

Airborne Allergic Contact Dermatitis: Management and Responsible Allergens on the American Contact Dermatitis Society Core Series

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Airborne allergic contact dermatitis occurs when allergen particles suspended in the air deposit on the skin. Many allergens can result in an airborne distribution if presented in an aerosolized form. This review summarizes the allergens in the American Contact Dermatitis Society Core Allergen Series that have been documented to cause airborne allergic contact dermatitis. In addition to responsible allergens, this article also reviews management and treatment options.

CLINICAL ASPECTS

Airborne allergic contact dermatitis (ACD) occurs when allergen particles suspended in the air deposit on the skin. Allergens can be in the form of dust, powder, pollen, sprays, or other volatile substances. Airborne ACD can occur in patients with preexisting allergy, or initial sensitization can occur directly from airborne exposure. The distribution of the rash typically involves exposed body areas such as the face, neck, “V” of the upper chest, forearms, and hands. Airborne ACD can mimic photodermatoses, which also affect exposed body areas. A clinical clue that favors a diagnosis of airborne ACD is involvement of relatively light-protected areas (upper eyelids, submandibular area, postauricular folds), which are typically spared in photodermatoses.^{1,2} The nose may be spared (“beak sign”) because of high sebaceous content.³

AIRBORNE ALLERGENS

Many allergens can result in an airborne distribution if presented in an aerosolized form. The purpose of this review is to summarize allergens that are recognized to cause airborne contact dermatitis and discuss avoidance/management strategies. The focus of this review

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is allergens in the American Contact Dermatitis Society (ACDS) Core Allergen Series.⁴ A comprehensive literature search was performed using the terms “airborne” and “contact dermatitis” and the name of each allergen (including synonyms) in the ACDS Core Allergen Series. In addition, references cited in review articles were hand searched.

PLANTS, WOODS, FRAGRANCES, AND NATURAL RESINS

Plant-derived allergens are the most common cause of airborne ACD worldwide.² Classic airborne ACD occurs from the Compositae (Asteraceae) family of plants, which contains more than 32,000 species. Table 1 lists some of the common Compositae plants in North America. Sesquiterpene lactones, which are essential oils common to Compositae plants, are the components of Compositae to which patients are typically sensitized. The ACDS Core Allergen Series includes both a Compositae mix (German chamomile, arnica, feverfew, tansy, and yarrow) and a sesquiterpene lactone mix (alantolactone, dehydrocostus lactone, and costunolide). Airborne ACD to Compositae can be caused by outdoor plants as well as edible Compositae plants, for example, vapor from chamomile tea.⁵ Table 2 lists common edible Compositae plants. Flares from Compositae exposure typically occur in spring and summer, although symptoms can persist year-round in severe cases.⁶

Fragrances can also cause airborne ACD. The ACDS Core Allergen Series consists of 3 “fragrance markers.” These include 2 fragrance mixes—fragrance mix I (cinnamic aldehyde, cinnamic alcohol, hydroxycitronellal, eugenol, isoeugenol, oakmoss absolute, geraniol, and α-amyl cinnamic aldehyde) and fragrance mix II (coumarin, linal, citronellol, farnesol, citral, and α-hexylcinnamic aldehyde)—and balsam of Peru. Balsam of Peru is a mixture of natural substances from an El Salvadorian tree called *Myroxylon balsamum* var. *pereirae* with a vanilla and cinnamon scent. These 3 fragrance markers are often used to screen for airborne ACD

TABLE 1. Common Compositae Plants in North America

Common Name	Latin Name
Absinthe	<i>Artemisia absinthium</i>
Alkali marsh aster	<i>Almutaster pauciflorus</i>
Alpine gold	<i>Hulsea</i>
American aster	<i>Symphyotrichum</i>
American basketflower	<i>Centaurea americana</i>
Ankle-aster	<i>Ionactis</i>
Arnica	<i>Arnica montana</i>
Artichoke (globe)	<i>Cynara scolymus</i>
Artichoke (wild)	<i>Cynara cardunculus</i>
Aster	<i>Aster</i>
Baccharis	<i>Baccharis</i>
Bachelor's button	<i>Centaurea cyanus</i>
Balsamroot	<i>Balsamorhiza</i>
Barbara's buttons	<i>Marshallia</i>
Barkley's Ragwort	<i>Barkleyanthus salicifolius</i>
Bartlett daisy	<i>Bartlettia scaposa</i>
Beak rush	<i>Rhynchospora</i>
Beak sedge	<i>Rhynchospora</i>
Bearded creeper	<i>Crupina vulgaris</i>
Beggartick	<i>Bidens tripartita</i>
Benitoa	<i>Benitoa occidentalis</i>
Big tarweed	<i>Blepharizonia</i>
Bitterweed	<i>Helenium amarum</i>
	<i>Hymenoxys</i>
	<i>Tetaneuris</i>
Black-eyed Susan	<i>Rudbeckia hirta</i>
Blackfoot	<i>Melampodium</i>
Blackroot	<i>Pterocaulon pycnostachyum</i>
Blanket flower	<i>Gaillardia</i>
Blazing star	<i>Liatris</i>
Blow wife	<i>Achyraea mollis</i>
Blue mistflower	<i>Conoclinium coelestinum</i>
Bolander's madia	<i>Kyhosia</i>
Boneset	<i>Eupatorium</i>
Brickellbush	<i>Brickellia</i>
	<i>Flyriella</i>
Brightwhite	<i>Prenanthes exiguua</i>
Bristlehead	<i>Carphochaete</i>
Brittlebush	<i>Encelia farinosa</i>
Brittlestem	<i>Psathyrotes</i>
Broomsage	<i>Lepidospartum</i>
Broomweed	<i>Amphiachyris dracunculoides</i>
Brownturban	<i>Malperia tenuis</i>
Budsage	<i>Artemisia spinescens</i>
Bull thistle	<i>Cirsium vulgare</i>
Burdock	<i>Arctium minus</i>
Burnweed	<i>Erechtites hieraciifolius</i>
Bursage	<i>Ambrosia artemisiifolia</i>
Bushsunflower	<i>Simsia</i>
Buttonweed	<i>Cotula</i>
Calliopsis	<i>Coreopsis</i>
Camphorweed	<i>Heterotheca</i>
	<i>Pluchea</i>

TABLE 1. (Continued)

Common Name	Latin Name
Capeweed	<i>Arctotheca calendula</i>
Cardoon	<i>Cynara cardunculus</i>
Carveseed	<i>Glyptopleura</i>
Catsear	<i>Hypochaeris radicata</i>
Catsfoot	<i>Antennaria</i>
Chaffbush	<i>Amphipappus fremontii</i>
Chaffhead	<i>Carphephorus</i>
Chamomile (German)	<i>Matricaria recutita</i>
Chamomile (Roman)	<i>Chamaemelum nobile</i>
Chaparral broom	<i>Baccharis pilularis</i>
Chicory	<i>Cichorium intybus</i>
Chrysanthemum	<i>Chrysanthemum</i>
Cinchweed	<i>Pectis</i>
Climbing aster	<i>Ampelaster carolinianus</i>
Coast tarweed	<i>Madia sativa</i>
Cocklebur	<i>Xanthium</i>
Cocoonhead	<i>Lasiospermum bipinnatum</i>
Coltsfoot	<i>Tussilago</i>
Coneflower	<i>Echinacea</i>
	<i>Rudbeckia</i>
Cornflower	<i>Centaurea cyanus</i>
Cosmos	<i>Cosmos bipinnatus</i>
	<i>Cosmos sulphureus</i>
	<i>Micropus</i>
Cottonseed	<i>Baccharis pilularis</i>
Coyote brush	<i>Sanvitalia</i>
Creeping zinna	<i>Verbesina</i>
Crownbeard	<i>Glyptopleura</i>
Crustleaf	<i>Amphidoxa</i>
Cudweed	<i>Gamochaeta</i>
	<i>Gnaphalium</i>
	<i>Filago</i>
	<i>Pseudognaphalium</i>
Dahlia	<i>Dahlia</i>
Daisy (common)	<i>Bellis perennis</i>
Dandelion (common)	<i>Taraxacum officinale</i>
	<i>Taraxacum erythrospermum</i>
Chocolate daisy	<i>Berlandiera lyrata</i>
Desert dandelion	<i>Malacothrix</i>
Desert marigold	<i>Baileya</i>
Desert peony	<i>Acourtia</i>
Desert star	<i>Monoptilon belliioides</i>
Desert sunflower	<i>Geraea</i>
Dogweed	<i>Adenophyllum</i>
Dozedaisy	<i>Aphanostephus</i>
Dusty maiden	<i>Chaenactis</i>
Dwarf coastweed	<i>Amblyopappus pusillus</i>
Dwarf cudweed	<i>Hesperervax</i>
Dwarf dandelion	<i>Krigia</i>
Dwarf nipplewort	<i>Arnoseris minima</i>
Elephant feet	<i>Elephantopus carolinianus</i>
Elecampane	<i>Inula helenium</i>

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TABLE 1. (Continued)

Common Name	Latin Name
Endive	<i>Cichorium endivia</i>
Engelmann's daisy	<i>Engelmannia</i>
Estragon	<i>Artemisia dracunculus</i>
Everlasting	<i>Antennaria</i>
	<i>Syncarpha</i>
False dandelion	<i>Agoseris</i>
False dandelion	<i>Nothocalais</i>
False fleabane	<i>Pulicaria</i>
False goldeneye	<i>Heliomeris</i>
False goldenweed	<i>Oonopsis</i>
False neststraw	<i>Ancistrocarphus filagineus</i>
False sunflower	<i>Phoebanthus</i>
Fanleaf	<i>Psathyrotes</i>
Feverfew	<i>Parthenium</i>
Fireweed	<i>Erechtites hieraciifolius</i>
Flat-topped white aster	<i>Doellingeria umbellata</i>
Fleabane	<i>Achaetogeron</i>
	<i>Erigeron</i>
	<i>Emilia</i>
Flora's Paintbrush	<i>Tetraneuris</i>
Four-nerve daisy	<i>Syntrichopappus</i>
Fremont's-gold	<i>Chamaechaenactis scaposa</i>
Fullstem	<i>Gerbera</i>
Gerbera	<i>Sartwellia</i>
Glowwort	<i>Tragopogon</i>
Goatsbeard	<i>Chrysopsis</i>
Golden aster	<i>Heterotheca</i>
	<i>Ericameria nauseosa</i>
Goldenbush	<i>Viguiera</i>
Goldeneye	<i>Acamptopappus</i>
Goldenhead	<i>Oligoneuron</i>
Goldenrod	<i>Solidago</i>
	<i>Euthamia</i>
Goldentop	<i>Isocoma</i>
Goldenweed	<i>Pyrrocoma</i>
	<i>Lasthenia</i>
Goldfield	<i>Atrichoseris platyphylla</i>
Gravel ghost	<i>Berlandiera</i>
Greeneyes	<i>Thelesperma</i>
Greenthread	<i>Roldana</i>
Groundsel	<i>Senecio</i>
	<i>Grindelia</i>
	<i>Lagophylla</i>
Gumweed	<i>Scorzoneroideis autumnalis</i>
Hareleaf	<i>Crepis</i>
Hawkbit	<i>Hieracium</i>
Hawksbeard	<i>Mikania scandens</i>
Hawkweed	<i>Glyptopleura</i>
Hempweed	<i>Actinospermum</i>
Holy dandelion	<i>Tetradymia</i>
Honeycombhead	<i>Calyptocarpus vialis</i>
Horsebrush	<i>Laennecia</i>
Horseherb	
Horseweed	

TABLE 1. (Continued)

Common Name	Latin Name
Indian headdress	<i>Tracyina rostrata</i>
Indian plantain	<i>Arnoglossum plantagineum</i>
Ironweed	<i>Vernonia fasciculata</i>
Jarilla	<i>Barkleyanthus salicifolius</i>
Jimmyweed	<i>Isocoma</i>
Joe-Pye weed	<i>Eutrochium</i>
Keysia	<i>Glyptopleura</i>
Knapweed	<i>Centaurea</i>
Kyhosia	<i>Kyhosia</i>
Lamb-succory	<i>Arnoseris minima</i>
Leafcup	<i>Polymnia</i>
Leastdaisy	<i>Chaetopappa</i>
Lettuce	<i>Lactuca sativa</i>
Marguerite	<i>Argyranthemum</i>
Marigold	<i>Tagetes</i>
Marsh elder	<i>Iva</i>
Matchweed	<i>Gutierrezia</i>
Mayweed	<i>Tripleurospermum</i>
Mexican devilweed	<i>Chloracantha spinosa</i>
Mexican marigold	<i>Tagetes lucida</i>
Milfoil	<i>Achillea millefolium</i>
Milkthistle	<i>Silybum marianum</i>
Mock goldenweed	<i>Stenotus</i>
Modest aster	<i>Canadanthus modestus</i>
Mountain dandelion	<i>Agoseris</i>
Mountain tobacco	<i>Arnica montana</i>
Mugwort	<i>Artemisia vulgaris</i>
Mule's ears	<i>Agnorhiza</i>
	<i>Wyethia</i>
Mum	<i>Chrysanthemum</i>
Nerveray	<i>Tetragonotheca</i>
Nipplewort	<i>Lapsana communis</i>
Nippon daisy	<i>Nipponanthemum</i>
Opposite leaved-tarweed	<i>Hemizonella minima</i>
Ox-tongue	<i>Helminthotheca echioides</i>
Oxeye	<i>Heliopsis</i>
Paperflower	<i>Psilostrophe</i>
Parachute plant	<i>Atrichoseris platyphylla</i>
Parasol whitetop	<i>Doellingeria umbellata</i>
Pathfinder	<i>Adenocaulon bicolor</i>
Pot marigold	<i>Calendula</i>
Pincushion	<i>Chaenactis</i>
Pink bogbutton	<i>Sclerolepis uniflora</i>
Pluchea	<i>Pluchea</i>
Plume thistle	<i>Cirsium</i>
Plumeseed	<i>Rafinesquia</i>
Plumeless thistle	<i>Carduus</i>
Poreleaf	<i>Porophyllum</i>
Pot marigold	<i>Calendula officinalis</i>
Prairie coneflower	<i>Ratibida</i>
Prickleleaf	<i>Hecastocleis shockleyi</i>
Prickly goldenfleece	<i>Urospermum picroides</i>

(Continued on next page)

TABLE 1. (Continued)

Common Name	Latin Name
Prickly leaf	<i>Thymophylla</i>
Pussytoes	<i>Antennaria</i>
Pygmy cedar	<i>Peucephyllum schottii</i>
Quickweed	<i>Galinsoga</i>
Rabbit tobacco	<i>Diaperia</i>
Rabbitbrush	<i>Chrysothamnus</i> <i>Ericameria nauseosa</i>
Rabbitbush	<i>Lorandersonia</i>
Ragged marsh-elder	<i>Hedosyne ambrosiifolia</i>
Ragweed	<i>Ambrosia artemisiifolia</i>
Ragwort	<i>Jacobaea vulgaris</i> <i>Senecio</i>
Rayless mock goldenrod	<i>Brintonia discoidea</i>
Rock daisy	<i>Perityle</i>
Rock goldenrod	<i>Petradoria pumila</i>
Rocklettuce	<i>Pinaropappus</i>
Rosinweed	<i>Silphium</i>
Rough eyelash	<i>Blepharipappus scaber</i>
Rubberweed	<i>Hymenoxys</i>
Rush skeletonweed	<i>Chondrilla juncea</i>
Safflower	<i>Carthamus tinctorius</i>
Sagebrush	<i>Artemisia tridentata</i>
Salsify	<i>Tragopogon</i>
Saw-wort	<i>Saussurea</i>
Scale bud	<i>Anisocoma acaulis</i>
Seaside tansy	<i>Borrichia</i>
Serpentweed	<i>Tonestus</i>
Silkgrass	<i>Pityopsis</i>
Silverback	<i>Luina hypoleuca</i>
Silvercrown	<i>Cacaliopsis nardosmia</i>
Silverpuff	<i>Microseris</i> <i>Uropappus lindleyi</i>
Skeletonplant	<i>Lygodesmia</i>
Sleep-daisy	<i>Xanthisma</i>
Snakeroot	<i>Ageratina</i>
Snakeroot	<i>Eupatorium</i>
Snakeweed	<i>Gutierrezia</i>
Sneezeweed	<i>Helenium autumnale</i>
Sow thistle	<i>Sonchus oleraceus</i>
Star thistle	<i>Centaurea</i>
Stinkwork	<i>Dittrichia graveolens</i>
Spanish needle	<i>Bidens tripartita</i>
Spotflowers	<i>Acmella oleracea</i>
Squarestem	<i>Melanthera</i>
Stevia	<i>Stevia</i>
Stickyseed	<i>Blennosperma</i>
Stiff-leaved asters	<i>Ionactis</i>
Stokesia	<i>Stokesia laevis</i>
Strawflower	<i>Xerochrysum bracteatum</i>
Sumpweed	<i>Iva annua</i>
Sunbonnet	<i>Leibnitzia lyrata</i>
Sunflower (common)	<i>Helianthus annuus</i>

TABLE 1. (Continued)

Common Name	Latin Name
Sunray	<i>Enceliopsis</i>
Swampprivet	<i>Forestiera</i>
Sweetbrush	<i>Bebbia juncea</i>
Tackstem	<i>Calycoseris</i>
Tansy	<i>Tanacetum vulgare</i>
Tansyaster	<i>Machaeranthera</i> <i>Psilactis</i> <i>Rayjacksonia</i>
Tarragon	<i>Artemisia dracunculus</i>
Tarweed	<i>Hemizonia</i> <i>Madia</i> <i>Flourensia cernua</i>
Tarwort	<i>Emilia</i>
Tasselflower	<i>Heterotheca</i>
Telegraph weed	<i>Hymenothrix</i>
Thimblehead	<i>Cirsium</i>
Thistle	<i>Eupatorium</i>
Thoroughwort	<i>Fleischmannia</i> <i>Trixis</i>
Threefolds	<i>Bidens tripartita</i>
Tickseed	<i>Coreopsis</i> <i>Layia</i>
Tidytip	<i>Atrichoseris platyphylla</i>
Tobacco weed	<i>Townsendia leptotes</i>
Townsend daisy	<i>Adenocaulon</i>
Trailplant	<i>Ismelia</i>
Tricolor daisy	<i>Psathyrotes</i>
Turtleback	<i>Dicoria canescens</i>
Twinbug	<i>Cotula</i>
Water buttons	<i>Astranthium</i>
Western daisy	<i>Anaphalis margaritacea</i>
Western pearly everlasting	<i>Calycadenia</i>
Western rosinweed	<i>Chaetadelpha wheeleri</i>
Wheeler's skeletonweed	<i>Ageratum</i>
Whistleweed	<i>Boltonia asteroides</i>
White doll's daisy	<i>Nabalus</i>
White lettuce	<i>Sericocarpus</i>
Whitetop aster	<i>Oclemena</i>
Whorled wood aster	<i>Barklyanthus salicifolius</i>
Willow groundsel	<i>Barklyanthus salicifolius</i>
Willow ragwort	<i>Stephanomeria</i>
Wirelettuce	<i>Rigiopappus leptocladus</i>
Wireweed	<i>Arnica montana</i>
Wolf's bane	<i>Xylorhiza</i>
Woodyaster	<i>Ancistrocarphus filagineus</i>
Woolly fishhook	<i>Psilocarphus</i>
Woolly heads	<i>Eriophyllum</i>
Woolly sunflower	<i>Psilocarphus</i>
Woollymarbles	<i>Hymenopappus</i>
Woollywhite	<i>Artemisia</i>
Wormwood	<i>Syntrichopappus</i>
Xerasid	<i>Achillea millefolium</i>
Yarrow	<i>Flaveria campestris</i>
Yellowtop	<i>Zinnia elegans</i>
Zinnia	

TABLE 2. Common Edible Compositae Plants

Common Names	Latin Name	Food Sources
Absinthe, wormwood	<i>Artemisia absinthium</i>	Absinthe spirits, bitters, vermouth, pelinkovac
Artichoke, cardoon	<i>Cynara cardunculus</i> var. <i>scolymus</i>	Vegetable, herbal teas, artichoke oil
Chamomile, German	<i>Matricaria recutita</i>	Chamomile tea
Chamomile, Roman	<i>Chamaemelum nobile</i>	Chamomile tea
Chicory	<i>Cichorium intybus</i>	Radicchio
Chicory root	<i>Cichorium intybus</i> var. <i>sativum</i>	Coffees, stouts, Belgian-style ales
Dandelion	<i>Taraxacum officinale</i>	Greens, dandelion wine
Endive, escarole	<i>Cichorium endivia</i>	Greens
Lettuce	<i>Lactuca sativa</i>	Greens, lettuce seed oil
Safflower	<i>Carthamus tinctorius</i>	Safflower seed oil, herbal teas
Salsify	<i>Tragopogon porrifolius</i>	Root vegetable
Stevia	<i>Stevia</i>	Sweetener
Tarragon	<i>Artemisia dracunculus</i>	Herb

due to fragrance.^{7,8} An interesting case report describes a balsam of Peru-sensitive Uber driver and multiple Uber passengers with airborne ACD due to car fragrance diffusers.⁷

The ACDS Core Allergen Series also includes several individual fragrances, many of which have been reported to cause airborne ACD. Cinnamic aldehyde is the component of cinnamon that gives it “spice.” One report describes a bakery worker who developed airborne ACD from ambient cinnamon.⁹ Tea tree oil is a camphoraceous oil from the leaves of *Melaleuca alternifolia*, and lavender absolute is oil extracted from the flowers of *Lavandula angustifolia*. Both are popular essential oils that are of particular importance as aromatherapy and essential oil diffusion trends are on the rise.¹⁰ A recent US general population study found that, of 282 respondents, 47.2% reported using essential oils, and 54.5% of users reported diffusing essential oils,¹¹ which may result in airborne ACD.^{12,13}

Propolis is a waxlike substance produced by honeybees. It contains many components including several fragrance chemicals, waxes, essential oils, and pollens. In nature, bees use propolis as an adhesive to repair the hive. Propolis is used in personal products and over-the-counter medications. Airborne ACD to propolis has been reported in beekeepers and in individuals who have close contact with beehives.^{14–18}

Colophony, also known as rosin, is a resin derived from pine trees. In addition to being used to provide friction for string instrument bows, it is found in many adhesives, cosmetics, and waxes and used as a grip aid for sports. Because it is plant derived, individuals with allergy to colophony often have concomitant allergy to fragrance. Colophony has caused airborne ACD from a variety of sources. There are several reports of patients with airborne ACD to colophony from occupational exposures, especially pine sawdust.^{19–21} Other reported occupational sources of airborne ACD include linoleum floor coverings,²² the waxy coating of paper cartons in a dairy factory,²² and vapor from the flux of a soldering machine.²³ There is also a nonoccupational report of a woman who developed airborne ACD to colophony in the adhesives in the lining of her car roof and doors.²⁴

GLUES, SYNTHETIC RESINS, AND ACRYLATES

Epoxy is a synthetic resin in the ACDS Core Allergen Series. Airborne ACD from epoxy resin is not uncommon. Epoxy glues typically consist of 2 parts: (1) the epoxy polymers and prepolymer monomers and (2) “hardeners” including polyfunctional amines, acids, phenols, alcohols, and thiols, which aid in cross-linking the epoxy polymers. Once completely cured, epoxy resin is not generally allergenic; however, epoxy monomers and hardeners are well-recognized allergens. Epoxy resins are found in many plastics, glues, and adhesives. Cases of airborne ACD to epoxy have typically occurred in occupational settings including in floorers,²⁵ bricklayers,²⁶ golf club repairmen,²⁷ cabinetry repairmen,²⁸ and microscopy workers (who were using an immersion fluid containing epoxy).^{29,30} An interesting, recent case report described airborne ACD to epoxy resin in 2 patients working in a 3-dimensional printing factory.³¹ In some of these cases, individuals were sensitized to epoxy within 3 months.³¹ Some patients are so sensitive that even outdoor exposure to epoxy, such as a construction site, may elicit dermatitis.²⁶ In some cases of epoxy sensitivity, patients are also allergic to hardeners and/or diluents, which can be more volatile than epoxy.^{25,28} Thus, in suspected airborne ACD to epoxy resin systems, it is important to patch test patients to these components as well.

Acrylates/methacrylates are monomers that undergo polymerization through a curing process to form glues and plastics. The monomers are allergenic and can be found in products that have been incompletely cured. Acrylates are used in many different products including dental fillings/prosthetics, acrylic nails, bone cements, and adhesives. Several acrylates/methacrylates are included in the ACDS Core Allergen Series including hydroxyethyl methacrylate, methyl methacrylate, ethyl acrylate, and ethyl cyanoacrylate. Most reported cases of airborne ACD to acrylates have been to methacrylates. Airborne ACD from methacrylates has occurred in a variety of settings including in a dental nurse working with a dental bonding material,³² in an employee of an artificial skin factory,³³ and in several nail technicians and customers using acrylic nails.³⁴ Patients

with this allergy should take caution as many of the acrylates show cross-reactivity and the acrylates can penetrate most protective gear, with the exception of Honeywell North Silver Shield/4H apparel. Available products include gloves, booties, aprons, sleeves, and coat aprons. A downloadable, comprehensive list of permeation rates and breakthrough times for this proprietary material is available on the Honeywell website.³⁵

RUBBER

Those with ACD to rubber products are typically sensitized to rubber additives and rubber accelerators. Some of the accelerators in the ACDS Core Allergen Series have been reported to cause airborne ACD. Thiurams are rubber accelerators used in the vulcanization process. The thiuram mix in the ACDS Core Series consists of dipentamethylenethiuram disulfide, tetraethylthiuram disulfide, tetramethylthiuram disulfide, and tetramethylthiuram monosulfide. Thiurams can be found in essentially any rubberized product, including but not limited to medical gloves, shoes, condoms, and elastic waistbands. Tetraethylthiuram disulfide, commonly known as disulfiram, is also the key ingredient in Antabuse. One case report described a man with known "rubber sensitivity" who developed airborne ACD from crushed Antabuse tablets.³⁶ Many cases have occurred in health care workers who developed airborne ACD from thiurams released from medical gloves.^{37,38}

Mercaptobenzothiazole is another rubber accelerator. In the ACDS Core Allergen Series, it is tested individually as well as in a mercapto mix containing N-cyclohexylbenzothiazyl-sulfenamide, dibenzothiazyl disulfide, and mercaptobenzothiazole. Like thiuram, mercapto can be found in most any rubberized item. A literature search found 1 case of airborne ACD to mercapto, which occurred from a rubberized hot water bottle.³⁹

PRESERVATIVES

Several preservatives in the ACDS Core Allergen Series have been reported to cause airborne ACD. The most common preservative associated with airborne ACD is methylisothiazolinone (MI). Methylisothiazolinone is frequently used in combination with methylchloroisothiazolinone (MI/MCI). The prevalence of MI and MI/MCI ACD has significantly increased in recent years as a result of increased use in products.⁴⁰ Airborne ACD from MI/MCI can be devastating; 1 retrospective review of 44 patients with airborne MI/MCI ACD found that 9.1% of patients required hospitalization and 20.5% required sick leave from work.⁴¹ In Europe, MI/MCI has been banned from leave-in cosmetics and is required to be below a certain threshold in other products.⁴² Isothiazolinones are used in many shampoos, conditioners, hand soaps, dish soaps, laundry detergents, and household cleaners. Isothiazolinones are also found in almost all interior and exterior paints. There are numerous reports of patients experiencing airborne ACD after painting interior walls.^{41,43–48} A recent study of 47 US residential wall paints found that all contained at least 1 isothiazolinone.⁴⁹ An analytical study found that emission

of MI/MCI from water-based wall paints peaks within several hours to a few days of application but continues for over 42 days.⁵⁰ Other reported cases of airborne MI/MCI allergy occurred from toilet cleaner,⁵¹ ironing water,⁵² and a slimicide used in paper-making machinery.⁵³

Benzalkonium chloride is a preservative found in many personal and industrial products. It commonly causes irritant reactions on patch testing; thus, borderline and weak patch test reactions should be interpreted with caution.⁵⁴ A literature search found cases of airborne allergy to benzalkonium chloride from cleaning solution vapors.^{55,56}

Iodopropynyl butylcarbamate is another preservative commonly used in paint products and water-based personal products. The one reported case of airborne ACD to this preservative occurred in workers at a paint plant that produced wood treatment products containing iodopropynyl butylcarbamate.⁵⁷

Benzyl alcohol is an aromatic compound that is used as a preservative. It is also a component of many plants and plant products; thus, it may cross-react with fragrance. Benzyl alcohol is found in many prescription and over-the-counter topical medications. It is also used as a solvent in lacquers, paints, and epoxy resins. A literature search found 1 report of airborne ACD to benzyl alcohol in a patient who worked at a parquet factory; benzyl alcohol was found in a component of one of the glues.⁵⁸

METALS

Each of the metals in the ACDS Core Allergen Series (nickel sulfate, cobalt chloride, and gold sodium thiosulfate) has been implicated in airborne ACD. The airborne source of these metals is typically occupational.

Nickel, a metal used frequently in alloys and metallic products, is one of the most common causes of ACD.⁵⁹ Reported cases of airborne ACD from nickel have included obvious sources such as nickel dust in a laboratory⁶⁰ and metal sprays at factories,⁶¹ to more subtle exposures including nickel released from a trumpet⁶² and dust from scratchcards.⁶³ Most reported cases of nickel airborne ACD have presented with dermatitis in the typical airborne skin distribution, but 1 case report describes airborne ACD from nickel dust mimicking facial rosacea.⁶⁰ A 2010 cross-sectional study found that there was a higher rate of patch test–confirmed allergy to nickel in children living in areas with higher ambient air nickel concentrations, suggesting that airborne nickel may be capable of inducing nickel sensitization.⁶⁴

Cobalt is a metal used in many metallic products, often in combination with nickel. Frequently, there is cosensitivity between nickel and cobalt; more rarely is there an isolated cobalt allergy. Interestingly, there have been several reported cases of airborne ACD to cobalt in patients with isolated cobalt sensitization. One such case was from cobalt dust in a factory,⁶⁵ and another was from cobalt-containing animal feed at a farm.⁶⁶

Gold is a precious metal less commonly implicated in ACD than nickel or cobalt and is often associated with gold jewelry. There are

TABLE 3. Management of Specific Airborne Allergens

Allergen	Management Pearls
Acrylates	Avoidance Honeywell North Silver Shield/4H apparel (gloves, booties, aprons, sleeves, coat aprons) Immunosuppression
Nickel	Avoidance Nickel barrier creams NIK-L-BLOK Skintifique Protective Cream HPS Immunosuppression
Plants	Avoidance (including removal of offending plant in close proximity to the home) Immunosuppression Narrow-band UV-B therapy
Isothiazolinones	Avoidance (including avoidance of freshly painted rooms for up to 42 d) Immunosuppression
Other allergens	Avoidance Immunosuppression

several case reports of airborne ACD to gold in patients whose work involved gold smelting, plating, leafing, and dusting.^{67,68} Cases describe facial dermatitis with pronounced eyelid involvement. In 1 patient, concomitant blepharoconjunctivitis was present.⁶⁸

OTHER AIRBORNE ALLERGENS

Benzophenones are chemical UV absorbers present not only in sunscreens but also in many personal products to prevent product photodegradation. They are also used in the printing industry. One case of airborne ACD to benzophenone-4, one of the benzophenones included in the ACDS Core Allergen Series, occurred from aerosolized printing dye.⁶⁹

Several corticosteroids are included in the ACDS Core Allergen Series including hydrocortisone-17-butyrate, budesonide, tixocortol-21-pivalate, clobetasol-17-propionate, and triamcinolone. Budesonide has been reported to cause airborne ACD from aerosolized bronchodilators. All reported cases of airborne ACD have been in health care workers working with budesonide aerosols.^{70–72}

TABLE 4. Oral Immunosuppressive Medications for Airborne ACD

Medication	Effective Doses	Major Adverse Effects	Studies Involving Airborne ACD
Azathioprine (AZA)	100 mg/d ^{79,80,82,83} 300 mg/wk ^{79,81}	Leukopenia, gastrointestinal (GI) symptoms, hepatotoxicity, hypersensitivity reactions (cholestatic hepatitis, pancreatitis, polyneuropathy, urticaria, drug fever), opportunistic infections ⁸⁸	Several studies have evaluated AZA for parthenium airborne ACD. Daily and weekly dosing are equally efficacious; there are significantly more frequent GI adverse effects with weekly dosing ⁷⁹
Methotrexate (MTX)	15 mg/wk ^{85,86}	Hepatotoxicity, pancytopenia, acute pneumonitis, pulmonary fibrosis, opportunistic infections, cardiovascular disease ⁸⁹	Several studies have evaluated MTX for parthenium airborne ACD; MTX is equally as safe and effective as 100-mg AZA daily for parthenium airborne ACD based on a 30-participant study in India; no. of weeks to 75% clearance was significantly lower with MTX (5.6 wk) vs AZA (9.5 wk) ⁸⁶
Cyclosporine	≥2.5 mg/kg per day ⁸⁷	Nephrotoxicity, hypertension, electrolyte and metabolic disturbances, neurological symptoms (paresthesias, headache), gingival hyperplasia, GI symptoms ⁸⁸	Cyclosporine has not been explicitly studied for airborne ACD. Dosing based on 2 case reports of successful treatment of parthenium airborne ACD ⁸⁷
Mycophenolate mofetil (MMF)	1–3 g/d	GI symptoms, anemia, leukopenia, thrombocytopenia, GU symptoms, fever, neurological symptoms (tremor, dizziness), opportunistic infections ⁹⁰	There are no studies evaluating MMF for airborne ACD. One case report describes a patient with concomitant ACD and atopic dermatitis whose symptoms improved with MMF ⁹¹
Dupilumab	600 mg subcutaneously, then 300 mg subcutaneously every other week	Infection (local herpes simplex), injection site reactions, conjunctivitis, headache ⁹²	There are no studies evaluating dupilumab for airborne ACD. One report describes a patient with known ACD to formaldehyde who failed to mount a response to formaldehyde during patch testing while on dupilumab (300 mg every other week). Another describes a patient with systemic nickel ACD successfully managed with dupilumab. ⁹³

Paraphenylenediamine is an organic compound found in most permanent and nonpermanent hair dyes and in black henna. Specific cases of airborne ACD to paraphenylenediamine have occurred from both sources: in a patient who dyed animal fur⁷³ and a patient who worked with black henna.⁷⁴

Disperse blue is another dye tested in the ACDS Core Allergen Series. Typically, ACD to textile dyes results from direct contact with fabrics. However, a recent case report describes a patient who developed airborne ACD from disperse blue dye in ultrasound gel.⁷⁵

AVOIDANCE AND TREATMENT

The most effective way to manage airborne contact dermatitis is avoiding the implicated allergen. This is particularly difficult for airborne ACD. Measures depend on the offending allergen. Bathing after airborne exposures as well as frequent laundering of clothing may help but is not always practical. For plant airborne ACD, it has been suggested that avoiding outdoor activities when pollen counts are high may be effective,⁷⁶ but there is little evidence to support this; in fact, it is unclear whether pollen is the main route of exposure for all allergens.⁶ There have been reports of remission of plant-derived airborne ACD after removal of the offending plants near the home.^{77,78} For those with airborne ACD to MI/MCI, patients should avoid freshly painted rooms, in some cases, for up to 2 months.⁴¹ For occupationally related dermatitis, increased use of protective equipment and clothing may be helpful. However, for those with severe, recalcitrant occupationally related dermatitis, changing occupations may be recommended. The use of barrier creams as a method of protection from airborne sources has been proposed, but to date, no formal studies have been conducted to assess the effectiveness of this method for airborne ACD. One case report describes a beekeeper's neighbor with airborne propolis allergy whose new lesions were prevented by Tetrix barrier cream.¹⁵ Nickel-specific barrier creams for nickel may be helpful (NIK-L-BLOK, Skintifique Protective Cream HPS). Table 3 describes the management strategies for the different categories of airborne allergens.

For the treatment of airborne ACD, mild symptoms can be managed with topical steroids or short-term courses of oral steroids. In more severe cases, patients may need long-term systemic immunosuppression. Immunosuppression for airborne ACD has primarily been studied in India in patients with parthenium dermatitis. Studies in this population have shown that azathioprine (100 mg daily or 300 mg weekly)^{79–84} and methotrexate (15 mg/wk)⁸⁵ are equally safe and effective.⁸⁶ Response rate may be quicker with methotrexate compared with azathioprine.⁸⁶ Although not formally studied thus far, cyclosporine at a dose of 2.5 mg/kg per day was effective in treating airborne ACD to parthenium in 2 patients.⁸⁷ Table 4 summarizes immunosuppressive medications that may be used for airborne ACD. Narrow-band UV-B has also been used successfully in 1 patient.⁹⁴

In summary, there are many allergens that cause airborne ACD. Although this review focused on the ACDS Core Allergen Series, the

list of reported airborne allergens extends beyond this. Most often, airborne ACD occurs in an occupational setting or from outdoor plant exposure. Identification of the offending allergen is key, although avoidance of allergen exposure may be difficult, especially for plant-derived allergens. Often, treatment involves long-term immunosuppressive medication or light therapy.

REFERENCES

- Gupta SK, Monika, Gupta V, et al. An overview of airborne contact dermatitis. *Air Water Borne Dis* 2016;5:126.
- Schloemer JA, Zirwas MJ, Burkhart CG. Airborne contact dermatitis: common causes in the USA. *Int J Dermatol* 2015;54:271–274.
- Staser K, Ezra N, Sheehan MP, et al. The beak sign: a clinical clue to airborne contact dermatitis. *Dermatitis* 2014;2:97–98.
- Schallock PC, Dunnick CA, Nedorost S, et al. American Contact Dermatitis Society Core Allergen Series: 2017 update. *Dermatitis* 2017;28(2):141–143.
- Anzai A, Vázquez Herrera NE, Tosti A. Airborne allergic contact dermatitis caused by chamomile tea. *Contact Dermatitis* 2015;72:254–255.
- Warshaw EM, Zug KA. Sesquiterpene lactone allergy. *Am J Contact Dermat* 1996;7:1–23.
- Perper M, Cervantes J, Eber AE, et al. Airborne contact dermatitis caused by fragrance diffusers in Uber cars. *Contact Dermatitis* 2017;77:116–117.
- Selvaag E, Holm JO, Thune P. Allergic contact dermatitis in an aroma therapist with multiple sensitizations to essential oils. *Contact Dermatitis* 1995;33:354–355.
- Ackermann I, Aalto-Korte K, Jolanki R, et al. Occupational allergic contact dermatitis from cinnamon including one case from airborne exposure. *Contact Dermatitis* 2009;60:96–99.
- MacLennan AH, Wilson DH, Taylor AW. The escalating cost and prevalence of alternative medicine. *Prev Med* 2002;35(2):166–173.
- Goodier MC, Zhang AJ, Boyd AH, et al. Use of essential oils: a general population survey in Minnesota. *Contact Dermatitis* 2018. <https://doi.org/10.1111/cod.13198>.
- Schaller M, Korting HC. Allergic airborne contact dermatitis from essential oils used in aromatherapy. *Clin Exp Dermatol* 1995;20:143–145.
- De Groot AC. Airborne allergic contact dermatitis from tea tree oil. *Contact Dermatitis* 1996;35(5):304–305.
- Basista K. Direct and airborne contact dermatitis in a beekeeper from the Małopolska region. *Int J Occup Med Environ Health* 2012;25:499–500.
- Walls AC, Silvestri DL. Prevention of airborne propolis-induced allergic contact dermatitis with barrier cream. *Dermatitis* 2012;23(3):128–129.
- Garrido Fernández S, Arroabarren Alemán E, García Figueroa BE, et al. Direct and airborne contact dermatitis from propolis in beekeepers. *Contact Dermatitis* 2004;50:320–321.
- Tobin AM, Kirby B. Airborne contact dermatitis induced by a neighbour's beehives. *Contact Dermatitis* 2003;49:214–215.
- Kleinhans D. Airborne contact dermatitis due to propolis. *Contact Dermatitis* 1987;17:187–188.
- Watsky KL. Airborne allergic contact dermatitis from pine dust. *Am J Contact Dermat* 1997;8(2):118–120.
- Alvarez-Cuesta CC, Lopez FV, Aguado CR, et al. Allergic contact dermatitis from colophonium in the sawdust of Asturian cider-bars. *Contact Dermatitis* 2001;45:57.
- De Cock P, van Ginkel CJ, Faber WR, et al. Occupational airborne allergic contact dermatitis from sawdust in livestock sheds. *Contact Dermatitis* 2000;42(2):113.
- Karlberg A, Gäfvert E, Meding B, et al. Airborne contact dermatitis from unexpected exposure to rosin (colophony). Rosin sources revealed with chemical analyses. *Contact Dermatitis* 1996;35:272–278.

23. Goh CL, Ng SK. Airborne contact dermatitis to colophony in soldering flux. *Contact Dermatitis* 1987;17:89–91.
24. Danielsen H. Airborne allergic contact dermatitis from colophony in a car. *Contact Dermatitis* 1999;41:51.
25. Geier J, Krauthelm A, Fuchs T. Airborne allergic contact dermatitis in a parquet fitter. *Contact Dermatitis* 2012;67:106–108.
26. Geier J, Lessmann H, Reinecke S. Occupational airborne allergic contact dermatitis in a concrete repair worker. *Contact Dermatitis* 2009;60:50–51.
27. Isaksson M, Möller H, Pontén A. Occupational allergic contact dermatitis from epoxy resin in a golf club repairman. *Dermatitis* 2008;19(5):E30–E32.
28. Guin JD. Airborne contact dermatitis from a polymercaptan hardener in a finished epoxy resin. *Contact Dermatitis* 2005;52:45.
29. Downs AM, Sansom JE. Airborne occupational contact dermatitis from epoxy resin in an immersion oil used for microscopy. *Contact Dermatitis* 1998;39:267.
30. Sommer S, Wilkinson SM, Wilson CL. Airborne contact dermatitis caused by microscopy immersion fluid containing epoxy resin. *Contact Dermatitis* 1998;39:141–142.
31. Creytens K, Gilissen L, Huygens S, et al. A new application for epoxy resins resulting in occupational allergic contact dermatitis: the three-dimensional printing industry. *Contact Dermatitis* 2017;77:349–351.
32. Isaksson M, Zimerson E, Svedman C. Occupational airborne allergic contact dermatitis from methacrylates in a dental nurse. *Contact Dermatitis* 2007;57:371–375.
33. Hickey JR, Sansom JE. Allergic contact dermatitis following airborne exposure to methacrylates used in the manufacture of artificial skin. *Contact Dermatitis* 2003;49:221.
34. Maio P, Carvalho R, Amaro C, et al. Allergic contact dermatitis from sculptured acrylic nails: special presentation with an airborne pattern. *Dermatol Rep* 2012;4(1):e6.
35. North Safety, North Chemical Resistance Guide. Available at: https://www.honeywellsafety.com/Supplementary/Documents_and_Downloads/Gloves/19327356486/1033.aspx. Accessed September 15, 2018.
36. Creytens K, Swevers A, De Haes P, et al. Airborne allergic contact dermatitis caused by disulfiram. *Contact Dermatitis* 2015;72:405–407.
37. Schwensen JF, Menné T, Johansen JD, et al. Persistent periorbital allergic contact dermatitis in a dental technician caused by airborne thiuram exposure. *Contact Dermatitis* 2015;73:321–322.
38. Jensen P, Menné T, Thyssen JP. Allergic contact dermatitis in a nurse caused by airborne rubber additives. *Contact Dermatitis* 2011;65:54–55.
39. Giorgini S, Martinelli C, D'Erme AM, et al. A case of airborne allergic contact dermatitis by rubber additives. *G Ital Dermatol Venereol* 2010;145(1):133–134.
40. Zirwas MJ, Hamann D, Warshaw EM, et al. Epidemic of isothiazolinone allergy in North America: prevalence data from the North American Contact Dermatitis Group, 2013–2014. *Dermatitis* 2017;28(3):204–209.
41. Amsler E, Aerts O, Raison-Peyron N, et al. Airborne allergic contact dermatitis caused by isothiazolinones in water-based paints: a retrospective study of 44 cases. *Contact Dermatitis* 2017;77(3):163–170.
42. Regulation (EC) no. 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009R1223-20160812&rid=1>. Accessed September 15, 2018.
43. Jensen JM, Harde V, Brasch J. Airborne contact dermatitis to methylchloroisothiazolinone/methylisothiazolinone in a boy. *Contact Dermatitis* 2006;55:311.
44. Bohn S, Niederer M, Brehm K, et al. Airborne contact dermatitis from methylchloroisothiazolinone in wall paint. Abolition of symptoms by chemical allergen inactivation. *Contact Dermatitis* 2000;42:196–201.
45. Finkbeiner H, Kleinhans D. Airborne allergic contact dermatitis caused by preservatives in home-decorating paints. *Contact Dermatitis* 1994;31:275–276.
46. Goodier MC, Ljungberg L, Persson C, et al. Allergic contact dermatitis from methylisothiazolinone in residential wall paint. *Dermatitis* 2017;28(4):284–287.
47. Wright AM, Cahill JL. Airborne exposure to methylisothiazolinone in paint causing allergic contact dermatitis: an Australian perspective. *Australas J Dermatol* 2016;57:294–295.
48. Alwan W, White IR, Banerjee P. Presumed airborne contact allergy to methylisothiazolinone causing acute severe facial dermatitis and respiratory difficulty. *Contact Dermatitis* 2014;70:320–321.
49. Goodier MC, Siegel P, Zang LY, et al. Isothiazolinone in residential interior wall paint: a high-performance liquid chromatographic–mass spectrometry analysis. *Dermatitis* 2018;29:332–338.
50. Lundov MD, Kolarik B, Bossi R, et al. Emission of isothiazolinones from water-based paints. *Environ Sci Technol* 2014;48(12):6989–6994.
51. Lundov MD, Menné T. Airborne exposure to methylchloroisothiazolinone and methylisothiazolinone from a toilet cleaner. *Contact Dermatitis* 2013;68:252–253.
52. Hunter KJ, Shelley JC, Haworth AE. Airborne allergic contact dermatitis to methylchloroisothiazolinone/methylisothiazolinone in ironing water. *Contact Dermatitis* 2008;58:183–184.
53. Majamaa H, Roto P, Vaalasti A. Airborne occupational hypersensitivity to isothiazolinones in a papermaking technician. *Contact Dermatitis* 1999;41:220.
54. Uter W, Lessmann H, Geier J, et al. Is the irritant benzalkonium chloride a contact allergen? A contribution to the ongoing debate from a clinical perspective. *Contact Dermatitis* 2008;58(6):359–363.
55. Mauleón C, Mauleón P, Chavarría E, et al. Airborne contact dermatitis from n-alkyl dimethylbenzylammonium chloride and n-alkyl dimethylethyl-benzylammonium chloride in a detergent. *Contact Dermatitis* 2006;55:311–312.
56. Corazza M, Virgili A. Airborne allergic contact dermatitis from benzalkonium chloride. *Contact Dermatitis* 1993;28:195–196.
57. Jensen CD, Thormann J, Andersen KE. Airborne allergic contact dermatitis from 3-iodo-2-propynyl-butylcarbamate at a paint factory. *Contact Dermatitis* 2003;48:155–157.
58. Lodi A, Mancini LL, Pozzi M, et al. Occupational airborne allergic contact dermatitis in parquet layers. *Contact Dermatitis* 1993;29(5):281–282.
59. Warshaw EM, Zhang AJ, DeKoven JG, et al. Epidemiology of nickel sensitivity: retrospective cross-sectional analysis of North American Contact Dermatitis Group (NACDG) data 1994–2014. *J Am Acad Dermatol* 2019;80(3):701–713.
60. Kanerva L, Alanko K, Jolanki R, et al. Laboratory assistant's occupational allergic airborne contact dermatitis from nickel presenting as rosacea. *Eur J Dermatol* 1999;9:397–398.
61. Handfield-Jones S, Boyle J, Harman RR. Contact allergy caused by metal sprays. *Contact Dermatitis* 1987;16:44–45.
62. Nakamura M, Arima Y, Nobuhara S, et al. Nickel allergy in a trumpet-player. *Contact Dermatitis* 1999;40:219–220.
63. Fréling E, Poreaux C, Valois A, et al. Occupational contact dermatitis caused by nickel in scratchcards. *Contact Dermatitis* 2015;73:371–372.
64. Mann E, Ranft U, Eberwein G, et al. Does airborne nickel exposure induce nickel sensitization? *Contact Dermatitis* 2010;62:355–362.
65. Ratcliffe J, English JS. Allergic contact dermatitis from cobalt in animal feed. *Contact Dermatitis* 1998;39:201–202.
66. Dickel H, Radulescu M, Weyher I, et al. Occupationally-induced “isolated cobalt sensitization”. *Contact Dermatitis* 2001;45:246–247.
67. Estlander T, Kari O, Jolanki R, et al. Occupational allergic contact dermatitis and blepharoconjunctivitis caused by gold. *Contact Dermatitis* 1998;38:40–41.

68. Giorgini S, Tognetti L, Zanieri F, et al. Occupational airborne allergic contact dermatitis caused by gold. *Dermatitis* 2010;21:284–287.
69. Caruana DM, McPherson T, Cooper S. Allergic contact dermatitis caused by benzophenone-4 in a printer. *Contact Dermatitis* 2011;64:158–184.
70. Baeck M, Goossens A. Patients with airborne sensitization/contact dermatitis from budesonide-containing aerosols 'by proxy'. *Contact Dermatitis* 2009;61:1–8.
71. Corazza M, Baldo F, Osti F, et al. Airborne allergic contact dermatitis due to budesonide from professional exposure. *Contact Dermatitis* 2008;59:318–319.
72. Pontén A. Airborne occupational contact dermatitis caused by extremely low concentrations of budesonide. *Contact Dermatitis* 2006;55:121–124.
73. Cordoba S, Sanz-Sanchez T, Hernandez-Nunez A, et al. Occupational contact dermatitis from *p*-phenylenediamine in a furrier. *J Eur Acad Dermatol Venereol* 2008;22:773.
74. Özkaya E, Topkarci Z. Airborne allergic contact dermatitis caused by a henna stone. *Contact Dermatitis* 2016;75:191–192.
75. Skalina KA, Ramesh M. A case of allergic contact dermatitis caused by disperse blue dye in ultrasound gel. *Contact Dermatitis* 2018;79:175–176.
76. Handa S, De D, Mahajan R. Airborne contact dermatitis—current perspectives in etiopathogenesis and management. *Indian J Dermatol* 2011;56:700–706.
77. Watt GC. Ragweed dermatitis and the distribution of ragweed in Australia. *Australas J Dermatol* 1987;28:27–29.
78. Paulsen E, Andersen KE. Clinical patterns of Compositae dermatitis in Danish monosensitized patients. *Contact Dermatitis* 2018;78:185–193.
79. Verma KK, Sethuraman G, Kalavani M. Weekly azathioprine pulse versus daily azathioprine in the treatment of parthenium dermatitis: a non-inferiority randomized controlled study. *Indian J Dermatol Venereol Leprol* 2015;81(3):251–256.
80. Sharma VK, Chakrabarti A, Mahajan V. Azathioprine in the treatment of parthenium dermatitis. *Int J Dermatol* 1998;37:299–302.
81. Verma KK, Bansal A, Sethuraman G. Parthenium dermatitis treated with azathioprine weekly pulse doses. *Indian J Dermatol Venereol Leprol* 2006;72:24–27.
82. Verma KK, Pasricha JS. Azathioprine as a corticosteroid-sparing agent in air-borne contact dermatitis. *Indian J Dermatol Venereol Leprol* 1996;62:30–32.
83. Verma KK, Manchanda Y, Pasricha JS. Azathioprine as a corticosteroid sparing agent for the treatment of dermatitis caused by the weed parthenium. *Acta Derm Venereol* 2000;80:31–32.
84. Verma KK, Mahesh R, Srivastava P, et al. Azathioprine versus betamethasone for the treatment of parthenium dermatitis: a randomized controlled study. *Indian J Dermatol Venereol Leprol* 2008;74:453–457.
85. Sharma VK, Bhat R, Sethuraman G, et al. Treatment of parthenium dermatitis with methotrexate. *Contact Dermatitis* 2007;57:118–119.
86. De D, Sarangal R, Handa S. The comparative efficacy and safety of azathioprine vs methotrexate as steroid-sparing agent in the treatment of air-borne-contact dermatitis due to Parthenium. *Indian J Dermatol Venereol Leprol* 2013;79(2):240–241.
87. Lakshmi C, Srinivas CR, Jayaraman A. Ciclosporin in parthenium dermatitis—a report of 2 cases. *Contact Dermatitis* 2008;59:245–248.
88. Ho VC, Zloty DM. Immunosuppressive agents in dermatology. *Dermatol Ther* 1993;11(1):73–85.
89. Bangert CA, Costner MI. Methotrexate in dermatology. *Dermatol Ther* 2007;20:216–228.
90. Orvis AK, Wesson SK, Breza TS Jr, et al. Mycophenolate mofetil in dermatology. *J Am Acad Dermatol* 2009;60(2):183–199.
91. Nguyen RH, Cruz PD Jr. Hepatitis due to mycophenolate mofetil used to treat atopic dermatitis and allergic contact dermatitis. *Dermatitis* 2014;25(5):284–285.
92. Sastre J, Dávila I. Dupilumab: a new paradigm for the treatment of allergic diseases. *J Invest Allergol Clin Immunol* 2018;28(3):139–150.
93. Joshi SR, Khan DA. Effective use of dupilumab in managing systemic allergic contact dermatitis. *Dermatitis* 2018;9(5):282–284.
94. Dogra S, Parsad D, Handa S. Narrowband ultraviolet B in airborne contact dermatitis: a ray of hope! *Br J Dermatol* 2004;150:373–374.