Wear and Flare: Allergic Contact Dermatitis to Personal Electronic Devices

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PRACTICE **POINTS**

- Personal electronic devices including smart phones, headphones, watches, and continuous glucose monitors represent an emerging source of allergic contact dermatitis.
- Reactions often are localized to areas of skin contact including the face, ears, wrists, and hands.
- Reported allergens in personal electronic devices include (meth)acrylates, metals, and rubber compounds.
- Patch testing is key in detecting and avoiding culprit allergens, but a major challenge is lack of transparency regarding device composition and ingredients.

Personal electronic devices including smartphones, headphones, fitness watches, and continuous glucose monitors (CGM) increasingly are integrated into daily life, driven by consumer interest in data tracking and wellness. Prolonged skin contact with these devices has emerged as a source of allergic contact dermatitis (ACD). This review explores the potential allergenicity of personal electronic devices, with the most commonly reported allergens including (meth)acrylates, metals, and rubber compounds. These allergens may be present in device components, casings, and adhesives. Exposure to mechanical friction and sweat as well as prolonged skin contact potentially enhance the risk for ACD. Diagnostic challenges are compounded by incomplete ingredient disclosure by manufacturers. With the personal electronic device market projected to experience massive growth, health care providers must be vigilant in recognizing and managing ACD related to these devices.

Personal electronic devices have become more common as consumer-driven health and entertainment practices continue to increase in popularity. A wide variety of devices including smartphones, headphones and earbuds, fitness watches, and continuous glucose monitors (CGMs) allow consumers to collect data and personalize their daily activities and health practices. The global market for fitness tracking devices alone was valued at $62.03 billion in 2024 and is projected to grow to $290.85 billion by 2032.[1] Accordingly, the growing demand for continuous data tracking has led to new and prolonged skin contact with these devices, which have become emerging sources of allergic contact dermatitis (ACD). In this article, we provide a summary of the potential allergenicity of personal electronic devices with a focus on wearable devices, including clinical manifestations, reported allergens, and patch testing and management considerations (Table[2-28]).

Earbuds and Headphones

Wireless earbuds and headphones are used for listening to media and may contain microphones for voice calls. Earbuds are inserted into the ears while headphones are worn over the ears with a connecting band across the scalp. These devices frequently are worn during physical activity and thus in the setting of moist sweaty environments and mechanical friction on the skin. Depending on the style of the earbuds or headphones, associated ACD may manifest as acute or chronic pruritic eczema involving the inner and/or outer ears and potentially the periauricular areas or scalp.[2] In a reported case of earbud ACD, the patient first presented to an otolaryngologist before being referred to a dermatologist for further evaluation and patch testing.[9] Clinicians may be unfamiliar with these devices as a source of ACD or may potentially overlook inner ear canal manifestations, which may delay diagnosis.

Allergens reported in earbuds include (meth)acrylates,[4-6] nickel, gold,[8] and silicone.[9] Apple AirPods and

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TABLE. Personal Electronic Devices and Associated Allergens

Product category	Common uses	Potential allergens
Headphones	Entertainment, exercise, voice calling	MI, MCI, OIT[2,3]
Earbuds	Entertainment, exercise, voice calling, hearing aid	(Meth)acrylates,[4-7] nickel, gold,[8] silicone[9]
Cell phones/smartphones (including covers and protectors)	Communication, internet, gaming, activity tracking	Nickel,[10-13] cobalt,[14] chromium,[14-16] rubber accelerators,[17,18] silicone,[17] PPD, CPPD,[17] unknown plastic allergens[19]
Fitness bands and watches	Tracking heart rate, electrocardiogram, calories, steps, location, sleep	Chromium,[20] nickel,[21] (meth)acrylates[22-25]
Continuous glucose monitors	Diet planning, energy optimization, distance athletics	IBOA, colophony/rosin and derivatives,[26] ethyl cyanoacrylate,[27] BHT,[28] MDI,[27] DMAA[27]

Abbreviations: BHT, butylhydroxytoluene; CPPD, N-cyclohexyl-N-phenyl-4-phenylenediamine; DMAA, N,N-dimethylacrylamide; IBOA, isobornyl acrylate; MCI, methylchloroisothiazolinone; MDI, 4,4'-methylene diphenyl diisocyanate; MI, methylisothiazolinone; OIT, octylisothiazolinone; PPD, paraphenylenediamine.

Samsung Galaxy Buds disclose the presence of acrylates and nickel.[5,6] Cases also have been reported of ACD to gold earbud microphones[8] and unknown allergens within silicone tips.[4,9] Acrylates, named the 2012 Allergen of the Year by the American Contact Dermatitis Society,[29] are used in a wide variety of consumer products as adhesives and coatings and are among the most frequently suspected headphone allergens.[4] While fully polymerized acrylates theoretically are nonallergenic, residual acrylic monomers are potent allergens that may be found in in these products due to incomplete curing or polymer breakdown.[29] It remains unclear whether earbud allergen concentrations are sufficient to induce sensitization or merely elicit ACD in previously sensitized users.[29] Among patients with earbud ACD, the finding of inconsistent patch test reactions/cross-reactions led to the hypothesis that these headphones may contain an unidentified proprietary (meth)acrylate.[4]

Headphones, often utilized by runners and gym-goers for their comfort and fit, also have gained recent attention for their unique allergen profiles. In 2024, a case series described primary sensitization to octylisothiazolinone causing severe headphone-related ACD.[3] This preservative, which is in the same family as methylchloroisothiazolinone/methylisothiazolinone, is used as a biocide in the leather or faux leather that encases the foam padding of headphones.[3] Another case report highlighted ACD caused by methylisothiazolinone, methylchloroisothiazolinone, and octylisothiazolinone present in various components of a pair of headphones.[2] These cases are notable, as European legislation limiting the use of methylchloroisothiazolinone/methylisothiazolinone in personal care products does not apply to inclusion of isothiazolinones in other product categories, such as detergents, paints, glues, and personal electronic devices.

Mobile Phones

Mobile phones are a staple in modern society, used for a multitude of tasks including communication, internet browsing, entertainment, and activity tracking. In the early 2000s, mobile phone ACD primarily manifested on the lateral face, ears, and periauricular regions,[12] as well as the thighs from carriage in pants pockets. Early cases of mobile phone ACD were attributed to metals including chromium[16] and nickel.[14] At that time, lengthy and frequent phone calls with the device against the ear were thought to increase exposure to metal allergens.[30] More recently, as the utility of these devices has evolved, ACD has been reported to manifest on the fingers and hands associated with contact with cell phone cases, accessories, and screen protectors (Figure). In one report, a 17-year-old boy with chronic eczema of the palms was diagnosed with ACD to the rubber-related chemicals paraphenylenediamine and N-cyclohexyl-N-phenyl-4-phenylenediamine, confirmed via chemical analysis to be present in a phone case the patient used during daily gaming.[17] Similarly, another case of palmar ACD resulted from thiuram rubber accelerators in a phone case.[18] Most recently, a Japanese patient with a history of skin reactions to costume jewelry developed ACD involving the proximal middle finger due to exposure to nickel in a ring-grip phone case.[11] While the European Union has enacted regulations regarding maximum nickel leaching in products that come into direct and prolonged contact with the skin, such regulations have not been implemented in Japan or the United States.[11] International e-commerce makes these grips widely available, even in regions where strict metal regulations are in place. As screen time increases, it is important to consider all phone-related exposures including components of the case, screen protector, and main device body.

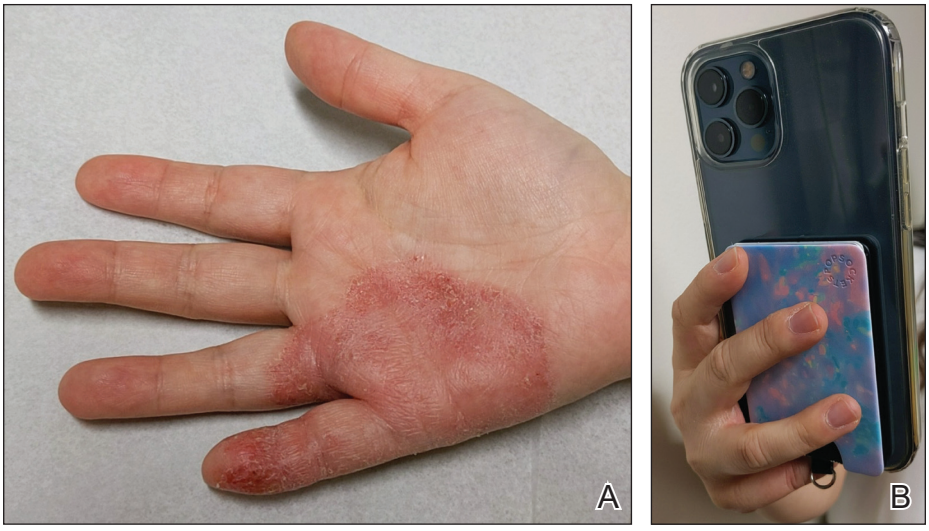

FIGURE. Allergic contact dermatitis to metals in a cell phone accessory. A, Chronic unilateral hand dermatitis affecting the palm and volar fourth and fifth fingers. Biopsy revealed chronic spongiotic dermatitis with eosinophils. B, The culprit phone accessory. Note the metal ring that came in contact with the affected areas of the hand. Patch testing showed strong positive reactions to nickel, cobalt, and palladium. The dermatitis resolved completely after removal of the phone accessory.

Watches

Smart watches and fitness bands are widely available to consumers and serve a variety of health and lifestyle functions. Features include fitness tracking, notification management, mobile payment, electrocardiography, navigation, and sleep and oxygen sensors. Multiple companies have produced hand- and wrist-based sensors for detailed wellness tracking within these categories. Allergic contact dermatitis to smart watches and wristbands manifests as eczematous lesions on the wrist (dorsal,[21,22] volar,[20] or circumferential involvement[23,24]).

(Meth)acrylates used to adhere screen protectors, house lithium ion batteries, and bind metal to plastic have been reported to cause ACD in smart watch users.[22,25] In addition, there are at least 2 published reports of ACD to nickel in Apple Watches.[21,31] Apple, having sold more than 229 million watches worldwide, has acknowledged the presence of trace acrylates and nickel in their watches (the latter falling below European Registration, Evaluation, Authorization, and Restriction of Chemicals limits).[32] Hosoki et al[20] identified ACD resulting from chromium exposure in the clasp of an Apple Watch band, which remains unreported by the manufacturer as a potential allergen.

Continuous Glucose Monitors

Continuous glucose monitoring systems provide users with dynamic information on their glycemic status and are associated with lower glycated hemoglobin and reduced episodes of hypoglycemia in patients with diabetes.[33] Recently, growing interest in personalized health monitoring and performance optimization has expanded CGM use to individuals without diabetes; there are 2 over-the-counter CGM options currently available in the United States.[34]

Allergic contact dermatitis to CGMs in patients with diabetes is well characterized, manifesting as pruritic acute or chronic dermatitis at the sensor site.[27] To date, we are unaware of published cases of ACD associated with use of CGM in individuals without diabetes; however, wearing a CGM during athletic activities and sweating could potentially increase adhesive degradation and/or penetration of allergens in the skin.[6]

Isobornyl acrylate, named the 2020 Allergen of the Year,[35] is the most well-known contact allergen in glucose sensors.[36,33] Initially suspected as a component of the CGM skin adhesive, isobornyl acrylate was found to leach from the device body onto the skin in users of one CGM device.[36] Other reported allergens in CGM devices include colophony and related rosin derivatives, ethyl cyanoacrylate, and several chemicals that are not available as commercial patch test substances.[27] Understanding these potential allergens is important for patch testing considerations as CGM use increases in individuals without diabetes.

Final Thoughts

Allergic contact dermatitis to personal electronic devices including wearables, sensors, and fitness trackers is an emerging problem that should be considered in cases of dermatitis of the wrists, hands, face, ears, or in any area that comes into contact with such devices. Although in-depth studies are lacking, certain wearable devices appear to introduce continuous, low-level allergen exposure that may be below the sensitization threshold but still is capable of eliciting ACD in previously sensitized users.[21,26] Furthermore, increased allergen exposure is facilitated by prolonged skin contact, mechanical friction, and sweat.

Comprehensive patch testing often is necessary to diagnose cases of ACD to personal electronic devices.[33] The thin-layer rapid use epicutaneous (T.R.U.E.) test does not include (meth)acrylates, which repeatedly have come up as culprit allergens.[37] Isobornyl acrylate, a key allergen related to CGMs, is absent from standard patch test series.[26] Nickel remains a common culprit in these devices

despite adherence to European regulations.[21] Since there is no obligation for manufacturers to declare all possible ingredients, chemical analysis can be useful in identifying potential allergens and directing the patch test strategy, but this is not feasible in general clinical practice outside the research setting.[2]

Following patch testing, patient education is essential to managing personal electronic device–induced ACD. Informed patients should switch to products that do not contain their triggers—although this may be more easily said than done, since incomplete ingredient disclosure from manufacturers may necessitate a frustrating and expensive trial-and-error approach. As wearable technology proliferates, device composition and potential contact allergen transparency must be prioritized by manufacturers and regulatory bodies. Until then, clinicians should stay on their toes regarding new and emerging clinical presentations and contact allergens in hopes of improving patient outcomes.

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