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# Patch testing with glucosides: The North American Contact Dermatitis Group experience, 2009-2018



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**Background:** Alkyl glucosides are nonionic surfactants that are increasingly used in personal care products.

**Objective:** To characterize positive patch test reactions to decyl glucoside (5% petrolatum, tested 2009-2018) and lauryl glucoside (3% petrolatum, tested 2017-2018).

**Methods:** Retrospective analysis of patients tested by the North American Contact Dermatitis Group.

**Results:** Of 24,097 patients patch tested to decyl and/or lauryl glucoside, 470 (2.0%) had positive reactions. Compared with glucoside-negative patients, glucoside-positive patients had higher odds of occupational skin disease (13.4% vs 10.1%;  $P = .0207$ ), history of hay fever (38.5% vs 31.6%;  $P = .0014$ ), atopic dermatitis (39.0% vs 28.6%;  $P < .0001$ ), and/or asthma (21.8% vs 16.5%;  $P = .0023$ ). Most glucoside reactions (83.9%) were currently relevant. The most common source was personal care products (63.0%), especially hair products (16.5%) and skin cleansers (15.2%). Of 4933 patients tested to decyl and lauryl glucoside, 134 (2.7%) were positive to 1 or both; 43.4% (43 of 99) of decyl-positive patients were also positive to lauryl glucoside and 55.1% (43/78) of lauryl glucoside patients were also positive to decyl glucoside.

**Limitations:** The cohort predominantly reflects a referral population, and follow-up after testing was not captured.

**Conclusion:** Glucoside positivity occurred in 2.0% of the tested patients. Reactions were often clinically

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relevant and linked to personal care products. Cross-reactivity was >40%. (*J Am Acad Dermatol* 2022;87:1033-41.)

**Key words:** allergic contact dermatitis; contact allergy; decyl glucoside; glucoside; lauryl glucoside; patch test.

## INTRODUCTION

Alkyl glucosides are plant-derived, nonionic surfactants created from the condensation of glucose (typically from corn, potato, or wheat starch) with a fatty alcohol (usually from coconut, palm, or rapeseed oil).<sup>1</sup> Alkyl glucosides (eg, decyl, lauryl, cetearyl, coco, and capryl glucosides) were introduced to consumer markets in the 1930s but were later largely replaced by synthetic surfactants (eg, sodium lauryl sulfate). However, since the 1990s, the use of glucosides in personal care products (PCPs) has increased, largely because of shifts in consumer preferences for “natural” and eco-friendly products; glucosides are biodegradable and are derived from renewable sources.<sup>2</sup>

Glucosides are used as emulsifiers and foaming agents, especially in rinse-off products, including liquid cleansers, soaps, and shampoos. A wide range of leave-on products, including cosmetics, wipes, sunscreens, and moisturizers, also contain glucosides.<sup>3,4</sup> In addition to PCPs, glucosides in medical products (eg, surgical cleansers, wound products, and foam dressings) may cause allergic contact dermatitis.<sup>5-7</sup>

Decyl glucoside is the most commonly used glucoside in PCPs. In 2013, the Cosmetic Ingredient Review Expert Panel identified 492 products with decyl glucoside—85.6% were rinse-off formulations.<sup>1</sup> A US Food and Drug Administration DailyMed advanced search identified 3038 products with a glucoside, 910 with decyl glucoside, and 514 with lauryl glucoside.<sup>8</sup> The Environmental Working Group database contains 1738 products with decyl glucoside and 1003 products with lauryl glucoside; the most frequent product categories were shampoos, facial cleansers, body washes, and liquid hand soaps.<sup>9,10</sup> Decyl glucoside was a “hidden” ingredient in Tinosorb M-containing sunscreens (BASF Care Creations) because it is used in its manufacturing but was not listed as an ingredient.<sup>11-16</sup> Following publications by Andersen and Goossens<sup>15</sup> and Andrade et al<sup>11</sup>, decyl glucoside is now labeled separately as an ingredient in Tinosorb M-containing sunscreens.

## CAPSULE SUMMARY

- Alkyl glucosides, surfactants used commonly in personal care products, may cause allergic contact dermatitis but are not on many screening series.
- In this retrospective review of 24,097 patients, 470 (2.0%) had positive patch test reactions to glucosides, 84% of which were clinically relevant. Personal care products were common sources.

Although there are many case reports on allergic contact dermatitis to glucosides, few studies have tested glucosides on routine screening series.<sup>3,17-19</sup> Glucosides are not on T.R.U.E. TEST (SmartPractice Dermatology) but are on American Contact Dermatitis Society Core Allergen series.<sup>20</sup> Our review of 26 different “baseline” series (including extended/comprehensive versions) found that 10 (38.5%)

included at least 1 glucoside; of 18 screening baseline series (excluding extended/comprehensive versions), only 4 (22.2%) included at least 1 glucoside.<sup>21</sup> This study of decyl and lauryl glucoside in routine patch testing provides detailed information on demographics, reaction characteristics, clinical relevance, occupational relevance, and sources.

## METHODS

### Database

Health Partners institutional review board approved this analysis of deidentified North American Contact Dermatitis Group (NACDG) data. The NACDG database includes patient demographics, including age, sex, race, history of atopy (asthma, atopic dermatitis, and hay fever), and body site(s) of dermatitis (up to 3).

Patch testing and coding were performed per NACDG guidelines.<sup>22</sup> Readings at 48 hours and at the final visits (most commonly 96 hours, range 72-168) were coded as negative, irritant, doubtful (macular erythema only), weak (+ [erythema, infiltration, possible papules]), strong (++ [edematous or vesicular]), or extreme (+++ [spreading, bullous, ulcerative]). At the last visit, the final interpretation of “allergic” or “not allergic” was determined. “Doubtful” reactions could be interpreted as allergic or not allergic on the basis of the temporal pattern (crescendo or decrescendo), patch test appearance, known characteristics of that allergen, and reactions to related allergens, products, or materials.

Clinical relevance was coded for all allergic reactions. Current relevance included “definite” (positive patch or use test to a substance(s)

*Abbreviations used:*

|        |                                         |
|--------|-----------------------------------------|
| CAMP:  | Contact Allergen Management Program     |
| NACDG: | North American Contact Dermatitis Group |
| OR:    | odds ratio                              |
| PCP:   | personal care product                   |

confirmed to contain an allergen), “probable” (identification of an allergen in a substance(s) contacting areas of dermatitis), or “possible” (an allergen likely in a substance(s) contacting areas of dermatitis). Other options for relevance included “unknown” or “past.” Occupational relevance was determined by clinical history and occupational exposures. One source code was entered per allergen; if multiple sources were identified, the most clinically relevant source was selected.

### Study population

Decyl glucoside (5% petrolatum) was added to NACDG screening series in 2009, and lauryl glucoside (3% petrolatum) was added in 2017. All patients who were patch tested to decyl glucoside (2009-2018) and lauryl glucoside (2017-2018) were included. Glucoside-positive patients were defined as those with a final patch test interpretation of “allergic” to decyl glucoside and/or lauryl glucoside. This included some doubtful (macular erythema) reactions coded as “allergic.” Glucoside-negative patients were defined as all those with patch test reactions interpreted as not allergic (negative, irritant, or doubtful coded as not allergic).

### Data analysis

Data were entered in Access and Excel (Microsoft). Descriptive analyses, including frequencies, counts, and percentages, were conducted using Excel. Using SAS (version 9.4), glucoside-positive and glucoside-negative groups were compared using the 2-sided  $\chi^2$  test. *P* values of <.05 were considered statistically significant.

## RESULTS

### Frequency of allergic patch test results

A total of 24,097 patients were patch tested to decyl and/or lauryl glucoside; 470 (2.0%) patients were positive to 1 or both the glucosides. In the 2017-2018 cycle (when both were tested), there were 134 glucoside-positive patients (*N* = 4933, 2.7%); of these, 41.8% were positive to decyl glucoside alone, 26.1% were positive to lauryl glucoside alone, and 32.1% were positive to both (Fig 1).

### Demographics

There were no statistically significant sex or age ( $\geq 40$  vs <40 years) associations with glucoside positivity (Table I). The odds of an occupationally related skin condition were significantly higher in the glucoside-positive patients (13.4% vs 10.1%; odds ratio [OR], 1.37; 95% CI, 1.05-1.79; *P* = .0207). The odds of a history of hay fever (38.5% vs 31.6%; OR, 1.36; 95% CI, 1.13-1.64; *P* = .0014), atopic dermatitis (39.0% vs 28.6%; OR, 1.60; 95% CI, 1.32-1.92; *P* < .0001), and/or asthma (21.8% vs 16.5%; OR, 1.41; 95% CI, 1.13-1.76; *P* = .0023) were also higher in the glucoside-positive patients.

### Anatomic site(s) of dermatitis

In the glucoside-positive patients, the most common primary anatomic sites were face (29.6%), scattered/generalized (26.8%), and hand (23.6%) (Table I). These were also the most common sites when up to 3 sites were considered.

### Reaction strength and clinical relevance

The final reading strength of glucoside-positive reactions was predominantly + (52.7%) or ++ (22.8%), with fewer +++ (9.1%) or +/- (15.4%) reactions. Over 80% of glucoside reactions were considered currently clinically relevant; most were possible (49.9%), followed by probable (27.5%) and definite (7.6%) (Table II).

### Glucoside sources

The most commonly identified glucoside sources were PCPs (63.0%) (Table III). Hair products were the most frequently specified category (26.3%); within this group, 90.6% of the products were shampoo/conditioners. Skin cleansers were commonly identified, followed by leave-on skin products (moisturizers, make-up, and antiaging products). Eight glucoside reactions were attributed to sunscreens. Household cleaning products were also frequently identified as glucoside sources.

Of the 180 definite or probable clinically relevant reactions (which require verification of glucoside on product information), most (84.4%, *n* = 152) were associated with PCPs. Hair products (28.9%, *n* = 52) and unspecified PCPs (24.4%, *n* = 44) were most common within this category. Other definite or probable sources included skin cleansers (*n* = 41), nonskin cleaners (*n* = 22), leave-on skin products (*n* = 10), and topical medications (*n* = 2).

### Occupationally related glucoside allergy

Seventeen patients had occupationally related glucoside allergy, with 4 having occupationally related reactions to both decyl and lauryl glucoside

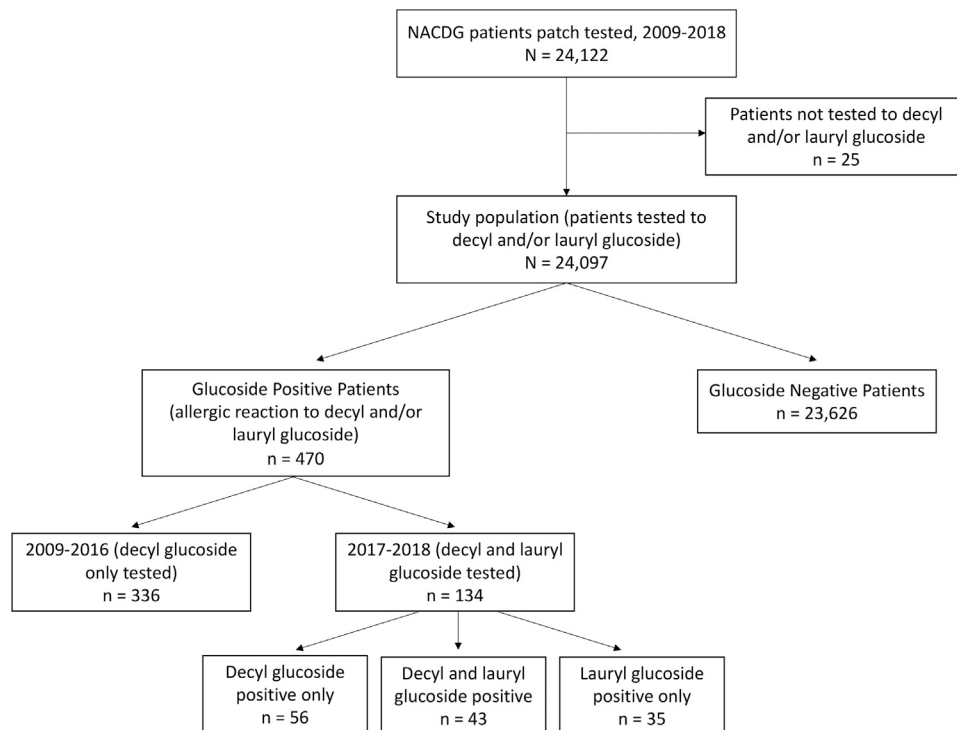


**Fig 1.** Study population flow diagram. NACDG, North American Contact Dermatitis Group.

(Table IV). Health care workers ( $n = 4$ ), automobile mechanics or machine operators ( $n = 4$ ), cleaners ( $n = 3$ ), and hairdressers or cosmetologists ( $n = 2$ ) were the most common occupations. Most (87.5%) had the hand(s) as the primary affected location. Skin cleansers and nonskin cleansers or disinfectants were predominant sources. Glucosides were verified in the ingredients of 7 products (definite or probable relevance).

## DISCUSSION

Of the 24,097 patients who were patch tested over 10 years, 2.0% had an allergic reaction to decyl and/or lauryl glucoside. Face, scattered or generalized, and hands were common anatomic sites of dermatitis. PCPs were frequently identified glucoside sources. Compared with the glucoside-negative patients, the glucoside-positive patients had greater odds of having an occupationally related skin problem, although the absolute numbers were small.

## Prevalence

Our finding of 2.0% glucoside positivity is slightly higher than that reported in 3 previous studies of general patch-tested patients (1.6%,  $N = 1893$ ; 1.0%,  $N = 2796$ ; 1.5%,  $N = 2803$ ).<sup>3,17,19</sup> We suspect that the actual glucoside allergy prevalence may be higher because we only tested 1 glucoside for most of the

study, whereas other studies tested 2 to 5 glucosides. Positivity is higher in selected patch test populations, such as those with cosmetic or toiletry-related dermatitis (5.4%,  $N = 897$ )<sup>18</sup> because glucosides are commonly found in PCPs.<sup>1</sup>

## Demographics

The glucoside-positive patients were primarily female (71.0%) and aged >40 years (71.8%); however, these frequencies were not significantly different from the glucoside-negative patients. In previous studies, female frequencies were 63.4%,<sup>19</sup> 72.4%,<sup>17</sup> and 80.0%.<sup>3</sup> This is not surprising because female patients tend to use more PCPs in their daily routines and, thus, have greater exposure risk to glucoside-containing products.<sup>23</sup>

## Anatomic sites

The most common primary anatomic sites of dermatitis in the glucoside-positive patients were face (29.6%), scattered or generalized pattern (26.8%), and hands (23.6%). Soriano et al<sup>19</sup> also found that the most common affected anatomic sites in glucoside-positive patients were face (63.2%), hands (31.6%), and a generalized pattern (15.8%). Gijbels et al<sup>3</sup> and Bhoyrul et al<sup>17</sup> found that many individuals with glucoside allergy had dermatitis of the hands (18.2%, 37.9%), face (15.6%, 27.6%), and

**Table I.** Demographics (MOAHFLA index) and anatomic sites of dermatitis of glucoside positive and negative patients (2009-2018)

| MOAHFLA index                |                             |                             |         |                     |
|------------------------------|-----------------------------|-----------------------------|---------|---------------------|
| Demographics                 | Glucoside-positive patients | Glucoside-negative patients | P value | Odds ratio (95% CI) |
|                              | No. (%)<br>N = 470          | No. (%)<br>N = 23,626       |         |                     |
| Male                         | 136 (29.0)                  | 7050 (29.8)                 | .6831   | 0.96 (0.78-1.17)    |
| Occupation-related*          | 63 (13.4)                   | 2379 (10.1)                 | .0207   | 1.37 (1.05-1.79)    |
| History of hay fever         | 180 (38.5)                  | 7415 (31.6)                 | .0014   | 1.36 (1.13-1.64)    |
| History of atopic dermatitis | 183 (39.0)                  | 6708 (28.6)                 | <.0001  | 1.60 (1.32-1.92)    |
| History of asthma            | 102 (21.8)                  | 3883 (16.5)                 | .0023   | 1.41 (1.13-1.76)    |
| Hand <sup>†</sup>            | 111 (23.6)                  | 4909 (20.8)                 | .1399   | 1.18 (0.95-1.46)    |
| Leg <sup>‡</sup>             | 10 (2.1)                    | 937 (4.0)                   | .0415   | 0.53 (0.28-0.99)    |
| Face <sup>†,‡</sup>          | 139 (29.6)                  | 7194 (30.5)                 | .6613   | 0.96 (0.79-1.16)    |
| Age >40 y                    | 311 (71.8)                  | 15,794 (66.9)               | .8081   | 1.98 (0.80-1.19)    |

| Anatomic sites        |                             |                                    |                                  |                                     |
|-----------------------|-----------------------------|------------------------------------|----------------------------------|-------------------------------------|
| Dermatitis site       | Primary anatomic site       |                                    | Any of ≤ 3 anatomic sites        |                                     |
|                       | Glucoside-positive patients | Glucoside-negative patients        | Glucoside-positive patients      | Glucoside-negative patient          |
|                       | No. (%)<br>N = 470          | No. (%)<br>N = 23,576 <sup>§</sup> | No. (%) <sup>  </sup><br>N = 470 | No. (%) <sup>  </sup><br>N = 23,576 |
| Face, total           | 139 (29.6)                  | 7194 (30.5)                        | 201 (25.1)                       | 9784 (26.0)                         |
| Face NOS              | 98 (20.9)                   | 3760 (15.9)                        | 138 (17.2)                       | 5385 (14.3)                         |
| Eyelids               | 29 (6.2)                    | 2434 (10.3)                        | 42 (5.2)                         | 3040 (8.1)                          |
| Lips                  | 12 (2.6)                    | 1000 (4.2)                         | 21 (2.6)                         | 1359 (3.6)                          |
| Eyes                  | 0 (0.0)                     | 104 (0.4)                          | 1 (0.1)                          | 193 (0.5)                           |
| Nose                  | 0 (0.0)                     | 9 (0.04)                           | 1 (0.1)                          | 35 (0.1)                            |
| Scattered generalized | 126 (26.8)                  | 4345 (18.4)                        | 182 (22.8)                       | 5570 (14.8)                         |
| Hand                  | 111 (23.6)                  | 4909 (20.8)                        | 143 (17.8)                       | 5847 (15.5)                         |
| Scalp/neck/ears       | 26 (5.6)                    | 1644 (6.9)                         | 86 (10.7)                        | 4214 (10.6)                         |
| Trunk                 | 19 (4.0)                    | 1346 (5.7)                         | 41 (5.1)                         | 3007 (8.0)                          |
| Leg/arm               | 19 (4.0)                    | 1995 (8.5)                         | 86 (12.0)                        | 5790 (15.4)                         |
| Other <sup>¶</sup>    | 13 (2.7)                    | 914 (4.0)                          | 19 (2.4)                         | 1142 (3.1)                          |
| Anal/genital          | 9 (1.9)                     | 546 (2.3)                          | 13 (1.6)                         | 768 (2.0)                           |
| Foot                  | 8 (1.7)                     | 570 (2.4)                          | 18 (2.2)                         | 1338 (3.6)                          |

Available demographic data varied slightly. Glucoside-positive sex, missing 1; hay fever, missing 3; atopic dermatitis, missing 1; asthma, missing 3; age, missing 2. Glucoside-negative sex, missing 23; occupation-related, missing 158; hay fever, missing 151; atopic dermatitis, missing 196; asthma, missing 153; primary anatomic site, missing 44; age, missing 48.

MOAHFLA, Male, occupational dermatitis, atopic dermatitis, hand, face, leg, age >40 years; NOS, not otherwise specified.

\*Overall skin condition.

<sup>†</sup>Primary anatomic site of dermatitis.

<sup>‡</sup>Includes eyelids, lips, eyes, and nose.

<sup>§</sup>Excludes 50 glucoside-negative patients missing primary anatomic site.

<sup>||</sup>Percentages total >100% because up to 3 sites per patients could be designated.

<sup>¶</sup>Other includes most exposed areas, only under clothing, erythroderma, and NOS.

neck (11.7%, 10.3%).<sup>3,17</sup> In previous work, our group found that the face is the most common site of cosmetic-related contact dermatitis, likely because of the high exposure from direct application of cosmetics and/or from rinse-off products, such as skin cleansers, shampoos, and conditioners.<sup>24</sup> Hand involvement and scattered or generalized pattern are also expected because of exposure to surfactant-containing products, such as skin cleansers and moisturizers.<sup>25</sup>

## Reaction strength

Over half of the positive glucoside reactions were + (52.7%). Among the patients tested to both the glucosides (2017-2018 cycle), there was a higher percentage of ++ (28.6% vs 16.7%) and +++ (14.3% vs 3.7%) reactions for decyl glucoside in those who were positive to both decyl and lauryl glucoside versus patients who were only positive to decyl glucoside. The same was true for lauryl glucoside reaction strength in patients positive to

**Table II.** Strength of reactions to glucosides at the final reading and clinical relevance

| Positive reaction characteristic  | Decyl glucoside<br>No. of<br>reactions (%) | Lauryl glucoside<br>No. of<br>reactions (%) |
|-----------------------------------|--------------------------------------------|---------------------------------------------|
| Strength of reaction <sup>†</sup> | <b>N = 429*</b>                            | <b>N = 77*</b>                              |
| Weak (+)                          | 226 (52.7)                                 | 39 (50.6)                                   |
| Strong (++)                       | 98 (22.8)                                  | 17 (22.1)                                   |
| Extreme (+++)                     | 39 (9.1)                                   | 8 (10.4)                                    |
| Macular erythema (+/-)            | 66 (15.4)                                  | 13 (16.9)                                   |
| Clinical relevance <sup>‡</sup>   | <b>N = 435</b>                             | <b>N = 78</b>                               |
| Current                           | 365 (83.9)                                 | 71 (91.0)                                   |
| Definite                          | 32 (7.4)                                   | 7 (9.0)                                     |
| Probable                          | 118 (27.1)                                 | 23 (29.5)                                   |
| Possible                          | 215 (49.4)                                 | 41 (52.6)                                   |
| Past                              | 19 (4.4)                                   | 2 (2.6)                                     |
| Unknown/not applicable            | 51 (11.7)                                  | 5 (6.4)                                     |

\*Excludes missing or miscoded final readings: decyl *n* = 6, lauryl *n* = 1.

<sup>†</sup>Excludes macular erythema coded as not allergic: decyl *n* = 68, lauryl *n* = 7.

<sup>‡</sup>Definite: positive patch or use test to item containing glucoside. Probable: positive patch or use test and glucoside found in item being used. Possible: skin contact with glucoside is likely to occur. Past: glucoside not in patient's current environment or applied to affected body site.

both glucosides versus only lauryl glucoside (+++, 26.2% vs 17.1%; ++, 16.7% vs 2.9%) (data not shown).

## Sources

PCPs were an important source of glucoside reactions (63.1%). This is not surprising because nonionic surfactants play various roles in PCPs. They are used for their cleansing properties in rinse-off products, such as soaps, shampoos, and facial cleansers, or as emulsion stabilizers in moisturizers and cosmetics.<sup>1</sup> Case studies have demonstrated allergic contact dermatitis to glucosides in PCPs, especially shampoos.<sup>4,26,27</sup>

In our study, hair products, especially shampoos or conditioners, were the most identified glucoside source. In a Contact Allergen Management Program (CAMP) database search, glucosides were documented in 12.4% of hair products, which included 51.0% of 202 hair dyes and 12.8% of 1008 shampoos or conditioners.<sup>28</sup> Tawfik et al<sup>29</sup> analyzed best-selling ethnic and nonethnic shampoos and found decyl glucoside in 44.2% of 36 ethnic shampoos and 11.3% of 150 nonethnic shampoos; they suggested that the higher presence of glucosides in ethnic shampoos may be because of desired gentler properties of glucoside surfactants.

Skin cleansers are an important glucoside source. A CAMP database search identified glucosides in 21.7% of 762 skin cleansers.<sup>28</sup> In previous work, our group found that of 891 allergic reactions to skin cleansers from 2000 to 2014, 2.9% were because of decyl glucoside.<sup>30</sup> Glucosides can also be found in facial wipes; of 178 facial wipes reviewed in 2016, 27.5% contained glucosides.<sup>31</sup> Here, only 1 source of a glucoside-containing wipe was documented (data not shown).

Leave-on skin products may also contain glucosides. In 2018, a study of 20 best-selling moisturizers found that 10% of the moisturizers contained glucosides.<sup>32</sup> In a 2021 study that focused on facial moisturizers for men, Schlarbaum and Warshaw<sup>33</sup> found that 26.2% of the moisturizers contained glucosides. A CAMP database search found that 17.9% of 3230 skin care products, including 35.5% of 490 antiaging or antiwrinkle products and 13.5% of 999 moisturizers, contained glucosides.<sup>28</sup>

Sunscreens were associated with 1.7% of glucoside-positive reactions in our study. In 1 study of 20 best-selling sunscreens, 15% of the sunscreens contained alkyl glucosides.<sup>32</sup> In the CAMP database, 14.5% of 269 sunscreens contained alkyl glucosides.<sup>28</sup> Tinosorb M contains decyl glucoside as a stabilizer. This UV filter is not approved by the US Food and Drug Administration, although it is available in Europe.<sup>34</sup> Since 2018, it is permissible in Canada<sup>35,36</sup>; however, this study does not include data beyond 2018. Importantly, even though Tinosorb M is not approved in the United States, non-US products may still be purchased online or when traveling.

In our study, nonskin (household or industrial) cleaners were important glucoside sources (6.6%). In the CAMP database, 65.0% of household cleaners contained glucosides, which included 65.0% of 100 laundry detergents and 45.2% of 42 laundry fabric softeners, bleach, or additives.<sup>28</sup> In a study of selected "free and gentle" products, decyl glucoside was found in 28.6% of 30 laundry detergents and in 33.3% of 17 stain removers.<sup>37</sup>

## Occupational considerations

The glucoside-positive patients had statistically significant higher odds of presenting with occupationally related skin disease than the glucoside-negative patients, although absolute numbers were small. Four occupationally related glucoside-positive patients were health care workers. Studies of ingredients in surgical hand scrubs<sup>6</sup> and medical hand skin cleansers<sup>38</sup> found that <6% contained glucosides. Here, other common occupations included mechanics or machine operators (25.0%), cleaners

**Table III.** Source of glucoside

| Source                                   | All reactions                     |                                   |                         | Definite/probable clinical relevance |                                   |                         |
|------------------------------------------|-----------------------------------|-----------------------------------|-------------------------|--------------------------------------|-----------------------------------|-------------------------|
|                                          | Decyl glucoside<br><i>N</i> = 435 | Lauryl glucoside<br><i>N</i> = 78 | Total<br><i>N</i> = 513 | Decyl glucoside<br><i>N</i> = 150    | Lauryl glucoside<br><i>N</i> = 30 | Total<br><i>N</i> = 180 |
| Personal care products                   | <b>274</b>                        | <b>49</b>                         | <b>323</b>              | <b>130</b>                           | <b>22</b>                         | <b>152</b>              |
| Hair products                            | 71                                | 14                                | 85                      | 45                                   | 7                                 | 52                      |
| Skin cleansers                           | 62                                | 16                                | 78                      | 32                                   | 9                                 | 41                      |
| Leave-on skin products                   | 21                                | 3                                 | 24                      | 9                                    | 1                                 | 10                      |
| Moisturizers, lotions, creams            | 13                                | 3                                 | 16                      | 3                                    | 1                                 | 4                       |
| Make-up                                  | 2                                 | 0                                 | 2                       | 1                                    | 0                                 | 1                       |
| Antiaging and skin rejuvenation products | 2                                 | 0                                 | 2                       | 2                                    | 0                                 | 2                       |
| Not otherwise specified                  | 4                                 | 0                                 | 4                       | 3                                    | 0                                 | 3                       |
| Sunscreens                               | 7                                 | 1                                 | 8                       | 3                                    | 1                                 | 4                       |
| Other                                    | 0                                 | 2                                 | 2                       | 0                                    | 1                                 | 1                       |
| Not otherwise specified                  | 113                               | 13                                | 126                     | 41                                   | 3                                 | 44                      |
| Nonskin (household/industrial) cleaners  | <b>30</b>                         | <b>4</b>                          | <b>34</b>               | <b>18</b>                            | <b>4</b>                          | <b>22</b>               |
| Topical medications                      | <b>1</b>                          | <b>1</b>                          | <b>2</b>                | <b>1</b>                             | <b>1</b>                          | <b>2</b>                |
| Dentistry materials/products             | <b>1</b>                          | <b>0</b>                          | <b>1</b>                | <b>0</b>                             | <b>0</b>                          | <b>0</b>                |
| Unknown/not applicable/other             | <b>129</b>                        | <b>24</b>                         | <b>153</b>              | <b>1</b>                             | <b>3</b>                          | <b>4</b>                |

Boldface represents total counts for each subcategory.

**Table IV.** Occupationally related glucoside reactions\*

| Occupation                         | Age (y)/ sex | Decyl glucoside | Lauryl glucoside | Source                | Primary location | Other location | Clinical relevance |
|------------------------------------|--------------|-----------------|------------------|-----------------------|------------------|----------------|--------------------|
| <b>Health care worker</b>          |              |                 |                  |                       |                  |                |                    |
| Physician                          | 36 F         | +++             | NT               | Skin disinfectant     | Scat/Gen         |                | Definite           |
| Physician                          | 35 F         | ++              | NT               | Skin cleanser         | Hand             | Arm            | Probable           |
| Registered nurse                   | 56 F         | +               | NT               | Skin cleanser         | Hand             |                | Possible           |
| Registered nurse                   | 51 F         | Neg             | +                | Unknown               | Hand             |                | Possible           |
| <b>Mechanics/machine operators</b> |              |                 |                  |                       |                  |                |                    |
| Auto mechanic                      | 42 M         | +               | + <sup>†</sup>   | Skin cleanser         | Hand             | Arm            | Possible           |
| Auto mechanic                      | 44 M         | +               | ++               | Pumice soap           | Hand             | Arm            | Probable           |
| Auto mechanic                      | 46 M         | Neg             | +                | Waterless hand soap   | Hand             | Arm            | Probable           |
| Machine operator                   | 47 M         | +               | +                | Skin cleanser         | Scat/Gen         |                | Possible           |
| <b>Cleaning occupations</b>        |              |                 |                  |                       |                  |                |                    |
| House cleaner                      | 38 M         | ++              | NT               | Nonskin disinfectant  | Hand             |                | Possible           |
| Janitor                            | 37 M         | +               | NT               | Nonskin cleaner       | Hand             |                | Possible           |
| Janitor                            | 55 F         | +/-             | NT               | Nonskin disinfectant  | Hand             |                | Possible           |
| <b>Hairdresser/cosmetologist</b>   |              |                 |                  |                       |                  |                |                    |
| Hairdresser/cosmetologist          | 39 F         | +               | NT               | Leave-on skin product | Hand             | Arm            | Probable           |
| Hairdresser/cosmetologist          | 52 F         | +               | NT               | Shampoo/conditioner   | Hand             |                | Possible           |
| <b>Other occupations</b>           |              |                 |                  |                       |                  |                |                    |
| Teaching assistant                 | 22 F         | ++              | ++               | Skin cleanser         | Hand             | Foot           | Probable           |
| Cook                               | 30 M         | +               | +                | Skin cleanser         | Hand             |                | Probable           |
| Sales worker                       | 61 F         | Neg             | +                | Massage/essential oil | Hand             | Arm<br>Trunk   | Possible           |

F, Female; M, male; Neg, negative; NT, not tested; Scat/Gen, scattered/generalized.

\*One occupation not coded.

<sup>†</sup>Lauryl glucoside + was not occupationally related.

(18.8%), and hairdressers or cosmetologists (12.5%). Blondeel<sup>26</sup> highlighted a case of occupationally related hand dermatitis in a hairdresser apprentice who did not use gloves when shampooing and

rinsing hair dyes; all of her workplace shampoos contained lauryl or decyl glucoside.

In our study, hands were the primary affected location in occupational cases (87.5%). Hand

dermatitis is the most common site of occupational skin disease; 1 study found that 75.8% of patients with occupational dermatitis had hand involvement.<sup>39</sup> Because soaps or hand disinfectants were common sources of exposure (56.3%), this is consistent with the use of these products. There was 1 definite occupationally relevant case and it involved exposure to a skin disinfectant. Of the 6 probable relevant reactions, most ( $n = 5$ ) involved skin cleansers.

### Cross-reactivity of decyl and lauryl glucoside

Cross-reactivity among glucosides is expected because of their structural similarity, with variations in the sidechain length and degree of polymerization. In 2017-2018, of 99 decyl glucoside-allergic patients, 43.4% were also positive to lauryl glucoside. Conversely, of 78 lauryl glucoside-allergic patients, 55.1% were also positive to decyl glucoside. Prior studies demonstrated that 42.9% to 73.8% of decyl glucoside-allergic patients were also positive to lauryl glucoside and 50% to 83.7% of lauryl glucoside-allergic patients were positive to decyl glucoside.<sup>18,19,40</sup> Gijbels et al<sup>3</sup> found that 88.5% of 26 patients who were tested to  $>2$  alkyl glucosides reactions had allergy to  $\geq 2$ .

With significant cross-reactivity, the management of glucoside allergy should include avoidance of all glucosides. In the setting of even a single glucoside allergy, CAMP excludes all glucosides because of the likelihood of cross-reactivity.<sup>28</sup>

### Limitations

Our study cohort largely represents a referral population and, thus, does not reflect the general population or general dermatology patients. Cross-reactivity data are limited to the 2017-2018 cycle. Additional testing and follow-up testing (ie, use tests, repeat open application tests, and subsequent patch testing), if performed, were not specifically captured in the dataset.

### Summary

This study describes 10 years of routine patch test data for decyl glucoside and 2 years of routine patch test data for lauryl glucoside in a North American tertiary referral population. Positive reactions were seen in 2.0% of the tested patients. The glucoside-positive patients were primarily female, aged  $>40$  years, and commonly presented with dermatitis of the face, hands, or a scattered generalized pattern. Common sources of glucoside exposure included PCPs, especially shampoos or conditioners and skin cleansers. There was significant cross-reactivity between decyl glucoside and lauryl glucoside. Because

glucosides are not on most screening series, including T.R.U.E. TEST, this important group of allergens will be missed without expanded patch testing.

### Conflicts of interest

Dr Warsaw reports investigator-initiated grant from WEN by Chaz Dean and has served as a consultant for WEN by Chaz Dean and Noven Pharmaceuticals. Dr Atwater has received a Pfizer Independent Grant for Learning & Change, has consulted for Henkel, and is employed by Eli Lilly and Company. Dr Taylor owns noncontrolling common shares of stock in Astra Zeneca, Cigna, Merck, Johnson & Johnson, and Opko Health; has consulted for Kao Brands and Monsanto (Bayer); is a member of the Cosmetic Ingredient Review Steering Committee; and has a nondependent child employed by Pfizer. Dr Sasseeville receives royalties from UpToDate (Wolters Kluwer Health). Author Xiong and Drs DeKoven, Pratt, Maibach, Belsito, Silverberg, Reeder, Zug, Fowler, DeLeo, Houle, and Dunnick have no conflicts of interest to disclose.

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