Antimicrobial Allergy From Polyvinyl Chloride Gloves

Kristiina Aalto-Korte, MD, PhD; Kristiina Alanko, PhD; Maj-Len Henriks-Eckerman, LSciTech; Riitta Jolanki, DTech

Background: Contact allergy to plastic gloves is rare. Benzisothiazolinone is a biocide that is mainly used in industrial settings. We first suspected delayed-type contact allergy to benzisothiazolinone from polyvinyl chloride (PVC) gloves in 2004. We looked through our medical records from 1991 to 2005 to find similar cases.

Observations: We found a total of 8 patients who are allergic to benzisothiazolinone and who had had exacerbations of their hand dermatitis while using PVC gloves. Patch testing revealed that 3 of them had weak allergic or doubtful reactions to the glove materials. Six of them had used Evercare Soft, Medi-Point, or Derma Grip PVC gloves, which in chemical analysis were shown to contain 9 to 32 ppm of benzisothiazolinone. Seven of the patients worked in dentistry or health care and 1 in farming. All of them had had hand dermatitis for many years.

Conclusions: To our knowledge, there have been no previous reports of contact allergy to antimicrobial agents in plastic gloves. Benzisothiazolinone is widely used as a biocide in the manufacture of disposable PVC gloves. Small amounts of benzisothiazolinone in the gloves may sensitize those who already have hand dermatitis. We recommend that all patients with hand dermatitis while using PVC gloves should be patch tested with benzisothiazolinone.

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<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Occupation</th>
<th>BIT CMI/MI OIT</th>
<th>Exposure to BIT: Patch Test Reaction to the Glove Material*</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assistant nurse</td>
<td>++ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from detergents and disinfectants</td>
</tr>
<tr>
<td>2</td>
<td>Dentist</td>
<td>++ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>Recurrent vesicular palmar dermatitis ACD from an formaldehyde-liberating antimicrobial in a liquid soap used at home</td>
</tr>
<tr>
<td>3</td>
<td>Dentist</td>
<td>+ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>Atopic dermatitis since childhood and atopic irritant hand dermatitis OICD from wet work</td>
</tr>
<tr>
<td>4</td>
<td>Dental nurse</td>
<td>+ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from wet work</td>
</tr>
</tbody>
</table>

### Previous Cases From the Test Files of Patients Who Had Used PVC Gloves at Work

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Occupation</th>
<th>BIT CMI/MI OIT</th>
<th>Exposure to BIT: Patch Test Reaction to the Glove Material*</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Dentist</td>
<td>+ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>Hand dermatitis and contact urticaria from NRL gloves</td>
</tr>
<tr>
<td>6</td>
<td>Dental nurse</td>
<td>++ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from thiuram rubber chemicals OICD from wet work and occlusive gloves</td>
</tr>
<tr>
<td>7</td>
<td>Dentist</td>
<td>++ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from wet work and occlusive gloves</td>
</tr>
<tr>
<td>8</td>
<td>Farming worker</td>
<td>+ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from wet work</td>
</tr>
<tr>
<td>9</td>
<td>Dental nurse</td>
<td>+ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>Dermographism (no dermatitis)</td>
</tr>
</tbody>
</table>

### Previous Cases of Patients Who Had Not Used PVC Gloves at Work

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Occupation</th>
<th>BIT CMI/MI OIT</th>
<th>Exposure to BIT: Patch Test Reaction to the Glove Material*</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Machine assembler</td>
<td>++ ++ ++</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from oils and petroleum</td>
</tr>
<tr>
<td>11</td>
<td>Carpenter</td>
<td>+ – ++</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from mineral wool and concrete dust</td>
</tr>
<tr>
<td>12</td>
<td>Electrician</td>
<td>++ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from epoxy and epoxy additives</td>
</tr>
<tr>
<td>13</td>
<td>Laboratory assistant</td>
<td>++ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from methylisitroso-p- tolensulfonamide laboratory chemical</td>
</tr>
<tr>
<td>14</td>
<td>Process worker</td>
<td>+ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from BIT in a biocide</td>
</tr>
<tr>
<td>15</td>
<td>Farmer</td>
<td>+ ++ –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>Status post-OACD from thiuram rubber chemicals OICD from dirty work</td>
</tr>
<tr>
<td>16</td>
<td>Laboratory worker in a paint factory</td>
<td>+ + – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from BIT in a biode</td>
</tr>
<tr>
<td>17</td>
<td>Machinist</td>
<td>++ + –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from BIT in an MWF‡</td>
</tr>
<tr>
<td>18</td>
<td>Paint production worker</td>
<td>+ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from BIT in an MWF</td>
</tr>
<tr>
<td>19</td>
<td>Machine repairer</td>
<td>++ ++ ++</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OACD from a coco-fatty acid derivative in a liquid soap and diethanolamine in MWFs</td>
</tr>
<tr>
<td>20</td>
<td>Newsman</td>
<td>+ – –</td>
<td>Recent Cases of Patients Who Had Used PVC Gloves</td>
<td>OICD from dirty work and mechanical irritation</td>
</tr>
</tbody>
</table>

Abbreviations: ACD, allergic contact dermatitis; BIT, benzisothiazolinone (1,2-benzisothiazolin-3-one); CMI/MI, 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one; IR, irritant reaction; MWF, metal-working fluid; NF, not found; NRL, natural rubber latex; NT, not tested; OACD, occupational allergic contact dermatitis; OICD, occupational irritant contact dermatitis; BIT, 2-N-octyl-4-isothiazolin-3-one; PVC, polyvinyl chloride; +, weak positive; ++, strong positive; ++++, extreme positive; ?+, doubtful reaction; −, negative.

*Manufacturer information: Derma Grip (Oriola Oy, Espoo, Finland), Evercare Soft (Selefate AB, Spånga, Sweden), Famon (Famon Oy, Helsinki, Finland), Medi-Point (insinjontistoisto Medi-Point Oy, Helsinki), Metatin K 518 (Acima Chemical Industries Ltd, Buchs, Switzerland), Nipacide (Clariant UK Ltd, Leeds, England), Roxel GLX (Avecia Inc, Wilmington, Del), Top Dent (Oriola Oy).

†Information in the material safety data sheet, label, or product description.

‡Chemical analysis was performed at the Finnish Institute of Occupational Health, Turku.

We have included BIT in our oil and lubricant series since 1991, and in 1992 it was also added to our antimicrobial series. It was first tested at a 0.05% concentration in alcohol and since 1994 at the same concentration in petrolatum (Chemotechnique Diagnostics, Malmo, Sweden). Also, BIT 0.1% in petrolatum (Trolab; Hermal, Reinbeck, Germany) was included in a dental patch series that was used in a study of dental nurses in 1999.30

We analyzed our skin test files for reactions to BIT. We checked the clinical records of the patients with an allergic re-
action (+, weak positive; ++, strong positive; and ++++, extreme positive) for other skin test reactions, symptoms, exposure, and diagnosis. The skin tests of the 3 most recent cases of allergic reaction to BIT (patients 2-4) were not yet in the skin test files, but we nevertheless analyzed their medical records in the same way. (These patients were not yet in the file when analysis took place because the test results of a patient are not put into the file until the examination is complete and the report sent to the insurance company.)

Glove material was tested in 1 test chamber (Finn Chamber; Epitest Oy, Tuusula, Finland) with a drop of acetone and in another with a drop of water. We tested the acetone extract of the glove material made in an ultrasonic cleaning bath in 3 cases (patients 1, 3, and 4), and in 1 case (patient 1) we also tested the water and ethanol extracts.

The concentrations of BIT in the suspected gloves (patients 1, 2, and 4) were analyzed by high-performance liquid chromatography with a UV detector at 230 nm. Mass spectrometry confirmed the detection. Accurately weighed slices taken from the palm or the back of a glove (100 and 200 mg, respectively) were extracted with 5 mL of a mixture of water and methanol (3:1) overnight at room temperature. The liquid chromatography column was a reversed-phase C18 column (Symmetry Shield; Waters Corp, Milford, Mass) (3.5-µm particles, 150 × 2 mm). The mobile phase was methanol and water (32:68) with 2mM of ammonium acetate, and the flow rate was 0.2 mL/min. The relative standard deviation of the repeatability of the analysis was about 25% for concentration levels corresponding to 20 to 200 ppm (wt/wt). The detection limit was about 2 ppm.

### RESULTS

#### PATCH TEST REACTIONS TO BIT IN 2264 PATIENTS

From January 1991 to September 2005, BIT was tested on a total of 2264 patients, and 17 (0.75%) of them had an allergic reaction to it. We tested 163 patients with 0.05% BIT in alcohol (with 2 allergic reactions), 123 with 0.1% BIT in petrolatum (with no allergic reactions), 1963 with 0.05% BIT in petrolatum (with 15 allergic reactions), and 15 with both 0.1% and 0.05% BIT in petrolatum (with no allergic reactions). The reaction index for the current test substance, 0.05% (petrolatum), in 1978 patients was −0.34.

### PATIENTS WITH ALLERGIC REACTION TO BIT

From 1991 to 2005 we had a total of 20 patients who had an allergic patch test reaction to BIT. Their patch test reactions to BIT and PVC gloves, occupations, exposure to BIT, and diagnoses are presented in the Table. Four of these 20 patients (patients 3, 10, 15, and 19) reacted to the mixture of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one (CMI/MI) and 2 (patients 10 and 11) to 2-N-octyl-4-isothiazolin-3-one (OIT).

### BIT CONCENTRATIONS IN PVC GLOVES (PATIENTS 1, 2, AND 4)

According to the analysis, the Evercare Soft glove (Selefatrade AB, Spånga, Sweden) and the Derma Grip (Oriola Oy, Espoo, Finland) PVC glove samples of patients 2 and 4 contained 9 and 22 ppm of BIT, respectively. The Derma Grip (Oriola Oy, Espoo, Finland) PVC glove samples of patients 2 and 4 contained 9 and 22 ppm of BIT, respectively. The Medi-Point (Insinooritoimisto Medi-Point Oy, Helsinki) PVC glove of patient 2 contained 31 ppm of BIT. (The Medi-Point glove of patient 3 was not analyzed because it was the same brand.) We also analyzed other gloves the patients had used, the Top Dent (Oriola Oy Hammashoito, Espoo) PVC glove of patient 2 and the Derma Grip nitrile glove of patient 4, but they did not contain BIT (concentrations were below the detection limit of 2 ppm). Patch tests with the Evercare Soft glove moistened with water and acetone were negative for allergic reaction in 5 control patients.

### COMMENT

On patch testing, BIT is an irritant, and the test concentration has been gradually lowered since the 1980s from 1% to the present concentration of 0.05%. Although the possibility of false-positive reactions to BIT cannot be excluded in the present series of patients, it is also possible that some patients with irritant or doubtful reactions might truly have been sensitized to BIT. Among these patients was a dentist with a doubtful reaction to BIT who had used the BIT-containing Derma Grip gloves.

Despite the similarity in chemical structure, BIT is not considered to cross react with CMI/MI or OIT. Concomitant reactions to these isothiazolinones were not common among our patients, which supports the idea of separate sensitization.

Occupational allergic contact dermatitis from BIT has been reported in a variety of industries using biocides with high BIT concentrations (>10%), and the relevance of the allergic reaction is usually clear in these cases. At the FIOH we have had 3 cases of occupational allergic contact dermatitis belonging to this category (patients 14, 16, and 18). In addition to these 3 cases, we have come across 1 case (patient 17) of occupational allergic contact dermatitis caused by BIT (1000 ppm) in a metal-working fluid; BIT is used in paints and putties at concentrations of 50 to 250 ppm. Our series included 1 patient (patient 12) who had possibly been sensitized to BIT when using water-based paints and another (patient 19) who had been handling metal-working fluids.

Among our patients there were 9 patients who were allergic to BIT and who had used PVC gloves at work daily. One of them (patient 9) had apparently not had dermatitis but rather dermographism, which explains why her symptoms arose from the use of various different gloves. Thus, we have had a total of 8 patients (patients 1-8) with BIT allergy and hand dermatitis in connection with PVC glove use. Six of them had used gloves that in the chemical analysis were shown to contain small amounts of BIT.

The question is whether the low BIT concentrations of 9 to 32 ppm in the gloves can sensitize or elicit contact allergy. Chemically, BIT is related to the extremely strong allergen CMI/MI, but it has been a somewhat weaker sensitizer in the local lymph node assay and in the human repeated insult patch test. Although the BIT concentrations in the PVC gloves were lower than those in the paints and putties, they were at the same level.
or a little higher than ordinary concentrations of CMI/MI in cosmetic products (3-15 ppm).37

In the present series of patients, the PVC glove material (or an ultrasonic bath extract from it) caused allergic reactions on patch testing in only 2 patients. One patient had doubtful reactions to the glove, and in 3 patients the BIT-containing glove was negative for allergic reaction in the patch test. In the 2 positive cases, the connection between BIT allergy and the PVC gloves is probable. However, the other patients’ negative patch test results do not exclude sensitization from the glove. Similarly, CMI/MI-containing cosmetic products, although positive on repeated open application test, are often negative for reaction on patch testing.37 Also, BIT does not belong to the frequent sensitizers in dentistry38 or health care.39 We searched for other possible sources of BIT sensitization, but of all the products our patients had used, we found BIT only in the PVC gloves. In Finland, the use of BIT is forbidden as an antimicrobial agent in cosmetics,40 but in daily life consumers may have skin contact with BIT in fabric softeners, cleaning agents, and polishes.3

A common feature of patients 1 to 8 was a long history of hand dermatitis (of at least 5 years’ duration), and they had also been diagnosed with other types of hand dermatitis besides BIT contact allergy. Thus, sensitization to BIT in the gloves was probably not the primary event. The occlusive effect of the PVC gloves on their eczematous skin might have enhanced the percutaneous penetration of BIT so that they had become sensitized despite the low allergen concentration.

Most of our patients were able to continue their work after they changed to a different type of glove, usually to nitrile gloves. Only 1 patient (patient 6), a dental nurse with primary rubber glove allergy, had to change her job because the dermatitis reappeared with use of Derma Grip PVC gloves. At that time we were not aware that these PVC gloves contained BIT. This allergy may have quite serious consequences if it is not recognized.

Antimicrobial additive systems are increasingly used in plastic polymers, mainly in PVC plastics,41 and particularly in the medical and food industries.42 Products that are already on the market include domestic applications such as rubber bins, kitchen utensils, tubing, air filters, containers, and mattresses. Medical antimicrobial products such as gloves, catheters, wound dressings, and bedding are also available.42 Antimicrobial agents are used in plastics to reduce microbe populations both within the material and at the surface.43 The organic antimicrobials used in plastics include 10, 10′-oxybisphenoxysarins, OIT, dichloro-2-N-octyl-4-isothiazolin-3-one, tributyl tin, 2, 4, 4′-trichloro-2′-hydroxy diphenyl ether, zinc pyrithione, zinc oxadine, N-butyl-1,2-benzisothiazol-3-one, 3-i-odo-2-propynyl butyl carbamate, and N-(trichloromethylthio) phthalimide.41,45 The plasticizer can act as the carrier for the biocide (eg, 10, 10′-oxybisphenoxysarins or OIT).42

The number of patients treated for allergic reaction to BIT in PVC gloves at our small clinic is alarming, although our patient material is strongly selected. The true extent of the problem remains to be settled in other clinics with larger patient populations. It is interesting that all 8 of these patients (patients 1-8) were investigated in 2001 or later, although we have tested BIT in almost every patient since 1992. Inquiries to several representatives of PVC glove sales representatives in Finland have uniformly revealed that BIT is a component in a biocide compound that has been widely used for at least 15 years as a slimicide in the manufacturing process of disposable PVC gloves. The market for these products has considerably increased over recent years.

At the FIOH, BIT is included in the antimicrobial series, which is tested on most of our patients, irrespective of their occupation. In the commercial patch test series, BIT is included in Chemotechnique Diagnostics’ “Oils and Cooling Fluids” series and in Trolab’s “Cutting Oils” and “Industrial Biocides” series. It is possible that BIT is not commonly tested on dental and health care personnel. We recommend that all patients with hand dermatitis while using PVC gloves should be patch tested with BIT.

In summary, to our knowledge, there are no previous reports of antimicrobial skin contact allergy deriving from PVC gloves. We described herein 8 patients with BIT allergy and hand dermatitis in connection with PVC glove use. In findings from chemical analysis, 3 brands of disposable PVC gloves contained small amounts of BIT, and 6 of the patients had used at least 1 of these brands. All of the patients had a long history of hand dermatitis. Small amounts of BIT in the glove seem to be able to sensitize persons who already have hand dermatitis. We recommend that BIT should be tested on all patients with hand dermatitis who use PVC gloves.

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