

Research article

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## Workers' compensation claims related to natural rubber latex gloves among Oregon healthcare employees from 1987–1998

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**Keywords:** latex, latex allergy, workers' compensation, NRL gloves

### Abstract

**Background:** Occupational reaction to natural rubber latex (NRL) glove use by healthcare employees has been an area of increasing concern. Unfortunately, there is little data demonstrating the prevalence and severity of actual reactivity to NRL.

**Method:** Occupational reaction to NRL was estimated using workers' compensation claims filed by healthcare employees in Oregon for the period of 1987–1998. For the first ten years, these claims were estimated by source and conditions consistent with NRL glove reactions, while in the last two years a specific code developed in 1997 for NRL glove reactions was also employed.

**Results:** The claim rate was on average 0.58 per 10,000 healthcare workers annually, which constituted 0.29% of all workers' compensation claims. The most common condition experienced was dermatitis (80%) and most common body part affected was the hands (55.4%). The majority of claimants, 45 (69.2%), reported taking less than a month off work, suggesting most reactions were minor in nature, although one fatality was reported. The average NRL claim cost was \$8,309.48. Overall the average cost per insured healthcare worker was approximately \$0.50 per year. The occupational groups with the highest number of claims were nurses (30.8% of claimants) and nursing aides and orderlies (24.6% of claimants).

**Conclusions:** In comparison with other workers' compensation claims filed by healthcare workers during this period, 0.25% of the total was potentially related to NRL gloves. The rare incidence of respiratory and ocular claims is inconsistent with the hypothesis that asthmatic or conjunctival reactions to NRL gloves are common.

### Background

Questions regarding the prevalence and severity of healthcare worker reactions to natural rubber latex (NRL) due to occupational exposure to NRL gloves have generated a considerable body of research. To date, most studies have

concentrated on data collected using clinical methodologies, such as in vitro assays testing for the prevalence of IgE antibodies or direct exposure tests including skin prick and skin patch tests. The results of these efforts have produced varying and inconsistent results, estimating the rate

of healthcare worker sensitivity between 2.9% to 22% [1–7]. These methods do not adequately address reactions actually experienced on the job by healthcare workers, because sensitization does not equate to reactivity [8]. As sensitization data does not provide any information regarding reactivity, these data do not provide information regarding the type or severity of reactions, nor the associated costs.

One method that has recently been used to examine reactions to NRL gloves in healthcare settings has been the analysis of workers' compensation data. Unlike the varied results of sensitization findings, results from workers' compensation research have been more consistent across studies. The number of claims per 10,000 healthcare workers in the states previously examined have ranged from a low of 0.71 in Minnesota to a high of 2.66 in Washington State, with average annual costs ranging from a low of \$0.08 in North Dakota to a high of \$0.74 in Washington State per covered healthcare worker [9–11].

While these results are compelling, further research is needed to verify the generalizability of results across states, given the variability of workers' compensation systems, which are administered on the state level. The current study extends this past research by investigating claims from the state of Oregon over a 12-year period. This makes this study the longest period over which NRL workers' compensation claims have been examined. Additionally, Oregon's workers' compensation system adopted a specific category for NRL glove reactions beginning in 1997, making this the first state analyzed with a code specifying reactions to NRL.

## Methods

Accepted healthcare worker workers' compensation claim data were provided by the Oregon Department of Consumer and Business Information and Management Division for the period of 1987–1999. Records were kept for all claims that were disabling or potentially disabling (i.e. those which have either potential or actual lost work time involved), although records were available for some claims that did not actually result in disability. Because the claim data for 1999 was incomplete due to insufficient claim maturation, and consequently had missing data fields, it was excluded from the analysis in this report. Oregon began specific coding for NRL glove workers' compensation claims in June 1997 and retroactively re-coded some 1996 claims as NRL related after the coding change, so the estimation method for earlier years was supplemented with a specific code for NRL reactions in these later years. Data on costs for potential NRL allergy claims for 1997 and 1998 were provided by the Oregon Department of Business Information and Management Division from

the ongoing data files and thus may not represent finalized costs for those two years.

The data set included information on claimant occupation, claimant demographics (age and gender), nature of reported injury, body part reported affected, time off taken by claimants, and cost of claims. It should be noted that the claims provided by the state are confined to those which resulted in either some form of medical payment and/or where there was lost time from work as a result of the reported condition. All dollar amounts coded in these extracts are amounts paid out and do not include scheduled but unpaid amounts. All denied claims were excluded from analysis. Data on the Oregon healthcare worker population was collected from the Oregon Labor Market Information System's Archival Current Employment Statistics website.

As Oregon did not specifically code for NRL reactions due to glove use for most of this time period, it was necessary to estimate these conditions. The first method for identifying relevant claims was to identify claims whose source was potentially allergic reactions due to glove use. The relevant source codes in the Oregon database were: unspecified items of clothing; belts, gloves, neckties, and scarves; and the aforementioned specific code for NRL reactions. The former two methods for identifying source of injury information may capture claims unrelated to NRL glove use, and thus may overestimate the number of NRL glove claims. As all three might have captured claims attributed to gloves, but not due to NRL reactions, the nature of the condition associated with the claim was examined as well. Associated claim code numbers for these conditions are listed in the Appendix (see Additional File 1: Appendix).

NRL glove reactions have been classified by medical researchers into three basic categories [12,13]. Irritant contact dermatitis, which is not an allergic reaction, results in dry, swollen, and/or irritated skin. This is the most common type of condition. The two remaining reaction types are allergic in nature. Those allergic reactions related to chemicals used in glove processing are classified as Type IV, and may result in eczema, open lesions, and swelling. Allergic reactions that result from IgE mediated antibody response to specific NRL allergens, are classified as Type I, and may result in angioedema, asthma, rhinitis, urticaria (hives), and rarely, anaphylaxis. The nature of injury codes from the Oregon worker's compensation database was investigated for any claim potentially attributable to NRL glove reaction. When the nature of injury was described as toxic effects, non-viral conjunctivitis, any respiratory condition not definitively attributable to infections or genetic conditions, and any disorders of the skin not definitively attributable to infections, the claims were included as potentially resulting from NRL glove use. Thus,

**Table 1: Potential NRL claims as a percentage of HCW population and total healthcare workers' compensation**

Year	Estimated Number of Claims	Estimated HCW Population	Percentage Filing Potential NRL Claims	Claims per 10,000 HCW's	Total Number of Healthcare W.C. Claims Reported	Potential NRL Claims as a Percentage of All Healthcare W.C. Claims
1987	2	74,639	0.0027%	0.268	3,063	0.0653%
1988	5	77,284	0.0065%	0.647	3,223	0.1551%
1989	1	81,835	0.0012%	0.122	2,746	0.0364%
1990	2	84,961	0.0024%	0.235	2,316	0.0864%
1991	4	87,406	0.0046%	0.458	2,247	0.1780%
1992	8	89,028	0.0090%	0.899	2,175	0.3678%
1993	3	91,118	0.0033%	0.329	2,139	0.1403%
1994	9	92,896	0.0097%	0.969	2,029	0.4436%
1995	0	95,299	0.0000%	0.000	1,834	0.0000%
1996	9	98,387	0.0091%	0.915	1,746	0.5155%
1997	9	101,763	0.0088%	0.884	1,535	0.5863%
1998	13	104,454	0.0124%	1.245	1,433	0.9072%
Average	5.42	89,922.5	0.0058%	0.581	2,207	0.2902%

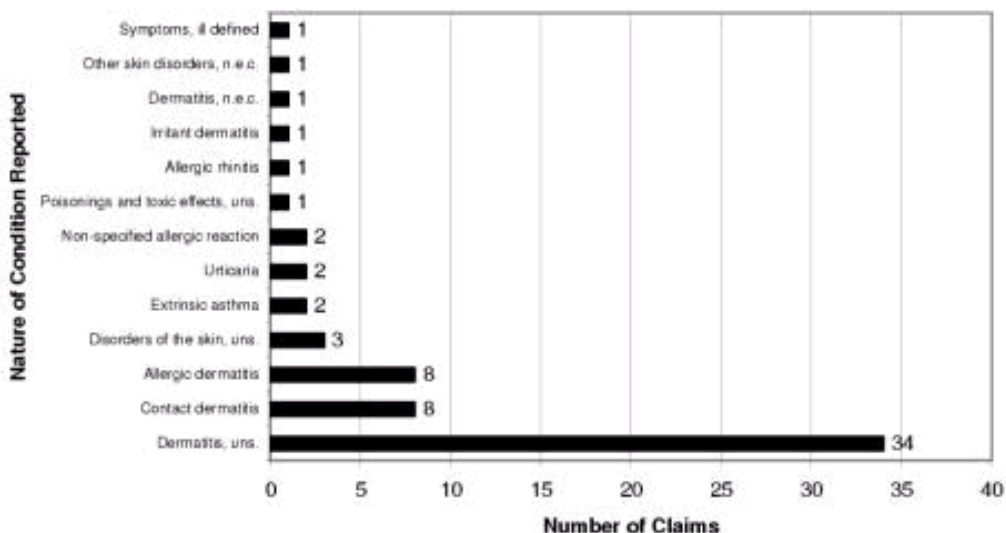
claims were excluded only when the nature of injury was clearly not related to NRL glove reaction, such as infections, parasitic diseases, sprains, dislocations, or carpal tunnel syndrome. The nature of injury codes used in the estimates or that were used to specifically exclude claims are listed in the Appendix.

Examination of the probability of filing a claim was tested through the use of logistic regression, treating each year as a sample and using the total healthcare worker population in a given year as a weighting variable. To test whether there was an increase in expected claim costs over time, the natural logarithm of costs was regressed on year of claim filing, gender, age, and a series of dichotomous variables for occupation. To test whether there was an increase in expected claim duration over time, the natural logarithm of time off work was regressed on year of claim filing, gender, age, and a series of dichotomous variables for occupation. Due to the small number of cases and the possibility for collinearity in the predictor set, subset regressions were also run first with only age and year entered, then only gender and year entered, then only the set of occupational dummies and year entered. The logarithmic transformation was necessary to normalize the distribution of the dependent variables, both of which were right skewed. This transformation resulted in the elimination of a small number data points for which the dependent variables equaled zero. Logistic regression using the subsets was used to predict the zero values for these dependent variables, and none of the regressions were significant. All models were estimated using Stata 6 software.

## Results

For the entire 1987–1998 period, there were 65 total estimated NRL glove claims reported. These claims demonstrated an average frequency of 5.24 per year, from an average healthcare worker population of 89,923, and represented an overall average claim rate of 0.0058 percent or 0.58 claims per 10,000 Oregon healthcare workers over the 12-year period examined. Additionally, during this time, the average overall claim rate for all occupational conditions experienced by healthcare workers during this time was 2,207 annually, of which the estimated NRL claim rate constituted 0.29 percent of those claims. Table 1 presents the breakdown of number of claims per year over this time period as contrasted against number of healthcare workers and number of workers' compensation claims.

To test if changes in claim rates were indicative of a trend, weighted logistic regression for grouped data was employed to determine if there was a change in the log-odds ratio for claim filing over time with year of claim as a predictor and the size of the healthcare worker population as a weighting variable. The odds ratio for year was 1.11 (95% C.I. = 1.03–1.20;  $p = 0.014$ ), indicating a statistically significant increase in claims over time. These results were checked for robustness using negative binomial models to predict whether the number of claims were changing over time (as opposed to the probability of filing a claim) and similar results were obtained with respect to significance and estimated incidence rate ratios. However, because of fluctuations in claim rates across years ranging from zero in 1995 to 0.000124 in 1998, relying on this estimate to predict future claim rates is questionable.



**Figure 1**  
Nature of Condition

The highest proportion of estimated NRL glove claims, 31 (47.7%), were filed by employees who worked in general medical and surgical hospitals. Workers in skilled nursing care facilities filed the next highest number of claims, 13 (20%), followed by employees in the offices and clinics of dentists with 10 (15.4%) claims, and employees in the offices and clinics of doctors with 3 (4.6%) claims. Workers in nursing/personal care facilities and in intermediate nursing care facilities each filed 2 (3.1%) claims, while workers employed in the offices and clinics of health practitioners, specialty hospitals (non-psychiatric), medical laboratories, and allied health services each filed 1 (1.5%) claim.

With respect to occupation, nurses filed 20 claims (30.8%), followed by nursing aides and orderlies, who filed 16 claims (24.6%), dental assistants who filed 9

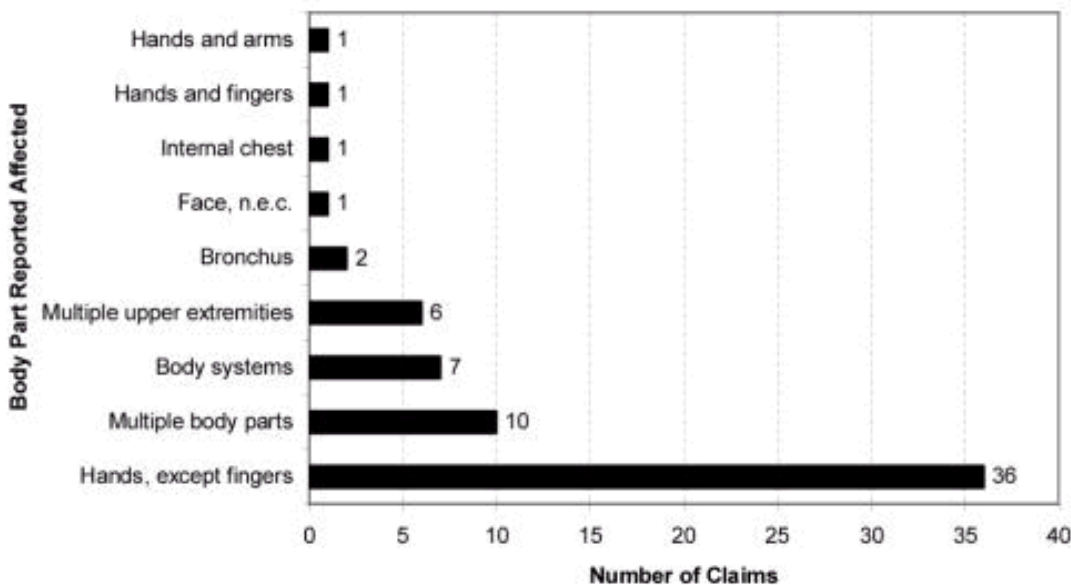
claims (13.8%), clinical laboratory technicians who filed 6 claims (9.2%), and maids/housemen who filed 3 claims (4.6%). There were 2 claims (3.1%) for each of the occupations of miscellaneous food preparers, and laundry workers, and 1 claim each (1.5%) filed by therapists, general office clerks, private household cleaners, cooks, and personal service occupations. Two claims were filed with no occupation listed.

The ages of claimants were widely distributed, with 2 claims (3.1%) made by healthcare workers between of 18–20 years of age, 16 claims (24.6%) by workers 21–30 years of age, 23 claims (35.4%) by workers 31–40 years of age, 15 claims (23.1%) by workers 41–50 years of age, and 9 claims (13.8%) by employees 51–60 years of age.

Of all claimants, the majority 52 (80%) cited a form of dermatitis as the primary nature of their condition. Of these dermatitis cases, 34 reported unspecified dermatitis, 8 reported contact dermatitis, 8 reported allergic dermatitis, 1 reported unclassified dermatitis and 1 reported irritant dermatitis. Of the remaining 13 claimants (20%), 3 (4.6%) reported disorders of the skin, 2 (3.1%) reported urticaria, 2 (3.1%) reported a non-specified allergic reaction, 2 (3.1%) reported extrinsic asthma, and there was 1 claim each (1.5%) specifying other unclassified skin disorders, allergic rhinitis, poisoning and toxic effects, and ill-defined symptoms. These data are summarized in Figure 1.

The most common body part reported affected was the hands (55.4%), followed by multiple body parts (15.4%), body system (10.8%), multiple upper extremities (9.2%),

bronchus (3.1%), internal chest (1.5%), hands and fingers (1.5%), hands and arms (1.5%) and face (1.5%). While 58 cases of skin-related disorders were estimated to be attributable to NRL glove use over the 12-year period, there were 97 other claims by healthcare workers of skin disorders filed that were attributed to sources other than NRL gloves. To this extent, NRL glove use only contributed to 37.4% of all healthcare worker claims citing skin disorder as nature of condition experienced. Only 2 cases of asthma were reported from the use of gloves during the 12-year period, representing an average of 0.02 cases of asthma per 10,000 healthcare workers employed in Oregon per year. There were 62 claims of asthma from non-NRL related sources reported during this time, and thus potentially NRL related asthma claims represented 3.2% of the total healthcare worker asthma claims. These data are summarized in Figure 2.



**Figure 2**  
Body Part Reported Affected

The mean number of days of lost work time for NRL glove claims was 44.3, although the distribution of time off for NRL glove claims was extremely right skewed, as shown by the median number of 7 days off. Of all claimants, 8 (12.3%) took no time off, 22 (33.8%) took off between one day and one week, 5 (23.3%) took off between eight days and two weeks, 8 (12.3%) took off between 15 days and three weeks, and 2 (3.1%) took off between twenty-two days and one month. Of those who took over a month off work, 4 (6.2%) took off between thirty-one days and two months, 8 (12.3%) took off between 4 and 6 months, 2 (3.1%) took off between 7 months and 1 year, and 1 (1.5%) took off more than one year but less than two years. There was 1 fatality reported during this period (which is not included in the time off statistics). In addition, there were 4 other claims in which time off information was not provided.

For the entire period of 1987–1998, the total costs associated with all estimated NRL glove claims was \$540,116.00. The mean claim cost was \$8,309.48, with the median claim cost equaling \$2,682.00, and the standard deviation of the claim costs was \$17,434.00. The summary of claim costs over time is provided in Table 2.

In total, the weighted average cost per healthcare worker employed in the state of Oregon amounted to \$0.50 annually. Using only the years with finalized costs (1987–1996), the weighted average cost per healthcare worker was \$0.44 annually. Because the NRL cost data was updated for 1997 and 1998, but the data of total healthcare worker claim costs were not, total claim costs were compared to NRL glove claim costs limited to the period of 1987 through 1996. During this time, the total claim cost for all non-NRL related healthcare worker claim costs in the state amounted to \$150,150,242, while NRL costs amounted to \$380,068, and NRL costs thus represented 0.25% of all healthcare employee workers' compensation costs accrued in the state for the 10-year period.

To determine if the severity of claims was predictable based on when a claim was filed or by characteristics of the claimants, multivariate regressions were estimated. Claim costs and time off work (as proxies for condition severity) were the dependent variables and year of claim filing, gender, age, and occupation were the predictors. These predictors were not related to claim costs (overall model  $p = 0.419$ ) or time off work (overall model  $p = 0.899$ ).

To examine how the claims from NRL glove use compared to other commonly used items in Oregon healthcare settings, the claims were contrasted against claims arising from other sources of claims in the 1987–1998 period. It was found that the number of NRL claims (65) were

slightly higher than for those made arising from the use of office and business machinery (50), but less than those from tanks, vats and bins (81), cleaning tools (125), tables and worktables (162), pots, pans and trays (258), bags, sacks and totes (379), boxes, crates and cartons (498), and carts, dollies and handtrucks (689).

## Discussion

The results of the Oregon analysis extend the findings from previous NRL workers' compensation studies conducted in other states with different workers' compensation systems. Overall, there was an average of 0.58 claims annually per 10,000 healthcare workers employed in the state, which is similar to previous annual NRL glove claim prevalence rates of between 0.71 and 2.66 claims per 10,000 workers. While there was some statistical evidence of an increasing claim rate over time, the variation between years and small number of claims in any given year (with the highest number being 13 in 1998) casts doubt on whether this increase holds any predictive value. This increase in workers' compensation claims in more recent years is consistent with data from Minnesota, but is inconsistent with results from North Dakota, Washington, and Rhode Island. Possible explanations for the slight increase in claims over time include the greater number of healthcare workers regularly using gloves, dissemination of information on NRL allergy among healthcare workers, and increased diagnosis of NRL reactions by physicians [9].

The annual cost per employed healthcare worker of \$0.50 over the 12 years examined in Oregon was also similar to previous NRL workers' compensation findings which ranged from \$0.08 to \$0.74. The costs associated with NRL glove claims were generally low, and although high costs were associated with several claims, the mean cost per claim was \$2,682, averaged to just \$0.50 per healthcare worker per year, and in total constituted only 0.25% of all healthcare worker claim costs for the period of 1987–1996. Multivariate regression with controls for gender, age, and occupation did not show an increasing trend in cost per claim or time off work per claim. The evidence thus does not support a hypothesis of increased reaction severity, as indexed by claim costs and time off, over the twelve years examined.

Consistent with past NRL workers' compensation studies, most claimants reported experiencing some form of skin condition, while only 2 cases of asthma were reported over the 12-year period. While some researchers have hypothesized that aerosolized NRL allergens bound to glove powder may result in extensive allergic reactions (primarily manifested as asthmatic response in healthcare environments), other studies examining empirical data have found little evidence of this effect [14–16]. The current study, which specifically addresses reactivity rather than

**Table 2: Total claim costs**

Year	Total claim Costs	Mean Cost per Claim	Median Cost per Claim	Standard Deviation	Total Average Cost per Employed HCW
1987	\$924.00	\$460.00	\$462.00	\$138.59	\$0.01
1988	\$11282.00	\$2256.40	\$1743.00	\$2255.51	\$0.15
1989	\$1167.00	\$1167.00	\$1167.00	n/a	\$0.01
1990	\$33765.00	\$16882.50	\$16882.50	\$17645.85	\$0.40
1991	\$33325.00	\$8331.25	\$5716.00	\$6154.01	\$0.38
1992	\$54418.00	\$6802.25	\$3449.50	\$8515.11	\$0.61
1993	\$50136.00	\$16712.00	\$3935.00	\$25272.62	\$0.55
1994	\$27955.00	\$3106.11	\$1331.00	\$3497.64	\$0.30
1995	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
1996	\$167096.00	\$18566.22	\$1470.00	\$39400.70	\$1.70
1997	\$69589.00	\$7732.11	\$1838.00	\$12644.69	\$0.68
1998	\$90459.00	\$6958.38	\$4524.00	\$11088.65	\$0.87
Total	\$540116.00	\$8309.48	\$2682.00	\$17434.00	\$0.50

sensitization, extends the previous findings showing a low correspondence between NRL glove use and asthmatic reactions. Indeed, potential NRL-related asthma claims represented only 3.2% of all healthcare worker respiratory claims and averaged less than 1 case per 500,000 healthcare workers per year in the state of Oregon. Workers' compensation analyses in four other states have shown similarly low rates of NRL-related respiratory claims.

Oregon is the only state to date where workers' compensation data has recorded a fatality due to NRL reaction. Consistent with previous studies in Minnesota and Washington State, there were a small number of serious reactions. The majority of claims were relatively minor in nature, with 12.3% of claimants reporting no time off from work and 69.2% taking less than a month off work. The NRL glove claims were also compared to different sources of healthcare employee workers' compensation claims, and not found to be a greater source of occupational injury than other products and items frequently used in healthcare facilities.

Workers' compensation analyses have several inherent limitations. First, it is possible that some individuals who experienced a reaction to NRL did not file workers' compensation claims, so these claim prevalence rates should not be construed as direct estimates of reaction prevalence rates. Given that many claimants had relatively low dollar amounts for claims this may not be a substantial limitation, as it appears that even in cases where minor costs were incurred, claims were reported. Additionally, it is possible that the claim rate may overstate the number of true NRL reactions, because symptoms commonly report-

ed as NRL related are also potentially the result of other causes. This is suggested by studies showing a low correspondence between self-reported diagnosis of NRL reactions and positive RAST or skin prick tests for NRL sensitization [15,17,18]. Because Oregon primarily records claims with lost work time, it is also possible that individuals who may have experienced minor reactions were not included. This may explain the discrepancy found between Oregon and Washington State, which does collect data on claims involving no lost work time. An alternative explanation for the discrepancy is the fact that Oregon has more specific coding for potential NRL reactions.

Secondly, it should be noted that this paper deals exclusively with medical and indemnity costs associated with claims and does not reflect costs related to retraining and other accommodations for NRL-reactive employees. It is also possible that individuals who experienced a reaction may have switched from the healthcare occupation (the "healthy worker effect"). However, there is no reason to believe that these individuals would not avail themselves of workers' compensation for lost work time before switching, so this healthy worker effect should not substantially affect the claim prevalence rates reported in this study. The cost of turnover and replacement of these workers, however, would not be captured in the data.

## Conclusions

This study examined Oregon healthcare industry workers' compensation data over a 12-year period to determine the prevalence and costs associated with NRL glove claims. This is the longest period of time over which workers'

compensation data related to NRL reactions have been analyzed. The results were similar to those obtained in other analyses of workers' compensation data from other states. As in these other states, there were generally few claims related to NRL reactions, and with few exceptions most claims were not severe in nature. However, there were a small number of more serious claims, including one reported fatality. The results showed that the vast majority of cases were dermal in nature, and little evidence was found to suggest pervasive respiratory or ocular reactions related to NRL. Future research should continue to examine workers' compensation data in assessing NRL allergy because of the ability to determine number and types of reactions, compare reaction outcomes across demographic categories, and eventually develop risk predictive models of NRL allergy with respect to actual reactivity. From these results, potential cost-benefit analyses of NRL glove use can be developed to aid in policy development and implementation.

### Competing interests

This study was funded by Allegiance Healthcare Corporation.

### Author' contributions

IBH conceived of the study, procured the data and performed statistical analyses. JDKM performed background research, performed statistical analyses, and wrote parts of the manuscript. BPM performed statistical analyses, and wrote parts of the manuscript. All three authors participated in the study design and modification with regards to reviewer comments.

All authors read and approved the final manuscript.

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