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Case Study

Asthma Caused by Peracetic Acid-Hydrogen Peroxide Mixture

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Thorough preventive measures against potential patient infections caused by endoscopic material has become a priority in hospitals and has pushed hospital care personnel to use increasingly more powerful disinfectant products with much longer contact periods, which has been responsible for a deterioration in their health. Among chemical disinfectants, formaldehyde and glutaraldehyde were the most widely used[1)] for reducing microbial contamination responsible for infectious accidents following invasive endoscopies. At present, oxidizing agents such as PA-HP, have replaced them but are known to be ineffective for the prion inactivation cycle[2)] and to have toxic effects on patients, nursing staff and the environment[3)]. PA-HP is officially recommended with respective concentrations of 0.08% and 1% for best sterilization of germs responsible for infections and on biofilm (organic polymer sticking to a surface)[1)]. Occupational asthma has been documented in nurses exposed to solvents such as formaldehyde but has not yet been described in workers exposed to PA-HP. We report the cases of two subjects who developed cough, wheezing and shortness of breath after being exposed to PA-HP vapors.

Case Reports

Subject No.1

A 48-year-old man was employed as a hospital anaesthetist nurse in an endoscopy unit of a gastroenterology department. In his job, he managed and watched patients who came for invasive endoscopy explorations in an operating room and also sterilized flexible endoscopic equipment and accessories. In this room, he performed immersion in detergent-disinfectants containing quaternary ammonium compounds for 15 min before rinsing and brushing. In a communicating enclosed room, he performed every day, 2 disinfection cycles, manual and automatic. For manual decontamination, he prepared baths of PA-HP and for machine bowl automatic disinfection he used peracetic acid only. He was exposed to PA-HP vapors 5 d a week, particularly when he opened the machine washer 20 times a day and during manual decontamination. In the sterilizing room, a ventilation system with a chemical filter for extraction of PA-HP from the work area was used, but unfortunately there was no available data on area PA-HP concentrations. During his job, he wore protective clothing and gloves. When he added disinfectant product to the washer, every 2 d, his mouth and nose were covered by a mask (without a vapor filter) and his eyes were protected by goggles. Five months after beginning PA-HP employment, he noticed rhinorrhea, conjunctivitis and dry cough without wheezing, whilst present at the workplace. These troubles usually started on Monday evening, 8 h after exposure to PA-HP vapours and lasted all the work week. The symptoms completely improved when the subject was off work for 3 wk during holidays, but recurred upon his return to work associated with: continuous cough, breathlessness and chest tightness. Before being PA-HP exposed, he used quaternary ammonium compounds for several months; he had no personal or family history of asthma or atopic symptoms. He was a non-smoker and had never been exposed to cats. He associated his troubles with the introduction of PA-HP. Investigation data are presented in Table 1. Among atmospheric acetic acid measures performed, the higher level (1.6 ppm) was obtained in the disinfecting room after 20 min of PA-HP manipulation.

Symptomatology rapidly disappeared after 8 d away from work, but the signs reappeared on return to the work place. Serial monitoring of peak expiratory flow (PEF) rates, 3 times a day during 2 months, for a period including time at work and away from work, and particularly after having left the gastroenterology unit, highly suggested work-related asthma, Fig. 1.

Subject No.2

A 47-yr-old woman worked as auxiliary nurse in an otorhinolaryngology department for 5 years. Her daily duties consisted of preparing flexible endoscopic equipment for several patients' examinations and performing mainly decontamination procedures (3 time a day), including bags of quaternary ammonium compounds (like subject No.1) and PA- HP, which was used to prepare tubs for the sterilization process of soiled medical materials.

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Table 1. Blood, chest X-ray and spirometry data of subject No. 1 and subject No. 2

Investigations	Subject No. 1	Subject No. 2
Chest radiograph	Normal	Normal
Skin prick tests to common allergens		
Cat fur	(+)	(–)
Latex	(–)	(–)
Other common allergens	(–)	(–)
Baseline spirometric measurements		
VC (% predicted)	100.9%	96%
FEV1 (% predicted)	105.3%	96.7%
FEV1/VC	90.3%	81%
Methacholine challenge (PC20)	1.5 mg.ml^{-1}	0.8 mg.ml^{-1}

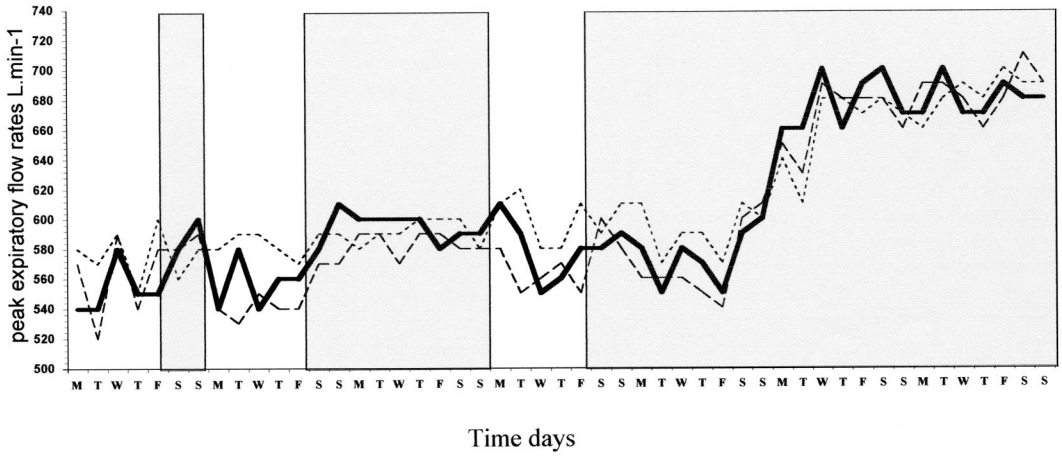

Fig. 1. Occupational asthma course of the endoscopy anaesthetist nurse (subject No. 1) during 2 months (see the increase of PEF during days away from work).
- - - : morning PEF rate; ▬: twelve o'clock PEF rate; — — — : evening PEF rate;
□: days away from work; □ : days at work.

She was exposed to PA-HP mix vapours, 5 d a week for 8 h a day, for 3 yr without any problem. The decontamination room was located near the operating room and the ventilation system of the area was considered to be poor. During the sterilization processes, the subject wore long gloves for the hands, covered her mouth and nose with a mask and protected her eyes with goggles. After two and a half years of daily exposure to this sterilization processes, she developed chest tightness, rhinorrhea, and conjunctivitis. Symptoms started 1–4 h after the end of exposure and persisted for several hours. She was seen by her personal physician 3–4 d later who prescribed an antihistamine and an inhaled bronchodilator. She also described after the end of a working week, an episode of contact dermatitis, epistaxis and dysphonia. These symptoms improved during weekends and completely disappeared on holidays. The subject associated all her troubles with the PA-HP exposure. She had been smoking about a pack of cigarettes daily for 30 yr. Three months after the symptoms began an investigation was made. Data are presented in Table 1. A specific inhalation challenge (SIC)[5] to PA-HP was performed, a routine in our institution for diagnosis purpose. Spirometric values were obtained before, during and after PA-PH exposure according to exposure protocol[5]. The subject was exposed to PA-HP with a closed-circuit particle generator for increasing intervals up to 2 h. She developed an early asthmatic reaction (20% drop in FEV1) 50 min after challenge with dysphonia (Fig. 2). The eosinophil rate in sputum[6] was found to be 2% and 4% before and after PA-HP exposure, respectively. The higher atmospheric acetic acid level (9.7 ppm) was obtained in the disinfecting room entrance, 2 h after PA-HP tub change and filling.

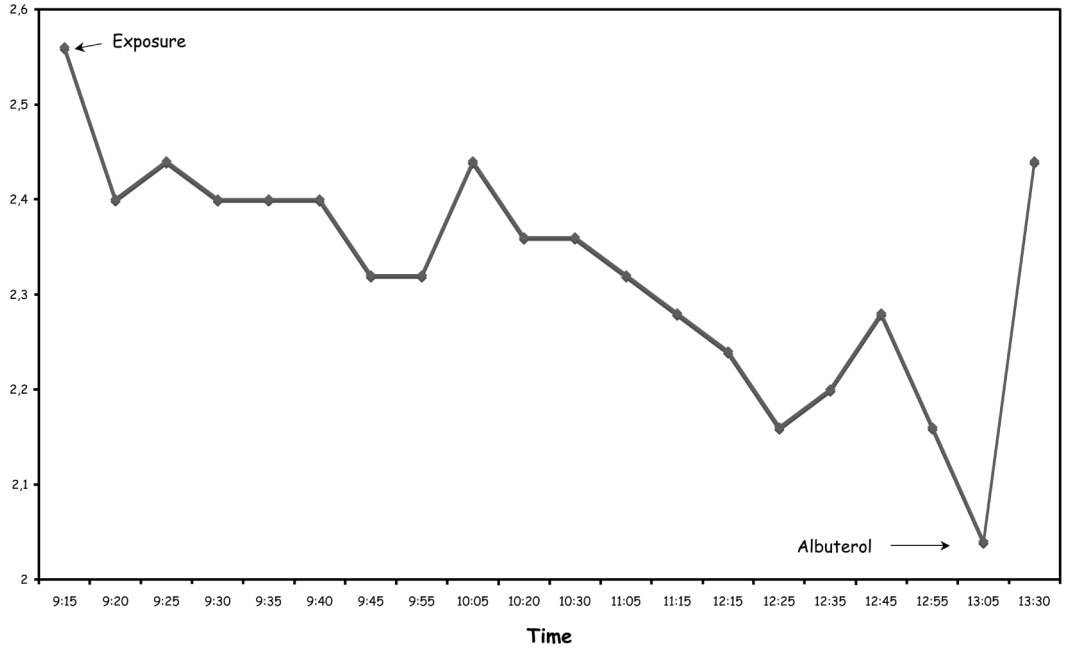

Fig. 2. Inhalation challenge test. FEV1 measures at defined time points from nurse (subject No.2) exposed to PA-HP. After a drop of FEV1 >20% of baseline, the bronchial obstruction was reversed by 200 μg of inhaled albuterol.

Discussion

Peracetic acid (PA) and hydrogen peroxide (HP, chemical symbolized H_2O_2) mixture have recently been introduced as disinfectants to maintain a high level of endoscopy disinfection. PA exhibits excellent antimicrobial properties, especially under acidic conditions. HP is more effective as a sporicide than as a bactericide. The combination of PA and HP, tested by a checkerboard micromethod, was found to be synergistic[7]. Despite little being known about the potential health risks presented by these oxidizers, their use is widespread. PA and HP are not known to induce allergic reactions[8]. PA is a compound with strong vinegar smell and a "reactive airways dysfunction syndrome" (RADS) can occur after exposure to a high concentration[9]. HP was described as being associated with interstitial pneumonia in a dairy worker[10]. To our knowledge, the possible asthma effects of PA-HP in usual employment have not been reported. The results of the present two cases suggest that oxidizers can induce occupational asthma. The causal relationship between symptoms and occupational exposure was emphasized by the significant decrease in the PEF rate recording of the first case. Besides, the positive result of the specific inhalation challenge test to PA-HP of the second subject confirms the diagnosis of occupational asthma. Quaternary ammonium compounds can be excluded from suspicion because vapors were absent or very low and no symptom was observed among the operating room workers. The two subjects attributed their symptoms to PA-HP. Due to technical difficulties, PA-HP exposure levels can't usually be measured at the work place and no threshold value has yet been defined. The acetic acid exposure levels obtained in the disinfecting rooms don't permit the estimation of the PA-HP levels.

Based on clinical features and pathophysiological characteristics, we should attempt to understand which mechanisms, allergic or irritative, should be incriminated in this symptomatology[11]. Because of the absence of a single, specific, accidental high concentration of disinfectant exposure, and because the pathology appeared after a latency period, (several weeks or months), the respiratory symptoms observed here, do not support the diagnosis of RADS. The existence of a latency period necessary for acquiring sensitization and the complete disappearance of symptoms after removal from exposure indicate an allergic mechanism. However, many arguments suggest the irritant induced asthma (IIA) thesis: 1) absence of a major sign of asthma (wheezing); 2) association of irritant syndrome such as epistaxis, dysphonia, agueusia; 3) repeated prolonged exposures to vapors containing irritant agents; 4) difficulty in breathing, breathlessness slowly appeared; 5) absence of signs of asthma just before occupational exposure; and 6) absence of sensitivity to inhalant common prick tests for subject No. 2. Thus, disinfectants belonging to the oxidant class, such as mixtures of PA-HP, seem to act as occupational irritants on subjects free of any apparent

pathology.

The mild degradation of the respiratory function, without any major asthmatic sign, led these two patients to seek a late consultation. The allergic or irritant mechanism of this OA is difficult to define; both seem possible. Recently, an increase in H_2O_2 concentrations in the expired breath of patients with some pulmonary pathology[12] has been reported. Another study reported a correlation between expired H_2O_2, sputum eosinophils and airway hyperresponsiveness[6]. H_2O_2 is considered to be an oxidative stress marker, and could therefore explain the mechanism of this kind of asthma: low concentrations of PA-HP might increase the oxidative stress, as well as lipids peroxidation, causing the appearance of bronchoconstriction[12].

In order to confront the risks of uncontrolled use of PA and HP disinfectants, manufacturers, health and hospital staff should be warned against the side-effects of such products, therefore enabling them to take the necessary preventive measures. These measures are also applicable to the agro-alimentary industry where PA and HP are frequently used for the sterilisation of different tools, instruments and glassware material.

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