

# Allergic and irritant reactions to rubber gloves in medical health services

## *Spectrum, diagnostic approach, and therapy*

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Delayed-type allergies account for most reactions to gloves. These have been found in 32 of 39 patients (82%) attending our department with occupationally induced contact dermatitis to gloves. Accelerators, mainly of the thiuram group, antioxidants, vulcanizers, organic pigments, and, presumably, glove powder ingredients are known responsible allergens. In contrast, immediate-type allergies to rubber gloves were less frequent (13 of 39 patients [33%] with occupationally induced glove allergies). They usually present as contact urticaria. Responsible allergens are latex, glove powder, and accelerators. On the basis of the numerous glove-related allergens, a comprehensive schedule of diagnostic tests is proposed. In addition, we introduce a new classification of hypoallergenic gloves according to their basic materials and ingredients and thus provide a guideline for individual therapy. (*J AM ACAD DERMATOL* 1991;25:831-9.)

Rubber gloves are indispensable in surgical procedures. Moreover, they protect wet-workers against skin damage and employees in medical health services against microbial contamination. With the rising public awareness of acquired immunodeficiency syndrome (AIDS), the use of rubber gloves in medicine has increased, along with an increase in allergic and irritant reactions to their ingredients. Hence glove allergies have become an important topic in occupational dermatology.<sup>1-3</sup> We review their causes and diagnostic procedures and present a new classification of hypoallergenic gloves with emphasis on their therapeutic indications.

### **ALLERGIC REACTIONS TO RUBBER GLOVES**

Skin manifestations caused by rubber glove allergies are usually limited to the dorsal surface of the hands, skin over the metacarpophalangeal joints, the thenar and hypothenar, wrists, and distal areas of the forearms.<sup>2,3</sup> However, extension beyond the

contact site, as well as generalized cutaneous symptoms and anaphylactic reactions, may also occur.<sup>2,3</sup> Two different allergic mechanisms are involved: (1) delayed-type allergy (type IV allergy)<sup>4</sup> and (2) immediate-type allergy (immunologic contact urticaria [type I allergy]<sup>4</sup> and immediate contact dermatitis [protein contact dermatitis]).

### **Delayed-type allergies (DTAs)**

Rubber glove-induced DTAs have become an increasing problem. They have been found in 11.6% of 542 patients with occupationally induced contact dermatitis,<sup>5</sup> as well as in 84% of 80 patients with occupationally acquired allergic reactions to rubber.<sup>6</sup> The main allergens that cause DTAs to rubber gloves are discussed in the following paragraphs.

**Accelerators and other rubber additives.** Accelerators account for most allergic reactions to gloves and have been found to evoke positive patch tests in 32 of 39 patients (82%) with occupationally induced contact dermatitis to gloves (unpublished data). The most frequent allergy-inducing accelerators in rubber gloves are thiurams, which Cronin<sup>2</sup> proposed as the marker allergens for domestic rubber products. In contrast, the *p*-phenylenediamine (PPD) group is the marker allergen for industrial rubber products.

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In our investigation,<sup>6</sup> thiurams were responsible for 72% of all occupationally related glove allergies, followed by carba-mix (25%) and mercapto-mix (3%). Typical single components in our glove-allergic patients were tetramethylthiuram disulfide, tetramethylthiuram monosulfide, and zinc diethyldithiocarbamate (ZDC). Coincidental sensitization and cross reactions have been proposed to be responsible for the frequent simultaneous positive patch tests to thiurams and chemically related carbamates.<sup>2</sup> Other additives such as antioxidants and antiozonants (PPD group, phenols, quinolines) as well as vulcanizers (4,4' dithiodimorpholine, benzoyl peroxide) are less important in glove allergies because they are mainly used in the production of heavy duty or synthetic rubber articles.<sup>1-3, 6-8</sup>

**Organic pigments.** Organic pigments are used as colorants for textiles, cosmetic lipsticks, and rubber and plastic materials.<sup>9</sup> Kanerva et al.<sup>9</sup> reported the azo dye Irgalite Orange F2G to be the responsible allergen in plastic glove-related skin eruptions in one patient.

**Glove powder.** Skin reactions to glove powder have often been interpreted as irritant reactions, especially in atopic patients.<sup>7, 10</sup> To our knowledge there are no reports of DTA to glove powder up to now. However, our inquiries to different manufacturers revealed epichlorhydrin and sorbic acid (known type IV allergens)<sup>10</sup> as ingredients of a few glove powders. Even an isothiazolin-3-one derivative, known as a potent sensitizer in numerous cosmetic products,<sup>11</sup> has been added as preservative (manufacturer's information). Therefore it is possible that some delayed-type reactions to glove powder have been misinterpreted as irritant in the past.

### Immediate-type allergies (ITAs)

**Immunologic contact urticaria (ICU).** ICU has been found in 13 of 39 patients (33%) with an occupationally induced glove allergy (unpublished data). Preexisting atopic dermatitis in 9 of 13 patients (69% [unpublished data]) seems to be a risk factor for ICU.<sup>12, 13</sup> Clinical signs and symptoms usually occur within 5 to 30 minutes after the initial contact and subside approximately 24 hours later. They consist of localized or rarely generalized wheal-and-flare reactions accompanied by burning and itching.<sup>14</sup> ICU may also affect mucous membranes and thus may lead to rhinitis, conjunctivitis, asthma, or life-threatening anaphylactic reactions (stages III

and IV according to the von Krogh and Maibach classification).<sup>15</sup> This risk occurs in sensitized physicians as well as in sensitized patients during surgical, gynecologic, and dental procedures.<sup>12, 16-25</sup> In the evaluation of a patient with suspected glove-induced contact urticaria, the allergens discussed in the following paragraphs have to be considered.

**Latex.** In a recent study from Finland, 2.9% of 512 hospital employees and 7.4% of 54 surgeons were found to have ICU to latex.<sup>13</sup> Carrillo<sup>26</sup> was the first to suggest a rubber-derived water-soluble protein with a molecular weight greater than 30 kd as one responsible allergen. Further investigations of natural latex revealed at least four soluble polypeptides.<sup>22</sup> Turjanmaa et al.<sup>27</sup> separated different protein fractions with a molecular weight of 1 to more than 45 kd and showed that each of them could induce a positive prick test reaction in latex-sensitized patients. The immunologic mechanism of these reactions has been shown to be type I by the discovery of specific IgE against latex (radioallergosorbent test [RAST]).<sup>28-30</sup>

**Glove powder.** In contrast to latex allergy, glove powder-induced immediate-type reactions have rarely been reported. van der Meeren,<sup>21</sup> in 1986, was the first to observe a 29-year-old male nurse with a severe anaphylactic reaction to glove powder. He detected a protein in glove powder as the most likely source. The results of our preliminary electrophoretic analysis of several glove powders suggest the presence of proteins (unpublished data); thus, in contrast to others,<sup>18</sup> our results seem to confirm the role of glove powder as a potential allergen in ICU. In highly sensitized patients, even the opening of a glove package and inhalation of glove powder have led to an anaphylactic reaction.<sup>16, 21, 31</sup>

**Accelerators.** Accelerators used to shorten the glove manufacturing process are potent type IV allergens.<sup>1-3</sup> Recent studies suggest an additional role of accelerators in glove-related immediate-type allergies.<sup>14, 19, 32-35</sup> Hence, contact urticaria to ZDC, in combination with relapsing eyelid edema, was found in a glove-allergic kitchen employee.<sup>33</sup> Latex allergy was not excluded in this patient, however. Immediate-contact urticaria to trimethylthiuram disulfide<sup>19</sup> and to zinc penta-methylene dithiocarbamate/zinc dibutyldithiocarbamate in a latex-allergic patient,<sup>14</sup> as well as to 2-mercaptobenzothiazole in a nonlatex-allergic patient,<sup>32</sup> has also been reported. We have recently seen a latex-allergic pa-

tient with a strong wheal-and-flare reaction to zinc dimethyldithiocarbamate (unpublished observation) although ZDC and zinc dibutyldithiocarbamate did not produce a positive prick test reaction.

→ **Immediate-contact dermatitis (ICD).** ICD (protein contact dermatitis) depends on previous sensitization and has been reported to be provoked by close contact with certain protein-containing foods. It has mainly been observed in bakers, butchers, kitchen workers, and veterinarians.<sup>36</sup> Clinical features include itching, erythema, burning, and IgE-mediated urticaria within 30 minutes to 6 hours after exposure to the causative allergen. In addition, dyshidrotic vesicles in patients who handle foods have been reported.<sup>36</sup> Secondary eczematous alterations, suggested to represent an IgE-mediated late-phase reaction,<sup>37, 38</sup> typically develop at the same contact area 6 to 48 hours later.

⇒ Latex-induced protein contact dermatitis was first suspected by Kleinhans.<sup>38</sup> He described a 25-year-old nurse with hand eczema and urticaria presumably caused by latex gloves. Similar reports from Turjanmaa and Reunala<sup>32</sup> seem to confirm ICD to latex as a clinical entity. Görtz et al.<sup>39</sup> hypothesized combined delayed- and immediate-type reactions to explain simultaneous positive prick and patch test results to latex in an 8-year-old boy in whom generalized urticaria and asthma developed after he blew up a rubber balloon. IgE receptors on Langerhans cells<sup>40</sup> seem to play a major role in the pathogenesis of concomitant latex-induced immediate- and delayed-type reactions.

#### PSEUDOALLERGIC REACTIONS AND OTHER URTICARIA-INDUCING MECHANISMS

In contrast to immediate-type allergy, nonimmunologic contact urticaria (NICU) occurs without any previous sensitization and may be induced by different chemical components that promote a nonantibody-mediated release of vasoactive mediators such as histamine, prostaglandins, leukotrienes, or substance P.<sup>35, 41</sup> NICU from gloves has not been reported up to now. According to the manufacturers' information, however, the preservative sorbic acid, a known NICU agent,<sup>35, 41</sup> has been added to glove powders and thus should be considered in the evaluation of glove-induced contact urticaria. Pressure and cholinergic urticaria provoked by gloves should generally be excluded by the patient's history and physical examination.

#### IRRITANT REACTIONS

Irritant reactions occur especially in atopic patients and may be mechanically provoked by glove powder crystals. In addition, the effect of occlusion and the frequent use of disinfectants, mainly in the operating theater, may lead to maceration and to irritant dermatitis that mimics rubber glove allergy.<sup>42, 43</sup> Bacterial endotoxins released by gamma irradiation of gloves, as well as ethylene oxide in freshly gas-sterilized gloves, rarely cause skin irritations.<sup>44, 45</sup> Ethylene oxide has been associated with third-degree burns.<sup>46</sup>

#### GLOVE-PERMEATING TYPE IV ALLERGENS

Glove-permeating allergens have to be considered in glove-related dermatitis if the evaluation does not reveal allergy to rubber chemicals, latex, or glove powder and irritation seems unlikely.<sup>47</sup> Important glove-permeating substances include sulfate and acrylate in hairdressing<sup>47-49</sup> acrylate in orthopedics and dentistry,<sup>50, 51</sup> as well as epoxy resins in metal and plastic industries.<sup>52</sup>

#### DIAGNOSTIC PROCEDURES

On the basis of a detailed history, allergy testing may be performed as discussed in the following paragraphs.

#### Evaluation of contact dermatitis (Fig. 1)

The evaluation of glove-induced dermatitis in our department consists of patch tests with the standard series (ICDRG), the battery of rubber chemicals (Table I), material from the patient's glove, glove powder, and, if indicated, with occupationally relevant substances including glove-permeating chemicals. In addition, accelerator-free latex fluid (provided by the manufacturer) may complete testing to detect possible (so far unknown) delayed-type allergy to latex. Depending on the patient's history, has to be considered and proved by prick test (readings at 20 minutes, 6 hours, and 24 hours) and scratch-chamber test (readings at 24, 48, and 72 hours) with accelerator-free latex fluid. Irritant false-positive reactions elicited by scratch-chamber tests may occur, however.<sup>29</sup> Delayed-type hypersensitivity reactions to glove powder require further patch tests with preservatives, including isothiazolin-3-one derivatives, and with epichlorhydrin as possible glove powder

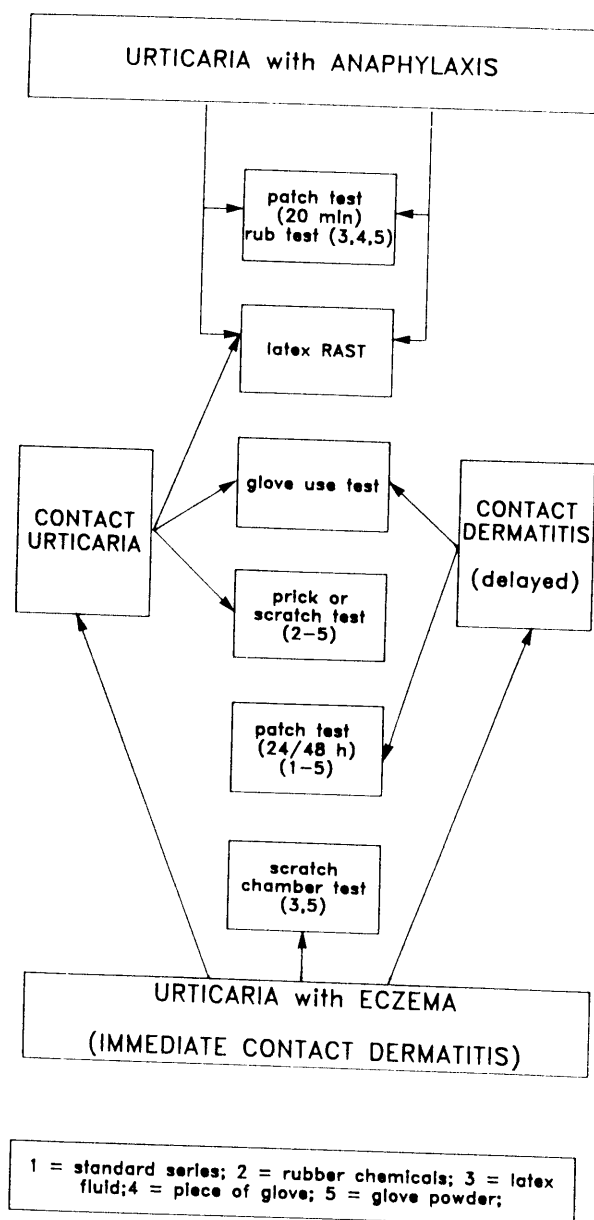


Fig. 1. Diagnostic evaluation of suspected glove-induced allergies.

constituents. If the allergic evaluation results are negative, irritant dermatitis caused by gloves or other agents should be considered in the differential diagnosis.

#### Evaluation of contact urticaria

Aside from the determination of specific IgE against latex by RAST, localized glove-induced urticaria (contact urticaria syndrome stage I)<sup>15</sup> should be investigated with prick or scratch tests with accelerator-free latex fluid, material of causative

Table I. Battery of rubber chemicals used for patch test

| Rubber chemical                                                         | % in petrolatum |
|-------------------------------------------------------------------------|-----------------|
| 1. Tetramethylthiuram disulfide                                         | 0.25            |
| 2. Tetramethylthiuram monosulfide                                       | 0.25            |
| 3. Tetraethylthiuram disulfide                                          | 0.25            |
| 4. Dipentamethylenethiuram disulfide                                    | 0.25            |
| 5. <i>N</i> -Cyclohexyl-2-benzothiazylsulfenamide                       | 1.00            |
| 6. Dibenzothiazyl disulfide                                             | 1.00            |
| 7. Morpholinyl mercaptobenzothiazole                                    | 0.50            |
| 8. Mercaptobenzothiazole                                                | 2.00            |
| 9. <i>N</i> -Isopropyl- <i>N'</i> -phenyl- <i>p</i> -phenylenediamine   | 0.10            |
| 10. <i>N,N'</i> -diphenyl- <i>p</i> -phenylenediamine                   | 0.25            |
| 11. <i>N,N'</i> -di- $\beta$ -naphthyl- <i>p</i> -phenylenediamine      | 1.00            |
| 12. <i>N</i> -Phenyl- <i>N'</i> -cyclohexyl- <i>p</i> -phenylenediamine | 0.25            |
| 13. Phenyl- $\beta$ -naphthylamine                                      | 1.00            |
| 14. Diethyldithiocarbamate zinc                                         | 1.00            |
| 15. Dibutyldithiocarbamate zinc                                         | 1.00            |
| 16. 1,3-Diphenylguanidine                                               | 1.00            |
| 17. <i>N,N'</i> -Diphenylthiourea                                       | 1.00            |
| 18. <i>N,N'</i> -Dibutylthiourea                                        | 1.00            |
| 19. Hydroquinone monobenzylether                                        | 1.00            |
| 20. 4,4'-Dihydroxydiphenyl                                              | 0.10            |
| 21. Hexamethylenetetramine                                              | 1.00            |
| 22. Benzoyl peroxide                                                    | 1.00            |

gloves, glove powder, and rubber chemicals (i.e., thiurams, carbamates, benzothiazoles). However, irritant false-positive reactions to latex fluid (native and diluted 1:10/1:100 in 0.9% sodium chloride) may hamper the interpretation of prick test results in some patients (unpublished data). In cases of glove-related anaphylactic reactions, diagnostic procedures should be restricted to (1) a determination of specific IgE against latex (RAST), (2) a 20-minute open patch test with latex fluid, a piece of the causative glove, and glove powder, and (3) the performed by rubbing the same substances about 10 times on the volar aspect of the forearm.<sup>53</sup> Further investigations (i.e., prick test) require emergency-care conditions.

Results of latex-RAST are frequently not consistent with the severity of clinical symptoms.<sup>29, 30</sup> This may be in part due to different latex proteins<sup>13, 27, 30</sup> that are not completely represented in available RAST-protein panels. An immediate prick test response to glove powder requires further testing with sorbic acid.

Table II. Hypoallergenic surgeons' gloves

| Brand name        | Allergens (immediate/delayed) and irritants |            |                |          |       |              | Manufacturer                                                           |
|-------------------|---------------------------------------------|------------|----------------|----------|-------|--------------|------------------------------------------------------------------------|
|                   | Thiurams                                    | Carbamates | Benzothiazoles | Thiourea | Latex | Glove powder |                                                                        |
| Puritee Pur       | ○                                           | ○          | ○              | ○        | ●     | ●            | J. Baker, Orox-Co., Cincinnati, Ohio                                   |
| Eudermic          | ○                                           | ●          | ○              | ○        | ●     | ●            | Deseret Medical Inc., Sandy, Utah                                      |
| Tradition         | ○                                           | ○          | ●              | ○        | ●     | ●            | Deseret Medical Inc., Sandy, Utah                                      |
| Ultraderm         | ○                                           | ●          | ○              | ○        | ●     | ●            | Travenol Labs., Deerfield, Ill.                                        |
| Regent Dispo      | ○                                           | ●          | ○              | ○        | ●     | ●            | Regent Hospital Products, Greenville, SC                               |
| Sempermed         | ○                                           | ●          | ○              | ○        | ●     | ●            | Semperit Inc., Montvale, N.J.                                          |
| Sempermed Forte   | ○                                           | ●          | ○              | ○        | ●     | ●            | Semperit Inc., Montvale, N.J.                                          |
| Micro-Touch       | ○                                           | ●          | ●              | ○        | ●     | ●            | Johnson & Johnson Medical Inc., Texas                                  |
| Perry Derma-Guard | ○                                           | ○          | ○              | ○        | ○     | ●            | Smart Practice, Phoenix, Ariz.                                         |
| Manex             | ○                                           | ●          | ○              | ○        | ●     | ●            | Beiersdorf Inc., Norwalk, Conn.                                        |
| Regent Biogel     | ○                                           | ●          | ○              | ○        | ●     | ○            | Regent Hospital Products, Greenville, S.C.                             |
| Manex nonpowdered | ○                                           | ●          | ○              | ○        | ●     | ○            | Beiersdorf Inc., Norwalk, Conn.                                        |
| Sempermed Ultra   | ○                                           | ●          | ○              | ○        | ●     | ○            | Semperit Inc., Montvale, N.J.                                          |
| Neutralon         | ○                                           | ●          | ●              | ○        | ●     | ●            | Johnson & Johnson Medical Inc., Texas                                  |
| Elastyren         | ○                                           | ●          | ○              | ○        | ○     | ●            | Allerderm Lab., Mill Valley, Calif.; Hermal Pharmaceutical Labs., N.Y. |
| Tactylon          | ○                                           | ●          | ●              | ○        | ●     | ●            | Smith & Nephew Med., Massillon, Ohio                                   |
| Neolon            | ○                                           | ●          | ○              | ○        | ○     | ●            | Deseret Medical Inc., Sandy, Utah                                      |
| Ansell dermaprene | ○                                           | ○          | ○              | ●        | ○     | ●            | Ansell America, Eatontown, N.J.                                        |

○, Absent in glove; ●, present in glove.

In our department the evaluation of urticaria with water-soluble glove extracts<sup>19</sup> or with an incubation fluid of glove pieces in sterile physiologic saline<sup>29</sup> is used only in patients with suspected irritant reactions to latex-test fluid because these methods do not differentiate between glove and glove powder-derived allergens. In addition, chemically bound proteins that are not extractable by water or physiologic saline may be missed.

#### Glove exposure test

The glove use tests are performed by instructing the patient to wear gloves 2 hours daily on three consecutive days. The main indications are equivo-

cal or unsatisfactory prick/patch test results that do not confirm the clinical diagnosis. These may be due to antioxidants or accelerators not included in routine test batteries, such as methylcyclohexyl-dimethylphenol<sup>2</sup> or zinc dimethyldithiocarbamate,<sup>54</sup> respectively.

#### Hazards in patch tests of latex fluid

To our knowledge there are no reports on delayed-type allergy to latex. Frequently observed positive patch tests (delayed-type allergies) to latex test fluid seem to contradict this observation. They presumably are due to thiurams or carbamates, added as stabilizers to latex test fluid<sup>23</sup> as well as to benz-

Table III. Hypoallergenic examination gloves

| Brand name                                 | Allergens (immediate/delayed) and irritants |            |                |          |       |              | Manufacturer                                  |
|--------------------------------------------|---------------------------------------------|------------|----------------|----------|-------|--------------|-----------------------------------------------|
|                                            | Thiurams                                    | Carbamates | Benzothiazoles | Thiourea | Latex | Glove powder |                                               |
| Ansell Fitted                              | ○                                           | ●          | ●              | ○        | ●     | ●            | Ansell America,<br>Eatontown, N.Y.            |
| Ansell Conform<br>(sterile and nonsterile) | ○                                           | ●          | ●              | ○        | ●     | ●            | Ansell America,<br>Eatontown, N.Y.            |
| B-D latex glove                            | ○                                           | ●          | ○              | ○        | ●     | ●            | Deseret Medical Inc.,<br>Sandy, Utah          |
| Sempermed EG                               | ○                                           | ●          | ○              | ○        | ●     | ●            | Semperit Inc.,<br>Montvale, N.J.              |
| Sempermed dental                           | ○                                           | ●          | ○              | ○        | ●     | ●            | Semperit Inc.,<br>Montvale, N.J.              |
| Micro-Touch EG<br>(sterile and nonsterile) | ○                                           | ●          | ●              | ○        | ●     | ●            | Johnson & Johnson<br>Medical Inc., Texas      |
| Regent Biogel D                            | ○                                           | ●          | ○              | ○        | ●     | ○            | Regent Hospital Products,<br>Greenville, S.C. |
| Tactylon EG                                | ○                                           | ○          | ○              | ○        | ○     | ●            | Smart Practice, Phoenix, Ariz.                |
| Vinyl (PVC) gloves<br>(powdered)           | ○                                           | ○          | ○              | ○        | ○     | ●            | Several manufacturers                         |
| Dahlhausen vinyl glove<br>(nonpowdered)    | ○                                           | ○          | ○              | ○        | ○     | ○            | P. J. Dahlhausen & Co.,<br>Cologne, FRG       |
| 4H glove                                   | ○                                           | ○          | ○              | ○        | ○     | ○            | Safety 4, Lyngby, Denmark                     |

○, Absent in glove; ●, present in glove.

isothiazolin-3-one, a preservative in some latex emulsions.<sup>11</sup>

### THERAPEUTIC ALTERNATIVES

Hypoallergenic gloves are produced by several manufacturers for patients with rubber glove-induced skin problems. The term *hypoallergenic* generally applies to specially washed latex gloves with a diminished allergen content as well as to inside-coated brands and synthetic rubber gloves. Accelerators used in rubber gloves are not yet considered in the definition of hypoallergenic gloves, although they account for the majority of glove-induced allergies.<sup>1-3, 8</sup> According to the present knowledge that thiurams are the most frequently allergy-inducing accelerators in rubber gloves,<sup>1-3, 6, 8, 10</sup> we apply the term *hypoallergenic* especially to thiuram-free therapeutic alternatives.

Hence we are providing a new classification of hypoallergenic gloves according to their additives (accelerators, glove powder, inside coating), basic materials (latex, synthetic rubber, plastic material) and therapeutic indications. Surgeons' gloves (SG) as well as examination gloves (EG) are considered (Tables II and III).

### Latex gloves

#### Accelerator free

Indications: Allergies to each accelerator group (thiurams, carbamates, benzothiazoles, and thioureas)

Brand: SG: Puritee Pur

#### Containing carbamates

Indications: Allergy to thiurams, thioureas, or benzothiazoles

Carbamates are the most frequent accelerators in hypoallergenic rubber gloves. Because they occasionally cause irritant reactions,<sup>2, 3</sup> special washing procedures are performed to keep carbamate concentration below 0.5%.

Brands: SG: Eudermic, Ultraderm, Regent Dispo, Sempermed SG, Sempermed Forte, Micro-Touch, Manex, gloves of the category "Non-powdered". EG: Sempermed EG, Sempermed dental, B-D latex glove, Regent Biogel D

#### Containing carbamates and benzothiazoles

Indications: Allergy to thiurams or thioureas

Brands: SG: Micro-Touch, Neutralon, Perry Derma-Guard; EG: Ansell Fitted, Ansell Conform (sterile and nonsterile), Micro-Touch EG (sterile and nonsterile)

**Containing benzothiazoles**

Indications: Allergy to thiurams, carbamates, or thioureas

Brand: SG: Tradition

**Nonpowdered**

Indications: Allergy to glove powder; irritant reactions to glove powder

Brands: SG: Regent Biogel, Manex nonpowdered, Sempermed Ultra. EG: Regent Biogel D

**Inside coated**

Indications: Allergy to thiurams or thioureas; allergy to latex (contact urticaria syndrome stage I).<sup>15</sup> Sixty percent to 80% of latex-allergic patients tolerate hydrogel-coated latex gloves; thus the inside coating is an effective barrier against latex. Gradual deterioration of the inside coating may limit the protective effect.

Brands: SG: Regent Biogel (inside coating: hydrogel), Neutralon (inside coating: polyurethane); EG: Regent Biogel D

**Synthetic rubber gloves**

**Containing carbamates**

Indications: Allergy to latex (including contact urticaria syndrome stages II to IV)<sup>15</sup>; allergies to thiurams, benzothiazoles, thioureas

Brands: SG: Elastyren, Neolon

**Containing diphenylthiourea**

Indications: Allergy to latex (including contact urticaria syndrome stages II to IV)<sup>15</sup>; allergies to thiurams, benzothiazoles, carbamates

Brand: SG: Ansell dermaprene

**Accelerator free**

Indications: Allergy to latex (including contact urticaria syndrome stages II to IV),<sup>15</sup> allergies to each accelerator group (thiurams, carbamates, benzothiazoles, and thioureas)

Brand: SG: Tactylon; EG: Tactylon EG

**Plastic gloves—polyvinylchloride (PVC)**

**Powdered**

Indications: Allergies to accelerators and latex. PVC gloves are completely latex and accelerator free. Because of their inflexibility their use is generally limited to nonsurgical activities.

Brands: EG: Triflex and Tru Touch (sterile and nonsterile)

**Nonpowdered**

Indications: Allergies to accelerators, latex, or glove powder

Brand: EG: such as Dahlhausen vinyl glove (nonpowdered)

**Five-layer plastic glove**

Indications: Allergies to any accelerator, latex, glove powder, or well-defined glove-permeating chemicals

The five-layer plastic glove contains polyethylene and ethylene-vinyl-alcohol-copolymer. Because of the inflexibility, its use is limited in medicine. However, in patients with allergy to glove-permeating chemicals such as methyl methacrylates used in orthopedics and dentistry, as well as nickel sulfate and thioglycolates used in hairdressing, the five-layer plastic glove is a safe alternative.<sup>55</sup>

Brand: EG: 4H glove

NOTE: PVC, polyethylene, or cotton undergloves are recommended if the allergic evaluation results remain negative, and thus irritant reaction due to glove powder seems likely.

**CONCLUSION AND FUTURE RESEARCH PROJECTS**

The growing prevalence of immediate- and delayed-type allergies to rubber gloves has become an important problem for employees in health care-related professions during the past few years. Despite definite progress in the understanding of glove-induced allergies, many questions remain to be answered and could be relevant for future studies.

1. Definite analysis of different proteins contained in latex may provide an explanation for simultaneous positive and negative prick tests to a panel of latex test fluids in patients with confirmed latex allergy.

2. Further investigations on additives in gloves or glove powders that are possibly allergenic or NICU agents (i.e., preservatives, pH neutralizers, stabilizers, emollients, colorants, accelerators, antioxidants) may resolve the controversy of positive glove use test results and negative results in the evaluation of some patients.

3. Further research is necessary to clarify the simultaneous occurrence of latex-induced urticaria and contact dermatitis (immediate-type or combined immediate/delayed-type allergy).

4. The probable existence of immediate-type allergy to accelerators awaits further confirmation, possibly by the detection of specific IgE.

5. With respect to the frequency of atopy in latex-allergic patients (60% to 80%), new or supplemented known test panels (i.e., latex-RAST) are desirable for a more precise differentiation between irritant and true allergic reactions.

6. Finally, an effective treatment of glove-induced allergies requires intensive cooperation between industry and dermatology. Potent allergens should either be excluded in the manufacturing process of rubber gloves as far as possible, or, if contained, their presence should be noted on the label.

## REFERENCES

- Brandão FM. Rubber. In: Adams RM, ed. Occupational skin disease. 2nd ed. Philadelphia: WB Saunders, 1990:462-85.
- Cronin E. Contact dermatitis. Edinburgh: Churchill Livingstone, 1980:714-70.
- Taylor JS. Rubber. In: Fisher AA, ed. Contact dermatitis. 3rd ed. Philadelphia: Lea & Febiger, 1986:603-43.
- Coombs RRA, Gell PGH. The classification of allergic reactions underlying disease. In: Gell PGH, Coombs RRA, eds. Clinical aspects of immunology. Philadelphia: FA Davis, 1963:317.
- Estlander T, Jolanki R, Kanerva L. Dermatitis and urticaria from rubber and plastic gloves. *Contact Dermatitis* 1986;14:20-5.
- Hintzenstern J, Heese A, Koch HU, et al. Frequency, spectrum and occupational relevance of type IV allergies to rubber chemicals. A retrospective study from the Department of Dermatology, University of Erlangen-Nuremberg 1/1985-3/1990. *Contact Dermatitis* 1991;24:244-52.
- Heese A, Peters KP, Koch HU, et al. Allergien und Intoleranzreaktionen gegen Latex-Handschuhe im medizinischen Fachbereich. *Dtsch Arztebl* 1989;86:2410-4.
- Frosch PJ, Born CM, Schütz R. Kontaktallergien auf Gummi-, Operations- und Vinylhandschuhe. *Hautarzt* 1987;38:210-7.
- Kanerva L, Jolanki R, Estlander T. Organic pigment as a cause of plastic glove dermatitis. *Contact Dermatitis* 1985;13:41-3.
- Fischer AA, ed. Contact dermatitis. 3rd ed. Philadelphia: Lea & Febiger, 1986.
- Foussereau J, Brändle I, Boujnah-Khouadja A. Allergisches Kontaktekzem durch Isothiazolin-3-on-Derivate. *Dermatosen* 1984;32:208-11.
- Ehl W, Hartjen A, Thiel CL, et al. Latex-Allergien als IgE-vermittelte Sofortreaktionen. *Allergologie* 1988;11:182-7.
- Turjanmaa K. Incidence of immediate allergy to latex gloves in hospital personnel. *Contact Dermatitis* 1987;17:270-5.
- Wrangsjö K, Mellström G, Axelsson JGK. Discomfort from rubber gloves indicating contact urticaria. *Contact Dermatitis* 1986;15:79-84.
- Von Krogh G, Maibach HI. The contact urticaria syndrome—an updated review. *J AM ACAD DERMATOL* 1981;5:328-42.
- Assalve D, Cicioni C, Perno P, et al. Contact urticaria and anaphylactoid reaction from cornstarch surgical glove powder. *Contact Dermatitis* 1988;19:61.
- Axelsson JGK, Johansson SGO, Wrangsjö K. IgE-mediated anaphylactoid reactions to rubber. *Allergy* 1987;42:46-50.
- Baur X, Jäger D. Airborne antigens from latex gloves. *Lancet* 1990;335:912.
- Geier J, Fuchs Th. Kontakturtikaria durch Gummihandschuhe. *Z Hautkr* 1990;65:267-72.
- Gerber AC, Jörg W, Zbinden S, et al. Severe intraoperative anaphylaxis to surgical gloves: latex allergy, an unfamiliar condition. *Anesthesiology* 1989;71:800-2.
- van der Meeren HLM, van Erp PEJ. Life-threatening contact urticaria from glove powder. *Contact Dermatitis* 1986;14:190-1.
- Morales C, Basomba A, Carreira J, et al. Anaphylaxis produced by rubber glove contact. Case reports and immunological identification of the antigens involved. *Clin Exp Allergy* 1989;19:425-30.
- Tarlo SM, Wong L, Roos J, et al. Occupational asthma caused by latex in a surgical glove manufacturing plant. *J Allergy Clin Immunol* 1990;85:626-31.
- Taylor JS, Cassettari J, Wagner W, et al. Contact urticaria and anaphylaxis to latex. *J AM ACAD DERMATOL* 1989;21:874-7.
- Zenarola P. Rubber latex allergy: unusual complication during surgery. *Contact Dermatitis* 1989;21:197-8.
- Carrillo T, Cuevas M, Munoz T, et al. Contact urticaria and rhinitis from latex surgical gloves. *Contact Dermatitis* 1986;15:69-72.
- Turjanmaa K, Laurila K, Mäkinen-Kiljunen S, et al. Rubber contact urticaria. Allergenic properties of 19 brands of latex gloves. *Contact Dermatitis* 1988;19:362-7.
- Frosch PJ, Wahl R, Bahmer FA, et al. Contact urticaria to rubber gloves is IgE-mediated. *Contact Dermatitis* 1986;14:241-5.
- Turjanmaa K, Reunala T, Räsänen L. Comparison of diagnostic methods in latex surgical glove contact urticaria. *Contact Dermatitis* 1988;19:241-7.
- Wrangsjö K, Wahlberg JE, Axelsson JGK. IgE-mediated allergy to natural rubber in 30 patients with contact urticaria. *Contact Dermatitis* 1988;19:264-71.
- Fisher AA. Contact urticaria and anaphylactoid reaction due to corn starch surgical glove powder. *Contact Dermatitis* 1987;16:224-5.
- Turjanmaa K, Reunala T. Latex-contact urticaria associated with delayed allergy to rubber chemicals. In: Frosch PJ, Dooms-Goossens A, Lachapelle J-M, et al. Current topics in contact dermatitis. Berlin: Springer, 1989:460-4.
- Helander I, Mäkelä A. Contact urticaria to zinc diethyldithiocarbamate (ZDC). *Contact Dermatitis* 1983;9:327-8.
- Camarasa JM, Alomar A. Allergic rhinitis from diphenyl guanidine. *Contact Dermatitis* 1978;4:242.
- Lahti A, Maibach HI. Immediate contact reactions. (Contact urticaria syndrome.) In: Maibach HI, ed. Occupational and industrial dermatology. 2nd ed. St. Louis: Mosby-Year Book, 1987:32-44.
- Hjorth N, Roed-Petersen J. Occupational protein contact dermatitis in food handlers. *Contact Dermatitis* 1976;2:24-42.
- Gleich GJ. The late phase of the immunoglobulin E-mediated

- ated reaction: a link between anaphylaxis and common allergic disease? *J Allergy Clin Immunol* 1982;70:160-9.
38. Kleinhan D. Soforttyp-Allergie gegen Latex: Kontakt-Urtikaria und Ekzem. *Akt Dermatol* 1984;10:227-8.
  39. Görtz J, Goos M. Immediate and late type allergy to latex: contact urticaria, asthma and contact dermatitis. In: Frosch PJ, Dooms-Goossens A, Lachapelle J-M, et al. *Current topics in contact dermatitis*. Berlin: Springer, 1989: 457-9.
  40. Bruynzeel-Koomen CAFM, van Wichen DF, Toonstra J, et al. The presence of IgE molecules on epidermal Langerhans cells in patients with atopic dermatitis. *Arch Dermatol Res* 1986;278:199-205.
  41. Lahti A. Non immunologic contact urticaria. *Acta Derm Venereol (Stockh)* 1980;60(suppl 91):1-49.
  42. Hansen KS. Occupational dermatoses in hospital cleaning women. *Contact Dermatitis* 1983;9:343-51.
  43. Singgih SIR, Lantinga H, Nater JP, et al. Occupational hand dermatoses in hospital cleaning personnel. *Contact Dermatitis* 1986;14:14-9.
  44. Shmunes E, Darby T. Contact dermatitis due to endotoxin in irradiated latex gloves. *Contact Dermatitis* 1984;10: 240-4.
  45. Fisher AA. Burns on the hands due to ethylene oxide used to sterilize gloves. *Cutis* 1988;42:267-8.
  46. Ippen H, Mathies V. Die protrahierte Verätzung. *Berufs-dermatosen* 1970;18:144.
  47. Moursiden HT, Faber O. Penetration of protective gloves by allergens and irritants. *Trans St Johns Hosp Dermatol Soc* 1973;59:1.
  48. Wall LM. Nickel penetration through rubber gloves. *Contact Dermatitis* 1980;6:461-3.
  49. Storrs FJ. Permanent wave contact dermatitis: contact allergy to glyceryl monothioglycolate. *J AM ACAD DERMATOL* 1984;11:74-85.
  50. Kassis V, Vedel P, Darre E. Contact dermatitis to methyl methacrylate. *Contact Dermatitis* 1984;11:26-8.
  51. Waegemaeker TH, Seutter E, den Arend JA, et al. Permeability of surgeons' gloves to methyl methacrylate. *Acta Orthop Scand* 1983;54:790-5.
  52. Pegum JS. Penetration of protective gloves by epoxy resin. *Contact Dermatitis* 1979;5:281-3.
  53. Fuchs E, Gronemeyer W. Hautproben. In: Fuchs E, Schulz KH, eds. *Manuale allergologicum*. München: Dustri, 1990;4(3):15.
  54. Zuger Ch. Allergy to zinc dimethyldithiocarbamate in rubber gloves. *Contact Dermatitis* 1981;7:337-8.
  55. Roed-Petersen J. A new glove material protective against epoxy and acrylate monomer. In: Frosch PJ, Dooms-Goossens A, Lachapelle J-M, et al. *Current topics in contact dermatitis*. Berlin: Springer, 1989:603-5.

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