Impact of Converting to Powder-Free Gloves
Decreasing the Symptoms of Latex Exposure in Operating Room Personnel

by Denise M. Korniewicz, DNSc, RN, FAAN, Nantiya Chookaew, MSN, RN, Jeanine Brown, BSN, RN, Nichol Bookhamer, BSN, RN, Kim Mudd, MSN, RN, and Mary Elizabeth Bollinger, DO

ABSTRACT
This study examined health care worker satisfaction with the use of non-powdered natural rubber latex (NRL) surgical gloves to determine the impact of non-powdered NRL gloves on the NRL sensitization of operating room personnel. The study used a 1-year longitudinal design to obtain recall information from employees about their NRL exposure. Additionally, a survey was completed by participants in regard to their satisfaction with non-powdered NRL gloves. Informed consent was obtained from 103 employees. After conversion to a non-powdered operating room, there was a significant decrease in reported symptoms with NRL exposure (42% pre and 29% post, Fisher’s exact, two-tailed, \( p = .0001 \)).

This study demonstrated that the conversion to non-powdered low protein NRL gloves resulted in decreased symptoms because of NRL exposure.

Natural rubber latex (NRL) is used to manufacture many products used in health care including surgical gloves (Korniewicz, Garzon, & Plitcha, 2003). Since 1987, there has been an increase in the use of NRL gloves by health care workers (HCWs) in response to the recommendations of universal precautions by the Centers for Disease Control and Prevention (CDC, 1987) and recommendations set forth by the Occupational Health and Safety Administration (OSHA, 1999). The OSHA guidelines state that gloves should be worn whenever there is a potential for contact with blood, non-intact skin, or any infectious materials (OSHA, 1999). These recommendations from CDC and OSHA have dramatically affected the quantity of NRL gloves used by HCWs, growing from 1.4 billion in 1988 to 12.3 billion in 2002 (Tan, 2002).

The use of powdered NRL gloves has been shown to increase the likelihood of sensitization to NRL. HCWs who continually use NRL powdered gloves have a higher likelihood of developing occupational allergy symptoms such as urticaria, angioedema, rhinitis, conjunctivitis, bronchospasms, and anaphylaxis (Charous, Tarlo, Charous, & Kelly, 2002; Kelly, Sussman, & Fink, 1996). Even when NRL-sensitive employees avoid personal use...
of powdered NRL gloves, but have coworkers who use powdered NRL gloves, they may continue to be at risk for NRL-related symptoms through airborne transmission of NRL. Operating room personnel are particularly susceptible to NRL sensitization because of increased exposure from the high volume of NRL gloves used in that setting (Kelly et al., 1994).

Recognizing the importance of NRL as an occupational hazard, particularly for HCWs, the new OSHA workplace guidelines recommend the use of non-powdered gloves as a way to decrease NRL sensitization and symptoms among HCWs. In April of 1998, the University of Maryland Medical System (UMMS) implemented a plan to identify employees at risk for NRL reactions and to decrease their exposure to NRL. This involved a “phased in” glove conversion plan to initially remove powdered NRL gloves from the environment and provide a NRL safe environment. In August 2001, the operating rooms were converted to non-powdered low protein NRL and non-NRL surgical gloves.

The purpose of this study was to determine the impact of non-powdered NRL gloves on the NRL sensitization and symptoms of operating room personnel and to examine HCW satisfaction with the use of non-powdered NRL surgical gloves. This report includes data on self-reported NRL related symptoms in a cohort of operating room personnel prior to and 7 to 12 months after the conversion to non-powdered surgical gloves.

METHODS

This study was approved by the University of Maryland Institutional Review Board. Seven to 12 months after conversion of the operating room to powder-free NRL gloves, UMMS employees who worked in the operating room were approached to participate. All operating room personnel \( n = 300 \) were asked to participate in the study and to take a radioallergosorbent (RAST) test. The study was advertised through announcements made at weekly nursing and physician meetings as well as advertisements placed on bulletin boards located throughout the operating room employee lounges. To be eligible, the individuals had to be at least 18 years old, fluent in English, and sign an informed consent.

All participants were given surveys that included demographics data including occupation (e.g., nurse, technician, surgeon, anesthesia), age, gender, race, number of years in health care, and number of years employed in the operating room. Participants were also asked about self-reported symptoms with NRL exposure before and after the operating room was converted to powder-free, as well as glove use practices and glove satisfaction. Participants were specifically asked about symptoms with latex associated foods such as banana, avocado, and kiwi, reported to be foods that are more likely to cause symptoms in NRL-sensitive individuals (Beezhold, Swanson, Zehr, & Kostyal, 1996; Blanco, Carrillo, Castillo, Quiralte, & Cuevas, 1994; Brehler, Theissen, Mohr, & Luger, 1997; Kim & Hussain, 1999; Levy, Mounedji, Noirot, & Leynadier, 2000; M’Raïhi, Charpin, Pons, Bongrand, & Vervloet, 1991).

The survey included items related to glove quality, comfort, safety, serviceability and performance, standardization, needlestick injuries, durability, and usage practices. Participants were asked to rank each item by using a Likert scale ranging from 1 (worse) to 3 (best).

Participants who consented to a blood draw underwent serologic screening for NRL-specific immunoglobulin E (IgE) using a RAST test (Pharmacia CAP, Pharmacia-Upjohn Diagnostics, Kalamazoo, MI) performed by Quest Labs (Baltimore, MD). All blood samples were coded to assure anonymity. The limit of detection for this assay is less than 0.35 KU/L. Anyone with a value greater

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N (103)</th>
</tr>
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<tbody>
<tr>
<td>Gender</td>
<td>58</td>
</tr>
<tr>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>Current Position</td>
<td>33</td>
</tr>
<tr>
<td>Registered nurse</td>
<td></td>
</tr>
<tr>
<td>Operating room/surgical technician</td>
<td>6</td>
</tr>
<tr>
<td>Surgeons</td>
<td>42</td>
</tr>
<tr>
<td>Anesthesia</td>
<td>22</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>71</td>
</tr>
<tr>
<td>Minorities</td>
<td>32</td>
</tr>
<tr>
<td>Total years in the operating room</td>
<td></td>
</tr>
<tr>
<td>more than 6 years</td>
<td>53</td>
</tr>
<tr>
<td>Glove usage</td>
<td></td>
</tr>
<tr>
<td>Six or more pairs per day</td>
<td>73</td>
</tr>
<tr>
<td>Latex gloves</td>
<td>38</td>
</tr>
<tr>
<td>Non-latex gloves</td>
<td>10</td>
</tr>
<tr>
<td>Both</td>
<td>49</td>
</tr>
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</table>

Table 1: Demographic Characteristics of Operating Room Personnel
than 0.35 KU/L or with reported symptoms with NRL exposure were counseled about NRL avoidance.

All survey data and RAST results were reviewed by members of the UMMS Allergy medical staff and evaluated to determine the need for further health care or need to change to synthetic gloves and avoid NRL products. NRL sensitivity was presumed if participants had positive IgE NRL-specific serology or if they reported symptoms with NRL exposure. All NRL-sensitized employees were advised to use non-NRL gloves and avoid exposure to other NRL products. If participants reported symptoms other than isolated skin symptoms with NRL exposure, they were advised to seek health care as well. Participants with occupation-related NRL associated symptoms were also advised to report those events to employee health services.

**STATISTICAL ANALYSIS**

Chi-square analysis or Fisher’s exact test (two-tail) were used to analyze survey results and determine statistical significance pre and post glove conversion by using the Statistical Package for the Social Sciences (SPSS) version 10.1 (Chicago, IL). A P-value of 0.05 was considered to be significant. Please check original

**RESULTS**

Of the 300 HCW who were offered serologic testing and participation in the study, only 103 consented to participate versus 125 who gave consent, but did not participate in all surveys or serologic testing. A total of 103 operating room HCWs were enrolled into the study between March and July 2002. As shown in Table 1, the average age of this cohort of operating room personnel was 35.9 years (range of 25 to 52) and 56% were men. Forty-one percent were surgeons, 32% were nurses, 21% were anesthesia personnel and the remaining staff (6%) were surgical technicians. More than half of the participants reported more than 6 years of operating room experience.

Forty-two percent of the participants reported symptoms with NRL exposure prior to conversion of the operating room to non-powdered gloves. Fifty-one percent of the HCWs stated that their NRL exposure symptoms did not improve when they were away from work and 38% stated that their NRL exposure symptoms were worse during work hours. Of the 73 participants who reported NRL-associated symptoms, only 12 individuals ever sought health care. Prior to conversion of the operating room to non-powdered gloves, 22% of participants reported NRL exposure symptoms occurring in less than 1 hour after exposure while 31% reported delayed symptoms occurring between 6 and 48 hours (data not shown). During the period when operating room personnel were still using powdered gloves, two nurses with significant NRL symptoms had to be reassigned to alternate positions until the operating room was converted to non-powdered gloves. One was able to return to the operating room position after conversion to non-powdered gloves and the other had chosen an alternative position.

Because of the known association of food allergy and NRL sensitivity (Beezhold et al., 1996; Blanco et al., 1994; Brehler et al., 1997; Kim & Hussain, 1999; Levy et al., 2000; M’Raihi et al., 1991), data were collected on allergic symptoms reported with food exposure. Of the 15 participants reporting symptoms with food ingestion, 13 gave more detailed information. Sixty-seven percent reported skin symptoms with exposure to NRL-associated food allergens such as banana, avocado, and kiwi, 40% reported gastrointestinal (GI) symptoms, 27% reported severe respiratory symptoms, and 13% reported upper respiratory with latex-related food exposure.

Not all of the 103 individuals who participated in the study consented to serologic testing. Only 60 participants completed RAST testing. Of the 60 participants who agreed to NRL-specific IgE serology (RAST) testing at the start of the study, only 3 (5%) were seropositive. Fifty-two percent of the participants who agreed to serologic testing reported prior symptoms with NRL exposure, versus 28% who refused to undergo testing for NRL specific IgE. Of this seropositive group, two individuals reported skin symptoms with NRL gloves and one individual reported skin, GI, or anaphylactic symptoms with NRL-associated foods (e.g., banana, celery, tomato). NRL-specific symptoms related to the use of

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**Table 2**

<table>
<thead>
<tr>
<th>Exposure Causing Symptoms</th>
<th>Type of Symptoms With Exposure</th>
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<tbody>
<tr>
<td></td>
<td>Skin</td>
</tr>
<tr>
<td>Latex products</td>
<td></td>
</tr>
<tr>
<td>Latex gloves</td>
<td></td>
</tr>
<tr>
<td>Reaction during dental or gynecological examination</td>
<td>3</td>
</tr>
<tr>
<td>Latex balloons</td>
<td></td>
</tr>
<tr>
<td>Condoms</td>
<td></td>
</tr>
<tr>
<td>Adhesive bandages</td>
<td></td>
</tr>
<tr>
<td>Latex associated food allergy (e.g., banana, avocado, kiwi)</td>
<td>10</td>
</tr>
</tbody>
</table>
NRL products or foods associated with NRL symptoms among operating room personnel are shown on Table 2. When potential sources of NRL exposure were examined, NRL gloves were listed as the major cause of NRL related symptoms and adhesive bandages the second for all skin symptoms. Participants who reported other allergic disorders were three times more likely to report symptoms with NRL exposure (data not shown) than non-atopic participants (76% versus 24%, \( p < 0.05 \)).

After conversion of the operating room to non-powdered NRL gloves, as shown in the Figure, there was a significant decrease in reported symptoms with NRL exposure (42% pre and 29% post, \( p = 0.0001 \)). There was a 27% decrease in skin symptoms (88% pre vs. 61% post, \( p = 0.006 \)), and a 12% decrease in upper respiratory symptoms (44% pre vs. 32% post, \( p = 0.0001 \)). Neither of the two HCWs who reported severe or lower respiratory symptoms prior to conversion to non-powdered gloves, reported symptoms after conversion.

Forty-seven percent of the HCWs reported wearing gloves more than 50% of the time while at work. In addition, 71% wore six or more pairs of NRL gloves per day. HCWs rated non-powdered latex gloves at or above expectations for all parameters including quality, comfort, safety, performance, standardization, needlestick injuries, and durability (see Table 3).

### DISCUSSION

The increased use of NRL gloves has coincided with an increase in the prevalence of reported allergic reactions to NRL. The prevalence of sensitization to NRL has been reported to range from 3% to 18% among hospital personnel and from 7% to 24% among operating room staff (e.g., nurses, surgeons, anesthesiologists, surgical technicians) (Charous, Hamilton, & Yunginger, 1994; Kelly et al., 1996; Slater, 1994; Turjanmaa & Reunala, 1988; Vandenplas et al., 2001). HCWs report NRL allergy symptoms ranging from immediate (i.e., less than 1 hour) to delayed symptoms (i.e., 6 to 48 hours), with varying degrees of severity. Type IV or delayed type hypersensitivity reactions, such as contact dermatitis, usually involve the hands. Type I IgE mediated reactions are more immediate and can cause not only immediate skin reactions, but also involve the respiratory system and is one of the leading causes of occupational asthma in health care workers (Charous, Blanco et al., 2002).

In severe cases of Type I hypersensitivity to NRL, affected individuals can experience anaphylaxis and even death (Vandenplas et al., 1995). Some HCWs are so severely affected by symptoms related to NRL exposure that they have had to change positions or leave the health care industry entirely. Despite the fact that NRL has been identified as the cause of allergic reactions ranging from localized skin reactions to fatal anaphylaxis, NRL gloves have been preferred by HCWs because of their effective two-way protective properties and their comfort (Korniewicz et al., 2003).

Powdered gloves are known to cause an increase in NRL sensitivity because the glove powder binds to the NRL protein and acts as a vector, emitting NRL into the air on particles small enough to enter the respiratory tract (M’Raihi et al., 1991; Swanson, Zakharov, Luss, Babakhan, & DuBuske, 2001). When studying areas of the Mayo Clinic Hospital, researchers found that airborne NRL allergen on particles small enough to enter the airways could be readily measured in areas of the hospital where powdered NRL gloves were used. In contrast, in hospital areas where non-powdered NRL gloves were used, measurable amounts of airborne NRL could not be...
found. Because of the risk associated with NRL exposure, current OSHA and American Academy of Allergy Asthma & Immunology (2000) recommendations propose that employers provide a NRL-safe environment for all HCWs by eliminating NRL or converting to low protein low-powder or non-powdered NRL gloves.

In this study, symptoms associated with NRL exposure were reported by more than one-third of the participants. However, only 3 of 60 participants who agreed to serologic testing had a positive NRL-specific IgE. Therefore, the rate of NRL sensitization by positive RAST testing (5%) was less for this operating room population than those reported earlier in the literature (range, 7% to 24%) (Charous et al., 1994; Slater, 1994). It is also lower than the sensitization rate of 8.6% found for a general population of UMMS health care workers who underwent serologic testing for NRL IgE at the onset of employment (Bollinger et al., 2002).

One might expect the sensitization rate to be higher among operating room personnel because of the significant glove exposure in that setting. What is not known is whether there would have been a higher rate of sensitization if the other 43 participants who did not complete serologic testing completed the RAST test. Unfortunately, this omission may have limited the results. The operating room personnel’s response to a major glove change may impact employee overall satisfaction, acceptance, and continued use of non-powdered low protein NRL or non-powdered non-NRL gloves. These data showed that satisfaction with the non-powdered low-protein NRL gloves was good. These data are consistent with reports by others (Korniewicz et al., 2003; Sussman, 2003) who showed that when low-powder or no-powder low-protein NRL gloves are used, HCWs report good satisfaction scores and decreased NRL sensitivity exposure symptoms. The high satisfaction rate found in this institution for non-powdered gloves may reflect the fact that a “Glove Selection Team” was enlisted to evaluate and rate numerous gloves prior to choosing the final product that was used in the glove conversion.

LIMITATIONS

There are some limitations to this study. UMMS is a teaching hospital and subject to yearly turnover, so some of the participants who enrolled in the study initially were not able to complete all the survey data and others were lost when resident training programs changed. In addition, this study is limited by the fact that all symptom data is self-reported and, therefore, subject to reporting bias. This may particularly be true in an operating room setting where employees may be reluctant to acknowledge symptoms with glove usage or to consent to NRL testing.

Of note, some participants had to be re-assured that survey information was confidential and would not affect their job status. Although the study population included a representative sample of the operating room work force in terms of demographics and job descriptions, it is unknown how it compares to those who did not choose to participate related to NRL sensitization and symptoms. If one compares the NRL sensitization rate of 5% found in this study population to the sensitization rate of 8.6% found in the same institution in the general work force as well as rates as high as 20% found in other operating room population studies, it is likely that NRL-sensitized employees may have been underrepresented in this study.

The discrepancy between this study and prior reports may be related to selection bias. The reported NRL-associated symptoms in the subset of participants who agreed to serologic testing was 52% compared to 28% in the subset or participants who did not agree to serologic testing. However, HCWs concerned about job security may have decided not to participate in the serological testing portion of the study, may have under-reported symptoms, or may have chosen not to participate at all.

Despite this limitation, a significant decrease in NRL reported symptoms was found 6 to 12 months after conversion of the operating room to a non-powdered environment. These findings are consistent with others (Sussman, Beezhold, & Kurup, 2002; Vandenplas, Jamart, Delwiche, Evrard, & Larbanois, 2002) who have reported that the use of low protein non-powdered NRL gloves can decrease NRL associated symptoms.

CONCLUSION

This study demonstrates that the conversion of the UMMS operating room to non-powdered low-protein NRL gloves resulted in decreased symptoms with NRL exposure in the subset of operating room employees who participated in the study. Future evaluation of this cohort of operating room personnel will determine if NRL associated symptoms and sensitization continue to decrease over time. Based on these results, the authors recommend the following:

- Removal of powdered NRL gloves from the operating room.
- Involvement of employees in the process of choosing gloves that will be well accepted by personnel.
- Counseling of HCWs with positive NRL serology or symptoms with NRL exposure to routinely use non-powdered non-NRL gloves.
- Provision of routine training of operating room personnel about NRL sensitivity and proper glove use.

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