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Clinical Evaluation and Patch Testing of Personal Protective Equipment-Related Allergic Contact Dermatitis During COVID-19 among Health Care Workers

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Abstract: ***Background**: Allergic contact dermatitis (ACD) is a common skin condition that causes significant disruption of a country's economy as a result of rising school and work-related absenteeism besides the persistent medical expenses. The COVID-19 pandemic in India is a part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). During the outbreak of coronavirus disease 2019 (COVID-19) both healthcare workers and the general population have to wear personal protective equipment (PPE) and are therefore susceptible to PPE-related adverse skin. **Aims and Objectives**: To Clinically evaluate allergic contact dermatitis due to component of PPE among healthcare workers and confirm it by Patch testing. To study the association between the duration of exposure of an antigen required for clinical manifestation of allergic contact dermatitis (by difference in mean duration) to components of personal protective equipment used during COVID-19 pandemic. To find out the most allergic component of PPE reactions. **Materials and Methods**: This study enrolled 75 healthcare workers who worked during COVID 19 Pandemic and have used PPE and diagnosed with ACD attending the Department of Dermatology, Venereology and Leprosy at tertiary care hospital in western Rajasthan and relevant history, clinical examination and patch test were done using standard protocols. **Conclusion**: The increased use of PPE during the COVID-19 pandemic has led to a rise in ACD among healthcare workers. Patch testing is crucial for diagnosis and management. Recommendations include public education, safer material use, and policy-based interventions to reduce occupational skin diseases.*

Keywords: Allergic contact dermatitis, COVID-19, Patch testing, Allergens

1. Introduction

Allergic Contact Dermatitis (ACD) is a common inflammatory skin disease that, especially when the condition becomes chronic, has a high impact on the quality of life and represents a significant disease burden.

ACD represents a type IV delayed-type hypersensitivity reaction that is triggered by contact with an allergen in previously sensitized individuals through the activation of allergen-specific T cells.

In the acute phase, it is characterized by eczematous dermatitis, which presents with erythema, edema, vesicles, scaling, and intense itch. Non-eczematous clinical forms are also described (lichenoid, bullous, and lymphomatosis). Lichenification is the most common clinical picture in the chronic phase if the culprit allergen is not found or eliminated.

A hospital-based prospective observational study was conducted in the Department of Dermatology, Dr. S.N Medical College, Jodhpur, where healthcare workers who were bound to wear PPE kits presented with contact dermatitis symptoms, they were evaluated clinically and the antigen was confirmed with patch testing. The association of the duration of exposure required for clinically manifesting the illness was also evaluated.

The patients were subjected to a complete workup, including a detailed history and examination of lesions. Individuals were selected irrespective of age, gender, and duration of illness, excluding pregnant and lactating females, immune compromised individuals, or those on immunosuppressive or immune modulatory drugs.

2. Material and Method

Patch Test Readings (ICDRG Guidelines)

-	Negative
?-	Doubtful. Faint erythema only
+	Weakly positive reaction, Palpable erythema, Infiltration, possible papules
++	Strong positive reaction, Erythema. Infiltration, papules and vesicles
+++	Extreme positive reaction. Intense erythema and infiltration and coalescing vesicles
IR	Irritant reaction
NT	Not Tested

1) Patch Testing Procedure:

Patch testing was done using the Indian standard battery kit, footwear, and cosmetic series, where allergens were stored at 4 to 8 degrees Celsius and were taken out 15 minutes before the procedure. Marking was done with indelible ink after

cleaning the upper back with sterile gauze. 2-3 mm of allergen ointment was put from a syringe in the center of individual aluminum chambers. Allergens with patch test units were applied gently over the upper back, with the first allergen at the top right corner and then downwards. Two readings were taken, one at 48 hours and another at 96 hours, after 45-60 minutes of removing the patch units.

Instructions to Patients:

- The patch must be left in place for two days and two nights.
- Do not take a bath, wash, or wet the back during the period.
- Avoid tight garments, exercise, or any activity causing sweating.
- Avoid friction or rubbing and lying on the back.
- Do not scratch the patch test site.
- Avoid exposure to sunlight/UV light.
- Report immediately if there is severe itching or irritation.
- Return after 48 and 96 hours for patch test readings.

2) Medical Gloves:

Medical gloves are made of different polymers, including latex, nitrile rubber, polyvinyl chloride (PVC), polyurethane, and neoprene. Nitrile and latex gloves were preferred during the COVID-19 pandemic due to better durability. Many adverse skin reactions, including irritant contact dermatitis, allergic contact dermatitis, and contact urticaria, have been reported with the use of all types of gloves.

Healthcare Workers (HCWs) are at high risk of developing allergic reactions to natural rubber latex (NRL), especially operating room personnel, dental assistants, laboratory personnel, hospital housekeeping staff, and ambulance attendants.

The gold standard in diagnosing contact allergy to latex gloves is skin-prick testing for patients with localized symptoms and latex-specific IgE antibody assessment in cases of systemic symptoms. However, the wear and/or use test and the patch test are alternative diagnostic options. Contact allergic reactions to PVC have also been reported as a result of allergies to many additives used in these gloves, including carba mix, mercaptobenzothiazole (MBT), thiuram mix, mixed dialkyl thioureas, and black rubber mix. Patch testing can confirm the diagnosis. Nitrile, neoprene, and polyurethane are also used in plastic gloves.

3) Alcohol-Based Hand Sanitizers (ABHS):

Ethanol and isopropanol (2-propanol) are the commonly used alcohols in ABHS. During the pandemic, the use of hand sanitizers and other PPE predisposed both healthcare workers and the general population to contact reactions to various components of these items. In practice, cases of irritant dermatitis are more prevalent than allergic contact dermatitis, and many times it becomes difficult to distinguish between the two. For diagnosing allergic contact dermatitis, patch testing remains the gold standard.

In this study the clinical evaluation according to the patch test which is done on the health care workers during COVID-19 most allergic contact is shown by following series:

1) NICKEL: It is the most common ingredient which is found in the soap used by health care workers for the purpose of hand washing etc. In this we find that we 17 people shown positive results with the reactivity towards nickel with the mean of 1.29. Nickel was 85%.
2) FORMALDEYDE: It is used in masks caused ACD in some Health care workers who were sensitive and/or allergic is shows by 13 individuals with the mean of 1.38. Formaldehyde was 65%.
3) CITRIMIDE: It is the most commonly ingredient use the preparation of the sanitizer we also find some health care workers figure of 1 is shown the allergic contact with the mean of 1.71. Citrimide percentage was about 35%.
4) THURAMINE: It is the most common agent which is use in the vulcanization of the rubber and the natural rubber. Rubber like gloves and goggles of the frame which is use in PPE kits they show contact dermatitis and ACD. We found the 17 individual shows positive reactions towards them with the mean of 1.54. Thuramine percentage was 85%.

3. Results and Discussion

Formaldehyde used in masks caused ACD in some individuals who were sensitive and/or allergic. Others reacted to thiuram, found in the ear loops of surgical masks. Frequent friction, trapping of sweat, and elevated temperature were contributing factors. Skin reaction to masks was characterized by a compromised skin barrier, as indicated by increased TEWL.

Table 1: Distribution of Allergic Contact Dermatitis by PPE Component and Patch Test Positivity

PPE Component	No. of HCWs Exposed (n=75)	Clinical ACD Cases	Patch Test Positive	Most Common Allergen
Gloves	75	40 (53.3%)	30 (75%)	Thiuram mix / Carbamates
Face Masks	75	28 (37.3%)	20 (71.4%)	Formaldehyde / Textile dye
Hand Sanitizers	75	15 (20%)	10 (66.7%)	Fragrance mix / Alcohol base
Gowns	75	10 (13.3%)	7 (70%)	Disperse dyes / Formaldehyde resin
Goggles / Face Shields	75	8 (10.7%)	5 (62.5%)	Rubber accelerators

Table 2: Anatomical Distribution of Allergic Contact Dermatitis Lesions Among Healthcare Workers (HWC)

Anatomical Site	Number of Cases (n = 75)	Percentage (%)
Hands	42	56.0%
Face	35	46.7%
Neck	18	24.0%
Forearms	10	13.3%
Ears	7	9.3%

Other (e.g chest, scalp)	3	4.0%

Table 3: Severity Grading of Allergic Contact Dermatitis among Healthcare Workers

Severity Grade	Clinical Features	Number of Cases (n = 75)	Percentage (%)
Mild	Erythema, itching, minimal dryness, no vesicles	25	33.3%
Moderate	Erythema with edema, vesiculation, scaling, mild oozing	30	40.0%
Severe	Intense erythema, bullae, widespread vesicles, marked oozing, crusting, secondary infection	20	26.7%

Table 4: Mean Duration of PPE Exposure Prior to Onset of ACD Symptoms

S. No	PPE Component	Mean Duration of Daily Use (hours)	Mean Days to Onset of ACD Symptoms	Standard Deviation (±)
1	Gloves	6.5	12.4	±3.2
2	Face Masks	8.0	9.8	±2.7
3	Hand Sanitizers	10-12 applications/day	14.1	±4.1
4	Gowns	4.5	16.7	±3.5
5	Goggles / Face Shields	5.2	11.3	±2.9

Figure 1

Figure 2

4. Conclusion

This study underscores a significant prevalence of ACD among healthcare workers using PPE. Early identification of causative allergens via patch testing facilitates timely intervention and preventive strategies. Strengthened regulatory measures, occupational safety education, and the selection of hypoallergenic PPE materials are essential to mitigate the burden of PPE-induced dermatosis in clinical settings. The increased use of PPE during the COVID-19 pandemic has led to a rise in ACD among healthcare workers. Patch testing is crucial for diagnosis and management. Recommendations include public education, safer material use, and policy-based interventions to reduce occupational skin diseases.

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