m³ and a maximum of

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Table 1 Concentration of NO_2 obtained for July

Site	Code	Start Date	Time	End Date	Time	Time hours	Conc in µg/m^3
Main Theatre	MT	2/7/99	9.10am	16/7/99	9.10am	336	6.20
(indoors)		16/7/99	9.10am	30/7/99	9.30am	336.20	6.09
Pharmacy Dept	PD	2/7/99	9.30am	16/7/99	9.30am	336	5.08
(Out door)		16/7/99	9.30am	30/7/99	9.35am	336.05	6.02

Table 2 Concentration of NO_2 obtained for August

Site	Code	Start Date	Time	End Date	Time	Time hours	Conc in µg/m^3
Main Theatre	MT	1/8/99	10.00am	15/8/99	10.15am	336.15	6.03
(indoors)		15/8/99	10.00am	29/8/99	10.15am	336	6.12
Pharmacy Dept	PD	1/8/99	10.15am	1/8/99	10.25am	336.10	5.82
(Out door)		15/8/99	10.25am	15/8/99	10.30am	336.05	6.02

Table 3 Concentration of NO_2 obtained for September

Site	Code	Start Date	Time	End Date	Time	Time hours	Conc in µg/m^3
Main Theatre	MT	2/9/99	9.30am	16/9/99	9.30am	336	5.83
(indoors)		16/9/99	9.30am	30/9/99	11.30am	338	6.22
Pharmacy Dept	PD	2/9/99	9.40am	16/9/99	9.40am	336	4.88
(Out door)		16/9/99	9.45am	30/9/99	9.50am	336.05	5.20

Table 4 Concentration of NO_2 obtained for October

Site	Code	Start Date	Time	End Date	Time	Time hours	Conc in µg/m^3
Main Theatre	MT	2/10/99	9.10am	16/10/99	9.10am	336	6.20
(indoors)		16/10/99	9.10am	30/10/99	9.10am	336	6.11
Pharmacy Dept	PD	2/10/99	9.20am	16/10/99	9.30am	336.10	5.36
(Out door)		16/10/99	9.30am	30/10/99	9.30am	336	6.03

Table 5 Concentration of NO_2 obtained for November

Site	Code	Start Date	Time	End Date	Time	Time hours	Conc in µg/m^3
Main Theatre	MT	1/11/99	9.00am	15/11/99	9.00am	336	5.83
(indoors)		15/11/99	9.00am	30/10/99	9.15am	338	6.22
Pharmacy Dept	PD	1/11/99	9.30am	16/10/99	10.30am	337	6.02
(Out door)		15/11/99	10.30am	29/11/99	10.30am	336	5.60

6.22µg/m^3 in the operating room. For the first month of sampling, a maximum concentration of 6.20µg/m^3 NO_2 was obtained. For the month of August. NO_2 was found to vary from 6.02 – 6.12µg/m^3. In the outdoor site, a range of 5.92 – 6.02µg/m^3 NO_2 was obtained.

In the third month measurement, a mean NO_2 concentration of 6.03µg/m^3 was measured, while a mean of 5.04µg/m^3 was obtained outdoor. In November the last month of measurement, a range of 6.08 – 6.12µg/m^3 NO_2 was obtained in the operating room. In the outdoor site, a range of 5.60 – 6.02µg/m^3 NO_2 was recorded.

Discussion of results

As seen from the tables, low concentration of NO_2 were recorded at both the operating room and the outdoor site created as a control. It is essential to state that this investigation is preliminary and embarked upon in response to anxiety expressed by doctors operating in the theatre for fear of possible exposure to excessive level of nitrogen dioxide a pollutant with deleterious effects. The low level of NO_2 obtained indoors in this study when compared with FEPA standard of 75 - 113µg/m^3 NO_2 daily average of hourly value range, indicates that N_2O might not be contributing significantly to the NO_2 budget in the operating room. As equally seen in the tables, no significant differences were observed in the indoor and outdoor NO_2 level for the five months of investigation. However, because we are talking about trace concentrations which are very significant in pollution studies, it is essential to highlight therefore that the NO_2 concentration obtained in the operating room was slightly higher than that obtained outdoor. This observed variation in the NO_2 levels in the two sites might be due to the use of N_2O as an anaesthetic agent in the operating room which is a potential source of NO_2. The major anthropogenic source of NO_2 in the atmospheric is the combustion of fossil fuels. Though nitrous oxide has been indicated as a potential source of NO_2 through the initial formation of NO, the formation process is predominantly photochemical and therefore should be of utmost significance in the stratosphere. The low concentration of NO_2 obtained in the operating room and the lack of obvious differences in the concentrations obtained at the two environments confirm therefore that the use of nitrous oxide cannot contribute significantly to the nitrogen dioxide budget in the troposphere. Though the level of NO_2 obtained in this study is low, efforts should be geared towards preventing an upsurge. It is equally essential to point out that accumulation of low concentration of a pollutant over a long period of time can be lethal with attendant catastrophic consequences.

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