

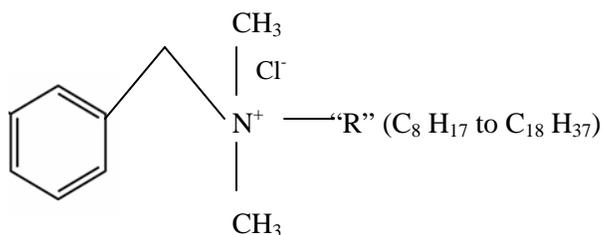
Disinfectants and Asthma

Recent concern about Methicillin Resistant Staphylococcus Aureus (MRSA) in schools and increased media hype to sell consumers cleaning agents that kill microbiological agents has led to increased disinfectant use among custodial and housekeeping staff as well as the general public. Unlike the other components of cleaning agents, regulations on disinfectants require the name of the disinfectant be listed on the cleaning product label. Quaternary Ammonium Chloride Compounds (QACs) are commonly used as the disinfectant in cleaning products.

Figure 1 shows the chemical structure of a QAC.

QACs have a benzyl group with carbon chains at the "R" position ranging in length from C_8H_{17} to $C_{18}H_{37}$. Commercial products are mixtures of QACs with different chain sizes. Manufacturers are not consistent in the way they assign the Chemical Abstracts Service number (CAS#) to the QAC in a product; some use the CAS# for QAC mixtures to represent mixtures of QACs, and some use a single CAS#, even though the cleaning product actually contains a mixture of different QACs. The inconsistent way that CAS#s are assigned to QACs makes it difficult to determine the exact agent responsible when a patient becomes sensitized.

Figure 1. Chemical Structure of Quaternary Ammonium Chloride



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The evidence that QACs cause asthma comes from case reports and case series where the affected cases had positive specific antigen bronchoprovocation studies and positive skin tests.

A case report from 1994 reported a woman in a factory that manufactured household cleaning products. She developed respiratory problems seven months after beginning to work at the facility (1). She had a positive specific bronchoprovocation challenge (50% drop in her FEV₁) to a liquid toilet bowl cleaner containing a QAC. She did not have reactions to challenges with a drain de-clogging solution, a window cleaner or an air freshener. She had skin testing with the components of the toilet bowl cleaner and only reacted to one of its components, a 1:1 mixture of **N-alkyl dimethyl benzyl and N-alkyl dimethylethyl benzyl ammonium chloride** (no CAS#s were provided in the paper). A control subject had both negative specific antigen bronchoprovocation and skin testing to this same mixture. The patient was removed from work and had complete remission of her symptoms. She had specific bronchoprovocation challenge testing two years later and again had a positive reaction.

A second report also from 1994 was on **lauryl dimethyl benzyl ammonium chloride** CAS# 139-07-1 (2). This is a high volume chemical with annual production exceeding 1 million pounds. In this report a 44-year old male pharmacist repeatedly had symptoms of asthma at work the day after the floor of the pharmacy he worked at was cleaned. His symptoms began one year after beginning to work at this location. Peak flow monitoring showed a clear relationship to work. He had multiple specific antigen bronchoprovocation testing. Testing was done with the suspect floor cleaner, each ingredient of the suspect floor cleaner, and a different detergent-based floor cleaner. He reacted to the suspect floor cleaner, with a drop in his FEV₁ from 4 to 2.5 liters at 10 hours and a similar drop in his FEV₁ after exposure to lauryl dimethyl benzyl ammonium chloride, which was an ingredient of the suspect floor cleaner. He did not react to any of the other ingredients of the suspect floor cleaner, the detergent-based floor cleaner or the suspect floor cleaner with all its ingredients included except the lauryl dimethyl benzyl ammonium chloride.

A third publication from 2000 reported on three nurses who developed asthma after exposure to a cleaning agent (3). All three had positive specific antigen bronchoprovocation tests to the cleaning agent, positive peak flow testing at work, positive methacholine challenge testing and no reactions to challenges of cleaning agents without the QAC. The exposure in this article was described as **benzalkonium chloride**. No CAS# was provided in the publication.

A fourth report from 2008 was on a 17-year-old woman who developed urticaria and dyspnea a few weeks after beginning to attend a catering school (4). Symptoms began 10 minutes after exposure to a particular cleaning agent and occurred "regularly" with exposure. She was tested for components of the cleaning agent. She had a positive skin test with urticaria for the QAC in the cleaning agent. For the other components in the cleaning agent, she had either negative skin tests or for one component erythema but no urticaria. Ten control patients were negative for all components. Avoiding exposure, she became symptom free. No mention is made of any pulmonary function testing. Although the dyspnea was not further evaluated, the authors described the patient's disease as urticaria, angioedema and asthma. The QAC identified in this article was **didecyl dimethyl ammonium chloride** CAS# 7173-51-5.

The difficulty in determining whether a QAC causes asthma is not with the medical documentation but rather with trying to pinpoint the actual QAC the patients were exposed to in the published medical reports of reactions to these disinfectants. Benzylalkonium, as used in the Purohit article, is not detailed enough to determine what mixture of QACs were the relevant exposures of the three nurses (3). The Bernstein article, which listed two specific QACs, was not of sufficient detail to be able to assign specific CAS#s to those QACs (1). It is likely that both reports contained QACs with varied carbon chain length. The other two articles listed specific compounds.

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Based on the likelihood that the Bernstein and Purohit articles were reports of mixtures of QACs causing asthma, it would be prudent to consider the following compounds capable of causing asthma:

- ✓ **Benzalkonium chloride** (Synonym - **Alkyl dimethyl benzyl ammonium chloride**) All of the following CAS#s are assigned to: **Dimethyl benzyl ammonium chloride**. The specific CAS# depends on the mixture of carbon chain lengths: 8001-54-5; 61789-71-7; 68424-85-1; 68989-00-4; 122-18-9; 122-19-0; 68391-01-5; 8045-22-5; 53516-76-0; 68607-20-5.
- ✓ **Dialkyl methyl benzyl ammonium chloride** CAS# 73049-75-9.
- ✓ **Dimethyl ethyl benzyl ammonium chloride** CAS# 68956-79-6.
- ✓ **Didecyl dimethyl ammonium chloride** CAS# 7173-51-5.
- ✓ **Lauryl dimethyl benzyl ammonium chloride** CAS# 139-07-1.

The use of these materials in spray products and plug-in air freshener products is particularly worrisome in terms of increased chemicals in the air and exposure to both the persons using the products as well as the individuals who are using the space. A recent CDC report considers disinfectant spray-fog technique to be an unsatisfactory method (5).

The results of a recent longitudinal study from the European Community Respiratory Health Survey, which found the highest risk of development of new onset asthma among consumers, usually women, who used three or more spray products in their homes four or more days a week, highlights the concern about spray cleaning products in general (6). The methodology of this paper was particularly strong with a longitudinal design, a large cohort, and standardized data acquisition including methacholine challenge testing. The authors were not able to identify the components of the spray products associated with the development of asthma but certainly QACs would be one of the suspect agents.

We are very interested in hearing from you about individuals with asthma possibly caused by cleaning agents and, in particular, with cleaning agents containing disinfectants. Since all disinfectants must be registered with the EPA, their presence in cleaning products is required to be clearly stated on the cleaning product container. Dr. Kenneth Rosenman can be reached at our toll free number, 1-800-446-7805, to discuss diagnostic issues and/or management of individual patients.

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