factor rather than genetics. However, their sharing of genes will not be increased above that expected (based on their relatedness) unless there is an association between gene and phenotype. It is possible that one might detect genes for susceptibility to helminthiasis (e.g., *Toxocara canis* or *Strongyloides stercoralis*) (7) rather than atopy, but it is more likely that the study's power to detect atopy genes would be decreased.

In view of these findings, if we were carrying out a genetic study of total serum IgE level, we would consider it prudent to test all subjects with high levels for the presence of helminth infections, even in families recruited in Western countries. These data would be included in the genetic analysis, and could also be used, along with genotype information, to examine the vexed question of the relationship between helminth infections and atopy (8).

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Glutaraldehyde-induced asthma

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Key words: glutaraldehyde; nonspecific bronchial hyperresponsiveness; occupational asthma; specific bronchial challenge test.

● Glutaraldehyde is a low-molecular-weight aliphatic dialdehyde widely used as a 2% aqueous solution in the cold sterilization of medical equipment and as a hardener in the development of radiographs. Exposure to this disinfecting agent has been shown to cause symptoms of irritation of the upper respiratory tract, dermatitis (1, 2), and occupational asthma of uncertain mechanism (3–6).

Glutaraldehyde disinfectant caused occupational asthma in a nurse.

We describe a 61-year-old nurse, an ex-smoker, who began working in a renal dialysis unit in 1976. Ten years later, she experienced sporadic and mild episodes of chest tightness and shortness of breath related to exposure to formalin, which was used to sterilize artificial kidney machines. In 1994, formalin was replaced with 2% glutaraldehyde (Cidex®, Johnson & Johnson Medical, Skipton, UK), which she handled daily in an open environment. She was symptomless until February 1998, when she developed symptoms of irritation of the eyes and upper respiratory tract, dyspnea on exertion, dry cough, and episodic attacks of wheezing, which she associated with glutaraldehyde exposure. Her symptoms were progressively severe, and she had an acute asthma attack requiring hospital admission. She then took sick leave, during which she slowly recovered. When initially evaluated in our clinic, she had been away from work for 3 months, had been

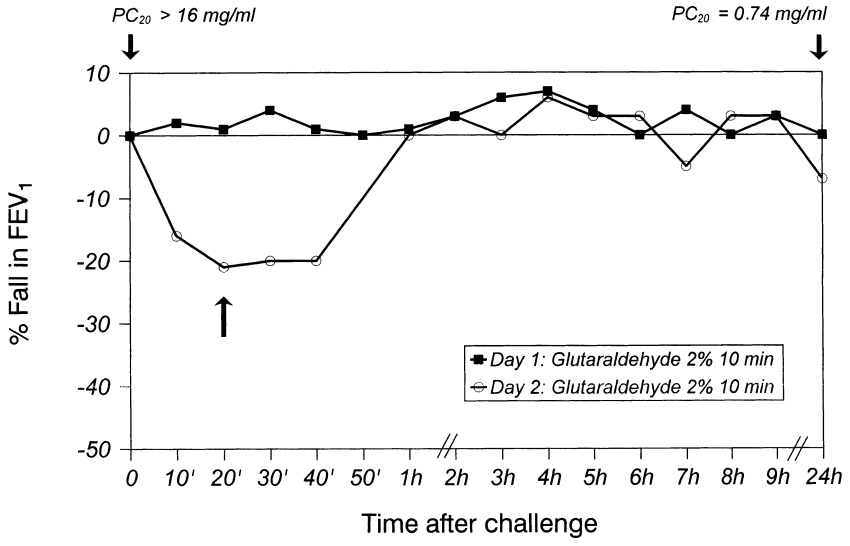

Figure 1. Exposure to 2% glutaraldehyde aqueous solution for 10 min on test day 1 did not induce significant changes in FEV_1, but methacholine inhalation test became positive (PC_{20} 0. 74 mg/ml). Re-exposure to 2% glutaraldehyde for 10 min on test day 2 elicited immediate asthmatic response. Arrow: salbutamol 200 μg.

treated with budesonide 1600 μg/daily and β-agonists, and was free of symptoms. A chest radiograph was normal. The absolute eosinophil count in peripheral blood was 730 mm^3. The serum IgE level was 16.9 kU/l. Skin prick tests to a battery of common aeroallergens, natural latex (ALK-Abelló, Madrid, Spain), and 2% glutaraldehyde were all negative. Spirometry revealed FEV_1 of 1.88 l (93% predicted), FVC of 2.74 l (112% predicted), and FEV_1/FVC of 69%. At that time, the methacholine inhalation test (tidal breathing method) was negative (PC_{20}>16 mg/ml). She then underwent the specific bronchial challenge test with activated 2% glutaraldehyde aqueous solution painted onto cardboard in a 7-m^3 challenge chamber for 10 min, as previously described (6). No changes in FEV_1 were observed during a 24-h monitoring period. However, at the end of this period, the methacholine inhalation test became positive (PC_{20} 0.74 mg/ml). One week later, the challenge test with 2% glutaraldehyde was repeated, and it elicited an early asthmatic response (Fig. 1). Although no late reaction was observed, a recurrent nocturnal asthmatic reaction occurred in the following days. The same test performed in two unexposed asthmatic patients elicited no response.

Occupational exposure to glutaraldehyde has been shown to cause rhinitis (1–3) and asthma (3–6), affecting mainly the staff of endoscopy and radiographic departments. These cases were diagnosed by occupational-type specific bronchial challenge. The level of glutaraldehyde in the air during simulated specific bronchial challenge tests with 2% glutaraldehyde was in the range 0.064–0.081 mg/m^3 (6), which is well below the short-term exposure standard of 0.7 mg/m^3 (0.2 ppm) or even the more stringent 0.05 ppm ceiling limit (ACGIH). Occupational asthma caused by formaldehyde has been reported among renal dialysis staff members (8), and cross-reactivity between formaldehyde and glutaraldehyde has been suggested (6).

The type of mechanism responsible for glutaraldehyde-induced asthma is not known because specific IgE antibodies have not been demonstrated in affected subjects, or can be detected in only a small percentage of exposed workers with work-related symptoms (7). In our patient, the specific challenge test provoked the appearance of nonspecific bronchial hyperresponsiveness (NSBH), which preceded the development of an asthmatic reaction to glutaraldehyde. This increase in NSBH may help to distinguish an asthmatic reaction due to specific mechanisms from bronchoconstriction triggered by an irritant effect. Changes in NSBH after challenge represent early and sensitive markers of bronchial response to occupational agents (9).

Since glutaraldehyde is frequently used in the hospital as a disinfecting agent, the potential for glutaraldehyde-induced asthma, which may be life-threatening (4), should be emphasized.

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