Ectoparasites

Scabies

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Learning objectives

After completing this learning objective participants should be able to describe the cutaneous manifestations of scabies and complications of secondary bacterial infection; recognize novel diagnostic tools for the identification of scabies; explain scabies treatment strategies in the context of current evidence; and discuss public health strategies for the control of scabies.

Disclosures

Editors

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Scabies is an ectoparasitic dermatosis caused by *Sarcoptes scabiei* var. *hominis* and is a public health issue in all countries regardless of socioeconomic status. In high-income countries, delays in diagnosis can lead to institutional outbreaks; in low- and middle-income countries, poor access to health care contributes to disease undertreatment and long-term systemic sequelae. With scabies now recognized as a neglected tropical disease by the World Health Organization, increased awareness and systematic efforts are addressing gaps in diagnosis and treatment that impede scabies control. This review summarizes the available data and provides an update on scabies epidemiology, clinical features, diagnosis, management, and public health considerations. (J Am Acad Dermatol 2020;82:533-48.)

Key words: crusted scabies; homeless; impetigo; infestation; ivermectin; mass drug administration; neglected tropical disease; optical coherence tomography; permethrin; poststreptococcal glomerulonephritis; pruritus; reflectance confocal microscopy; refugee; rheumatic fever; rheumatic heart disease; *Sarcoptes scabiei*; scabies; *Staphylococcus aureus*; *Streptococcus pyogenes*.

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Abbreviations used:

APSGN:	acute poststreptococcal glomerulonephritis
DALY:	disability-adjusted life year
MDA:	mass drug administration
RCM:	reflectance confocal microscopy

EPIDEMIOLOGY

Key points

- **Scabies affects around 200 million people worldwide**
- **The prevalence is highest in low- and middle-income tropical countries**
- **Population crowding and skin-to-skin contact promotes transmission among children, homeless individuals, and displaced groups**

Scabies is caused by *Sarcoptes scabiei* var. *hominis* (*S scabiei*), an obligate microscopic parasitic mite that lives its entire 10- to 14-day life cycle in the human epidermis (Fig 1).[1] Female mites burrow into the stratum corneum, inducing a cutaneous hypersensitivity reaction to the mite and its products. In classic scabies, prolonged skin-to-skin contact, including sexual contact, is the primary mode of transmission, and fomite-mediated transmission is uncommon.[2,3] Transmission via fomites may be more important in profuse and crusted scabies (formerly known as Norwegian scabies), wherein mites are more numerous and survive in shedded scale.[4]

In the 2015 Global Burden of Disease Study, the global prevalence of scabies was 204 million.[5] Disease burden was measured using the disability-adjusted life year (DALY), calculated as the sum of life years lost because of premature mortality and disability; greater DALYs represent a higher disease burden.[5] Scabies burden was greatest in tropical regions, including east Asia, southeast Asia, south Asia, Oceania, and tropical Latin America.[6] Although the prevalence in North America was lower than in other regions, age-standardized DALYs from scabies have increased.[6] Scabies contributed more age-standardized DALYs than atrial fibrillation/flutter or acute lymphocytic leukemia.[7] Notably, scabies was presumed to carry zero mortality, and thus the

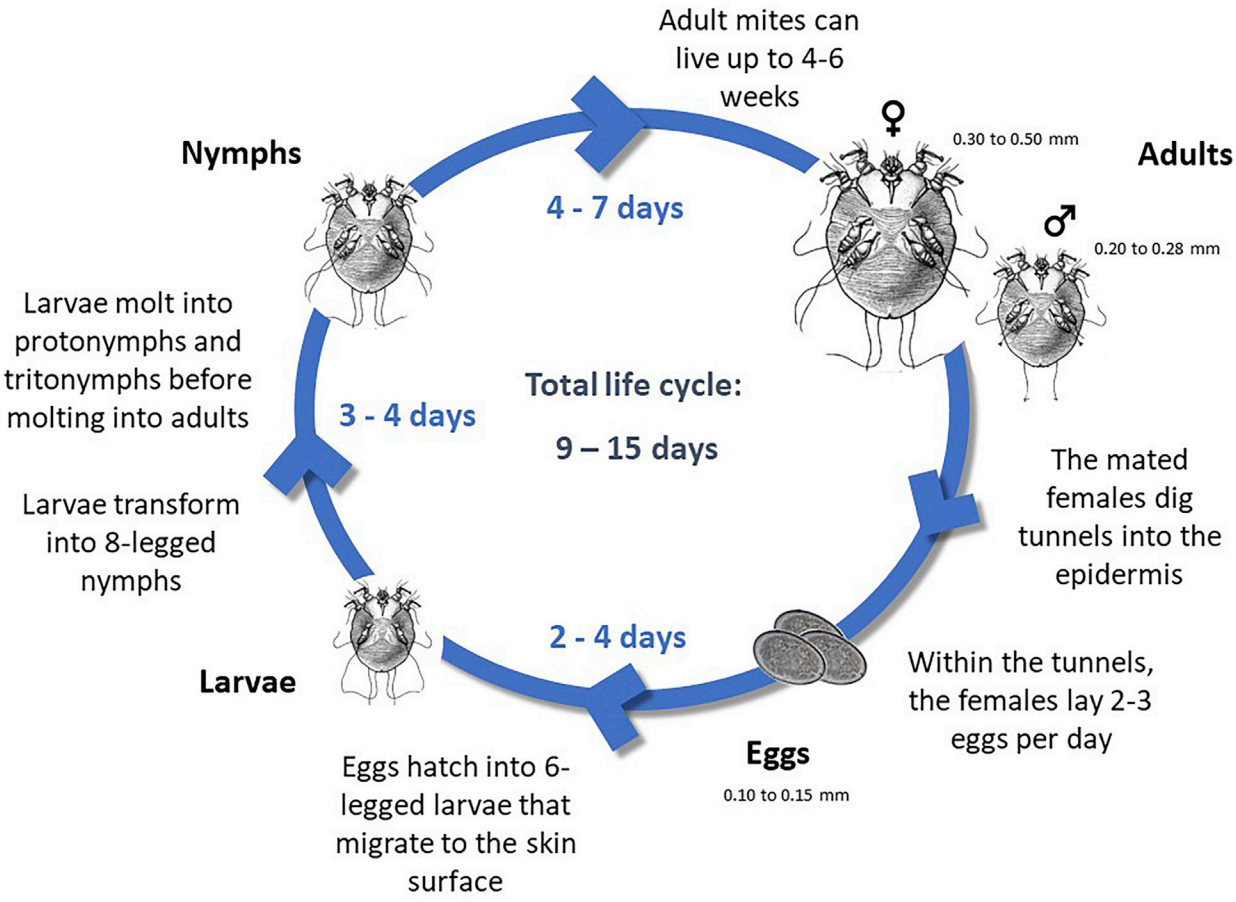

Fig 1. *Sarcoptes scabiei* life cycle. (Adapted with permission of Elsevier from Bernigaud C, Chosidow O. Scabies [in French]. Rev Prat 2018;1:63-8.)

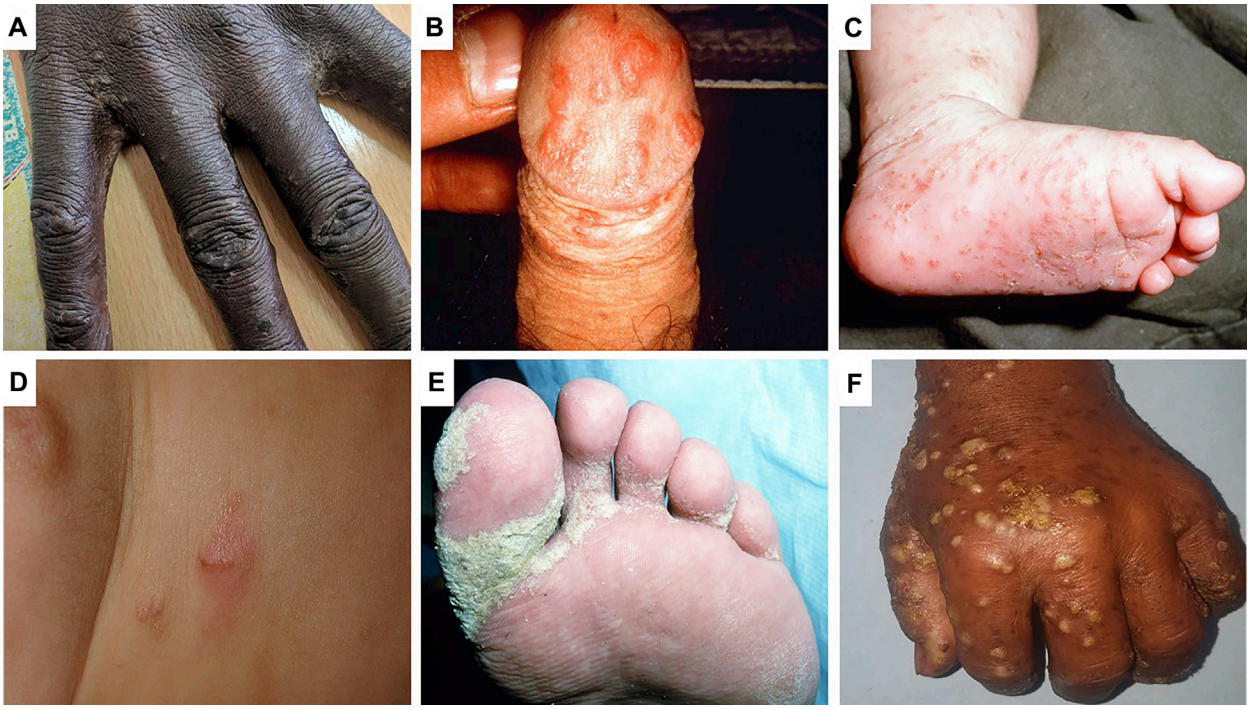

Fig 2. Scabies. **A**, Papules and scaling on the fingers and webspaces (courtesy of Aileen Chang, MD). **B**, Erythematous papules and nodules on the penile shaft and glans penis (courtesy of Timothy Berger, MD). **C**, Acral crusted papules and scaling in an infant (courtesy of Timothy Berger, MD). **D**, Red-brown nodules on the trunk of an infant (courtesy of Ilona Frieden, MD). **E**, Hyperkeratosis on the sole and interdigital webspaces in crusted scabies (courtesy of Timothy Berger, MD). **F**, Pustules and papules with overlying honey-colored crust on the dorsal surface of the hand in impetiginized scabies (courtesy of Wendemagegn Enbiale, MD, MPH).

estimated DALYs reflect only years lived with disability.[6,8] However, high mortality has been reported from scabies-related *Staphylococcus aureus* (*S aureus*) bacteremia in a majority indigenous Australian population.[9]

Certain subpopulations with increased skin-to-skin contact are at higher risk of infestation. In high-income countries, outbreaks frequently occur in institutional settings, homeless populations, and groups living in crowded conditions after displacement. For example, scabies was diagnosed in 56.5% of dermatologic consultations in a majority homeless population in Paris and 58% of infectious/dermatologic consultations in migrants arriving to Italy.[10,11] Outbreaks also occur in natural disaster victims after drought,[12] flooding,[13,14] and earthquakes.[15,16] In low- and middle-income countries and tropical regions, scabies disproportionately affects children.[17,18] In the Solomon Islands, 25.7% of children 1 to 4 years of age were diagnosed with scabies.[19] Overcrowding,[20] bed sharing,[21] high reinfestation rates,[22] and disease underrecognition[23] may account for higher prevalence in children. In tropical regions, DALY burden is greatest in children 1 to 4 years of age, gradually decreases from 5 to 24 years of age, drops in adulthood, and rises after 70 years of age.[6]

CLINICAL FEATURES

Key points

- **Classic scabies presents with pruritus and multiple skin lesion morphologies involving finger webspaces, hands, the volar surfaces of the wrists, axillae, buttocks, the areola in women, and genitalia in men**
- **Disease patterns may differ in infants, children, elderly, and the immunocompromised**
- **Crusted scabies most frequently occurs in immunocompromised patients, manifesting as hyperkeratosis with or without pruritus**
- **Complications include secondary impetigo, cellulitis, abscesses, poststreptococcal glomerulonephritis, rheumatic fever, and sepsis**

Scabies presents with multiple morphologies (Fig 2), and the differential diagnosis varies by clinical subtype (Table I). Generalized pruritus that is worse at night is a hallmark feature and may be mediated by nonhistaminergic itch mechanisms,

Table I. Differential diagnosis of scabies

Classic scabies	Arthropod bites
	Folliculitis
	Impetigo
	Papular urticaria
	Atopic dermatitis
	Contact dermatitis
	Nummular eczema
	Prurigo nodularis
	Bullous pemphigoid (urticarial stage)
	Dermatitis herpetiformis
	Lice infestation
	Delusional parasitosis
	Morgellons disease
Infantile scabies	Arthropod bites
	Papular urticaria
	Atopic dermatitis
	Infantile acropustulosis
	Langerhans cell histiocytosis
Bullous scabies	Bullous arthropod bites
	Bullous impetigo
	Bullous pemphigoid
	Pemphigus vulgaris
	Incontinentia pigmenti (inflammatory stage)
Crusted scabies	Psoriasis
	Pityriasis rubra pilaris
	Seborrheic dermatitis
	Atopic dermatitis
	Contact dermatitis
	Palmoplantar keratoderma
	Darier disease
	Erythrodermic mycosis fungoides/ Sézary syndrome

including tryptase, its receptor protease-activated receptor-2, and ion channels transient receptor potential cation channel subfamily V member 1 and transient receptor potential cation channel subfamily A member 1.[24] Pruritus can be severe, negatively impacting quality of life.[25-27] However, sensitization to mite antigens occurs 4 to 6 weeks after the initial infestation, and therefore asymptomatic carriage is common during this period.[28] With reinfestation, itching begins within days, and presentations may be more severe. Pruritus may be absent in infants,[29] the elderly,[30] patients inappropriately treated with topical corticosteroids,[31,32] or those taking immunosuppressive/antiinflammatory agents.[33]

Classic scabies

In classic scabies, lesions favor the finger webspaces, hands, the volar surfaces of the wrists, axillae, feet, waistline, lower buttocks, inner thighs, the areola in women, and genitalia in men. With an average mite load of 5 to 15 in classic scabies,[2] pathognomonic burrows are only occasionally visible as short, linear, or wavy tracks culminating with an intact or eroded vesicle/pustule containing the mite. Most burrows are found on the hands/wrists but can be seen on the elbows, genitalia, buttocks, and axillae. More commonly, nonspecific secondary lesions are seen, including excoriated papules, eczematous plaques, and impetigo. Prolonged scratching can result in lichenification and prurigo nodularis.

Atypical scabies and subpopulations

Atypical findings include scalp involvement, nodules, bullous lesions, and crusted scabies. Scalp involvement is seen in infants, children, the elderly, and immunocompromised individuals. Firm red-brown or violaceous nodules can occur on the axillae, groin, male genitalia, and trunk (in infants) and often persist for months after treatment. Bullous scabies manifests as tense or flaccid bullae in typical locations with or without pruritus.

In crusted scabies, psoriasiform and hyperkeratotic lesions are generally widespread with head/neck involvement and accentuation over acral sites. Localized crusted scabies can occur on the scalp,[3,34-36] face,[3,34] fingers,[3,34] toes/toenails,[3,34,37] soles,[3,34,38] and genitalia.[3,39,40] Eosinophilia[41] and generalized lymphadenopathy can be seen.[34] Despite high mite burden—estimated to be ≤4700 mites per gram of shedded skin[4]—lesions are not always pruritic. Crusted scabies is associated with immobility and immunocompromised states, including iatrogenic immunosuppression (topical/systemic glucocorticoids[35,42,43] and biologic therapy[44,45]), T-cell lymphoma/leukemia,[46,47] HIV infection,[48] and human T-cell lymphotropic virus-1 infection[41,48] but can occur in the absence of these risk factors.

Several subpopulations have distinct clinical presentations. In infants and young children, lesions are more widespread but favor the palms/soles, wrists, and ankles.[29] Impetiginization and eczematization are common. Infants may not scratch but rather feed poorly and appear irritable. In the elderly, atypical findings are common and though the inflammatory response may be subdued, pruritus is often still present. In bed-bound individuals, lesions may involve the back.[34]

Local complications

Scabies infestation is often complicated by *Streptococcus pyogenes* (*S pyogenes*) or *S aureus* impetigo because of scratching-induced skin trauma (Fig 3). Mite and host immune system interactions, including mite production of complement-inhibiting proteins, promote *S pyogenes* survival and *S aureus* growth.[49-53] Impetiginized scabies is common in areas with high

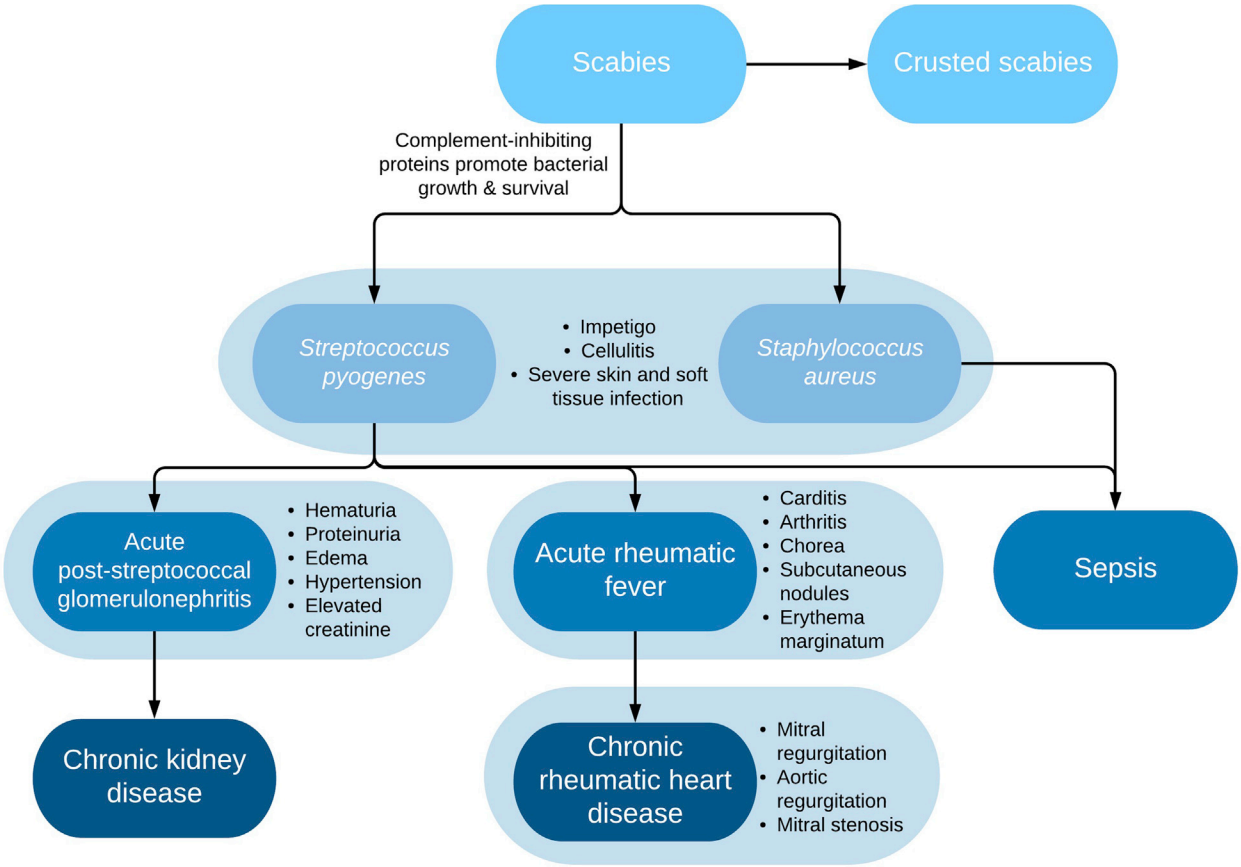

Fig 3. Systemic complications of scabies. (Adapted with permission of Elsevier from Engelman D, Kiang K, Chosidow O, et al. Toward the global control of human scabies: introducing the International Alliance for the Control of Scabies. PLoS Negl Trop Dis 2013;7:e2167.)

scabies prevalence.[18,54-57] In Australia, Aboriginal children were 7 times more likely to have scabies and concomitant skin infections with *S pyogenes* or *S aureus* than skin infections alone.[58] In addition, scabies treatment alone decreases impetigo rates in areas with high scabies and impetigo prevalences.[59-62] Abscesses, cellulitis, and, rarely, necrotizing soft tissue infections can also occur as local complications.[63-65]

Systemic complications

Systemic complications of scabies are mainly caused by secondary bacterial infection (Fig 3). *S pyogenes* infection may lead to acute post-streptococcal glomerulonephritis (APSGN), and APSGN epidemics are linked to *S pyogenes* superinfection of scabies lesions.[66-68] Although the immediate consequences of APSGN are limited, long-term effects, particularly chronic kidney disease, have substantial morbidity.[69] In the Aboriginal Australian community, high rates of end-stage renal disease are associated with scabies and secondary superinfection.[70]

As with APSGN, streptococcal skin infection is likely an important driver of acute rheumatic fever and subsequent rheumatic heart disease in some settings, although this link has not been conclusively established.[71,72] In New Zealand and Ethiopia, scabies diagnoses were associated with rheumatic fever and rheumatic heart disease development, supporting the potential role of scabies-associated impetigo in these high-morbidity conditions.[73,74]

Secondary bacterial infections also predispose those with scabies to bacteremia and sepsis.[9,75] Untreated crusted scabies carries a high risk of mortality from secondary sepsis.[76-79]

DIAGNOSIS

Key points

- **Consensus diagnostic criteria can be used in various clinical settings**
- **Visualization of mites, eggs, or feces on microscopy of skin scrapings confirms diagnosis but has low sensitivity**

Table II. 2018 International Alliance for the Control of Scabies diagnostic criteria for scabies[82]

A: Confirmed scabies
At least one of:
- A1: Mites, eggs, or feces on light microscopy of skin samples
- A2: Mites, eggs, or feces visualized on individual using high-powered imaging device
- A3: Mite visualized on individual using dermoscopy

B: Clinical scabies
At least one of:
- B1: Scabies burrows
- B2: Typical lesions affecting male genitalia
- B3: Typical lesions in a typical distribution and 2 history features

C: Suspected scabies
One of:
- C1: Typical lesions in a typical distribution and 1 history feature
- C2: Atypical lesions or atypical distribution and 2 history features

History features
- H1: Itch
- H2: Close contact with an individual who has itch or typical lesions in a typical distribution

Diagnosis can be made at 1 of the 3 levels (A, B, or C). A diagnosis of clinical and suspected scabies should only be made if other differential diagnoses are considered less likely than scabies.

- **Noninvasive diagnostic techniques include dermoscopy, videodermoscopy, reflectance confocal microscopy, and optical coherence tomography**
- **On dermoscopy, the "delta-wing jet" sign is a burrow ending in a mite**

Diagnostic criteria

Scabies is commonly misdiagnosed. In a single-center retrospective study in the United States, 45% of scabies patients were previously misdiagnosed.[80] The lack of standardized diagnostic criteria poses challenges to both patient care and research.[81] Recently, consensus diagnostic criteria were developed using the Delphi method (Table II) to enable standardization and comparison of findings, with validation studies ongoing.[82]

Imaging diagnostics

Classically, diagnosis is confirmed by light microscopy with ex vivo visualization of mites, eggs, or feces from skin scrapings (Fig 4). To obtain a skin scraping sample, a drop of mineral oil is placed at the terminal end of a burrow, and the lesion and underlying epidermis are gently scraped away with a surgical blade or sterile needle. Sensitivity can be low,[83] and testing is contingent on the availability of required equipment. Recently, several noninvasive in vivo diagnostic techniques have emerged (Fig 5).

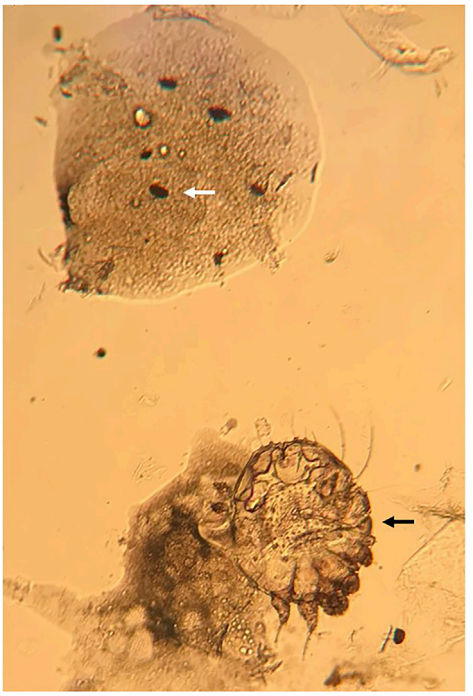

Fig 4. Mineral oil scraping showing *Sarcoptes scabiei* mite (*black arrow*) and feces (*white arrow*). (Courtesy of Kristen Corey, MD. Original magnification: ×10.)

Scabies can be rapidly diagnosed using dermoscopy. On 10× magnification, the mite head and trailing burrow can be visualized in the "delta-wing jet" sign.[84,85] In 2 studies, the sensitivity of dermoscopy was equivalent to skin scraping (91% vs 90%, respectively) in high-resource settings and higher than skin scraping (83% vs 46%, respectively) in low-resource settings.[83,84] Despite the ease and accuracy of dermoscopy, its use is limited by operator experience and low sensitivity in mild disease.[83]

Videodermoscopy uses video cameras to provide up to 1000× magnification.[86] Low magnification enables burrow detection while mites, eggs, and feces are visualized on higher magnifications.[87] When dermoscopy cannot distinguish burrows from excoriations, videodermoscopy's higher magnification is useful and contributes to its high specificity.[88]

Reflectance confocal microscopy (RCM) uses cellular structure light reflectance to visualize the epidermis and papillary dermis in vivo at resolutions comparable to histology. Although most commonly used to detect cutaneous neoplasm, RCM also reliably detects and quantifies classic and crusted scabies.[89-96] Comparisons between RCM and other

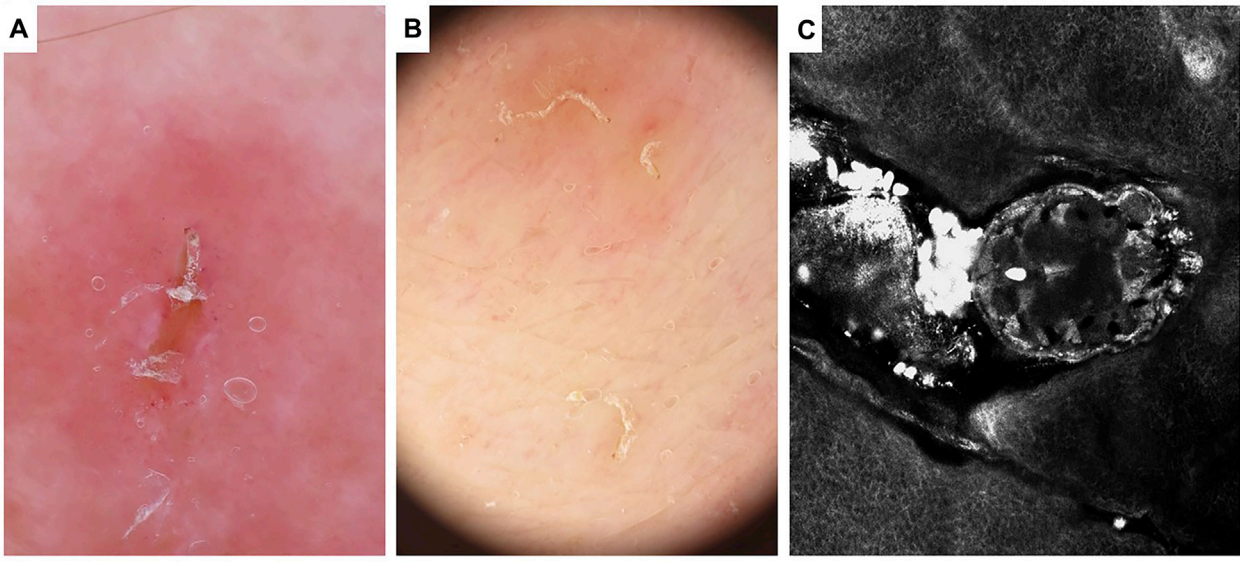

Fig 5. Noninvasive scabies diagnostic techniques. **A**, Dermoscopy showing the "delta-wing jet" sign composed of a burrow ending in a mite. (Reprinted with permission of Elsevier from Lallas A, Apalla Z, Lazaridou E, et al. Scabies escaping detection until dermoscopy was applied. Dermatol Pract Concept 2017; 7:49-50.) **B**, Videodermoscopy demonstrating burrows ending in mites. (Original magnification: ×20. Reprinted with permission of John Wiley and Sons from Cinotti E, Labeille B, Cambazard F, et al. Videodermoscopy compared to reflectance confocal microscopy for the diagnosis of scabies. J Eur Acad Dermatol Venereol 2016;30:1573-7.) **C**, Reflectance confocal microscopy showing a mite with feces. (Reprinted with permission of Elsevier from Micali G, Lacarrubba F, Verzi A, et al. Scabies: advances in noninvasive diagnosis. PLoS Negl Trop Dis 2016;10:e0004691.)

diagnostic tools are sparse, but RCM accuracy is comparable to 70× magnification videodermoscopy.[97] RCM's cost and time-intensiveness (approximately 10 minutes per lesion) limit widespread use, but it may have utility in research settings.[98]

Optical coherence tomography uses light refraction to produce high-resolution cross-sectional images similar to ultrasonography.[99] With this technique, mites, eggs, feces, and burrow contents can be identified.[100] Similar to RCM, availability and cost are barriers.[98]

MANAGEMENT

Key points

- **Topical permethrin and oral ivermectin are effective treatments**
- **Novel topical and systemic agents are being investigated**
- **Limited data exist on the role of environmental measures in scabies control**

Treatment

The traditional pillars of treatment are topical scabicides, most commonly 5% permethrin, and oral ivermectin (Table III). Despite the high burden of scabies globally, treatment efficacy and safety data are scarce. While a 2007 Cochrane review suggested that 5% permethrin (1 or 2 applications) was the most effective treatment, a recent Cochrane review concluded that 5% permethrin and ivermectin were equally effective.[101,102] Conflicting results are related to differences in study design, cure definition, and loss to follow-up.[103]

Topical scabicides used globally include 5% permethrin, 10% to 25% benzyl benzoate, 2% to 10% precipitated sulfur, 10% crotamiton, 0.5% malathion, and 1% lindane. Because of its high efficacy and tolerability, 5% permethrin is considered the first-line treatment in many countries and has been approved by the U.S. Food and Drug Administration for scabies treatment in individuals >2 months of age. When permethrin is unavailable, 10% to 25% benzyl benzoate and 2% to 10% precipitated sulfur are effective alternatives. While not available in the United States or Canada, benzyl benzoate is considered an essential medicine by the World Health Organization and is widely available outside North America.[104] Topical 10% crotamiton and 0.5% malathion are less effective than other treatments, but well-designed studies are limited.[101,105] Because of the risk of neurotoxicity, lindane is restricted in numerous countries and California.[106,107] For most topical treatments, a second course after 7 to 14 days will improve efficacy.

Table III. Therapies for scabies

	Therapy	Mechanism of action	Instructions	Adverse events	Level of evidence*	Considerations
Topical	Permethrin 5% cream, approved by the FDA in 1989	Inhibits sodium channels, causing neurotoxicity, paralysis, and death	Apply for 8-14 hours, then rinse off; may repeat in 7-14 days†	Burning, pruritus, and erythema	IA[102]	First-line treatment in the US; not approved by the FDA for infants <2 months of age given the theoretical risk of neurotoxicity[154]; safe in pregnancy[155]
	Benzyl benzoate 10-25% lotion, not approved by the FDA	Inhibits respiratory spiracles causing asphyxiation	Apply for 24 hours, then rinse off; may repeat in 7-14 days†	Burning and eczematous eruptions	IB[156]	Safe in infancy[157] and pregnancy[155]; dilute to 12.5% for children and 6.25% for infants to minimize irritation; widely used globally; not available in North America but is a WHO essential medicine[104]
	Sulfur 2-10% ointment or cream, not approved by the FDA	Keratolytic, thought to have direct scabicidal activity	Apply for 24 hours, then rinse off, repeat for 3 consecutive days; may repeat in 7-14 days†	Malodor and burning	IB[158]	Safe in infancy[157] and pregnancy[155]; limited data on safety and efficacy
	Crotamiton 10% cream or lotion, approved by the FDA in 1949	Unknown	Apply for 24 hours, then rinse off, repeat for 2 consecutive days. Rinse off 48 hours after second application; may repeat in 7-14 days†	Pruritus and local irritation	IV[118,119]‡	Safe in infancy[157] and pregnancy[155]; least effective topical agent; resistance reported[115]
	Malathion 0.5% lotion or aqueous liquid, not approved by the FDA	Organophosphate that inhibits acetylcholinesterase, causing paralysis and death	Apply for 24 hours; may repeat in 7-14 days†	Burning and local irritation	IIA[159]	Limited data in pediatric scabies, but contraindicated in infants <2 years of age for lice treatment[160]; safe in pregnancy[155]; classified by IARC as probably carcinogenic to humans[161]

	Lindane 1% lotion, approved by the FDA in 1981	Central nervous system stimulant causing paralysis, seizures, and death	Apply for 8 hours, then rinse off	Seizures, aplastic anemia, eczematous eruptions	IB[162]	Contraindicated in infants,[157] pregnancy/breastfeeding,[155] patients with seizure history, crusted scabies, and skin conditions that increase absorption[163]; resistance reported[112-114]; banned in several countries given risk of neurotoxicity[106]; classified by IARC as carcinogenic to humans[164]
Oral	Ivermectin, not approved by the FDA	Inhibits chloride and gamma-aminobutyric acid channels, causing neuronal hyperpolarization and death	Two doses of 200 μg/kg each, 7-14 days apart	Pruritus and headache	IA[102]	Insufficient safety data to recommend use in infants <15 kg,[108] children <5 years of age,[108] and pregnancy[109,165]; suggested to be safe in breastfeeding of infants >7 days of age[166]; cytochrome P450 3A4 −mediated drug interactions[167]; resistance reported in crusted scabies[116]
Environmental measures	Washing linens/ clothing	Fomite removal	Wash clothes/linens in hot water, dry with high heat	None	IV[110,118,119]	Efficacy unknown
	Sealing linens/ clothing in plastic bag	Fomite removal	Seal linens/clothing in plastic bag for 72 hours	None	IV[110,118,119]	Efficacy unknown

FDA, US Food and Drug Administration; *IARC*, International Agency for Research on Cancer; *WHO*, World Health Organization.

*Level IA, evidence from metaanalysis of randomized controlled trials; level IB, evidence from ≥1 randomized controlled trial; level IIA, evidence from ≥1 controlled study without randomization; level IIB, evidence from ≥1 other type of experimental study; level III, evidence from nonexperimental descriptive studies, such as comparative studies, correlation studies, and case-control studies; level IV, evidence from expert committee reports or opinions or clinical experience of respected authorities, or both.

†Repeating treatment in 7 to 14 days likely improves efficacy, but the risks of unnecessary overtreatment should be considered.

‡Several studies have evaluated crotamiton compared with 5% permethrin[105,168,169] and 1% lindane,[169] but crotamiton demonstrated inferior efficacy.

Oral ivermectin is a safe and efficacious systemic option with the benefit of simple administration. Ivermectin is not ovicidal, and therefore a second dose is required to kill newly hatched mites. Ivermectin is approved for scabies treatment in several countries but is not approved by the FDA. Although available data suggest safety and efficacy, ivermectin is not recommended for use in pregnant women or young children (<5 years of age or <15 kg) because of inadequate data.[108,109]

Pruritus commonly persists for 1 to 4 weeks, even after effective treatment.[3] This postscabietic pruritus, representing ongoing inflammation, can be managed with emollients, oral antihistamines, and low-potency topical corticosteroids.[110] High-potency or oral corticosteroids should be avoided because of potential complications, including iatrogenic Cushing syndrome.[111] If symptoms persist despite treatment for scabies and postscabietic itch, the following should be considered: treatment-related factors (ie, incorrect treatment application, treatment nonadherence, or irritant or allergic contact dermatitis from topical medications), incorrect initial diagnosis, reinfestation, or delusions of parasitosis. In rare cases, resistance to topical lindane,[112-114] topical crotamiton,[115] and oral ivermectin (in crusted scabies)[116] can occur. With persistent pruritus and skin lesions in the absence of burrow, mite, egg, or feces identification, the diagnosis (Table I) must be reconsidered. Skin biopsy specimens obtained for histopathologic review and immunofluorescence studies can be helpful.

Crusted scabies requires repeated concomitant oral and topical treatments to decrease the high mite burden and penetrate thick scale.[110,117-119] The Centers for Disease Control and Prevention recommend oral ivermectin in 3, 5, or 7 standard doses, topical permethrin or benzyl benzoate every 2 to 3 days for 1 to 2 weeks, and a keratolytic.[120] Isolation of the affected individual is important to prevent spread. Hospitalization may be considered to achieve isolation and optimize appropriate treatment.

For all scabies subtypes, close contacts may be asymptomatic carriers before mite sensitization. Accordingly, guidelines recommend that all close contacts, even if asymptomatic, be treated simultaneously with the index patient.[110,118,119]

Novel systemic treatments

Given barriers to compliance with multidose regimens, new single-dose therapies are under investigation. Moxidectin is similar to ivermectin but has a longer half-life (20-35 days vs 18 hours), enabling potential efficacy as a single-dose drug killing mites as they hatch.[121,122] The FDA recently approved moxidectin for onchocerciasis treatment in individuals >12 years of age.[123] Another promising oral drug class is the isoxazolines, including afoxolaner and fluralaner, which demonstrated efficacy as single-dose regimens in animal models.[124,125] Notably, the FDA issued an alert regarding potential neurotoxicity with these agents.[126]

Novel topical agents

Tea tree oil, a known antimicrobial, has demonstrated scabicidal activity.[127] Other agents with demonstrated scabicidal activity include *Tinospora cordifolia*,[128] *Ligularia virgaurea*,[129] and eugenols.[130] With increasing concern for drug resistance, permethrin synergists that evade resistance mechanisms are also under investigation.[131,132] Efficacy and safety data for these agents are limited.

Environmental measures

Although environmental measures, including hot water/high heat linen laundering and sealing linens in a plastic bag for at least 72 hours, are recommended in many treatment guidelines, little data exist on their efficacy.[118,119] Fomite-mediated transmission does not play a major role in classic scabies. In fact, several mass drug administration (MDA) studies in low-resource settings achieved scabies control without concomitant environmental decontamination.[61,62,133] Therefore, in settings where linen washing above 50°C is feasible, it is reasonable to recommend doing so. However, in low-resource settings, these measures may be impractical.

PUBLIC HEALTH CONSIDERATIONS

Key points

- **In the United States, outbreaks are reportable events**
- **Outbreaks are common in institutional settings**
- **In high-prevalence settings, MDA decreases the prevalence of scabies and impetigo**
- **Global scabies control requires multidisciplinary collaborations involving dermatologists**

Reporting and surveillance

Scabies is not a national notifiable infectious disease as determined by the Centers for Disease Control and Prevention; however, outbreaks are reportable events. The Council for Outbreak Response: Healthcare-Associated Infections and Antimicrobial-Resistant Pathogens has published guidelines for scabies outbreak detection and reporting.[134]

Institutional outbreaks

Solitary scabies cases can quickly become outbreaks in institutional settings, including health care facilities, residential care facilities, prisons, dormitories, and shelters. Several risk factors predispose institutionalized individuals to scabies and subsequent outbreaks. In health care and residential care facilities, index patients are more likely to be immunosuppressed through iatrogenic means or because of immunosenescence.[13-137] Crusted scabies is also associated with institutional outbreaks and was reported in 83% of index cases in 1 study.[138] Another common feature of outbreaks is delayed diagnosis of the index patient because of clinician unfamiliarity with scabies, atypical presentations caused by inappropriate treatment (eg, topical corticosteroid use), or patients' inability to complain of, or desire to hide, their symptoms.[30,138-140]

Several strategies exist for controlling scabies outbreaks. Patient and staff information campaigns[141] and mass treatment of affected individuals and contacts with ivermectin,[142] 5% permethrin,[143] and 25% benzyl benzoate[144] have halted outbreaks. Public health authorities at local and state levels publish guidelines for outbreak management.[145]

Mass drug administration

MDA is a public health strategy whereby treatment is administered to an entire population in high disease-prevalent areas, regardless of disease status. Scabies-targeted MDA has demonstrated efficacy in reducing scabies prevalence, decreasing secondary bacterial infection, and preventing systemic complications.

MDA of lindane lotion,[146] benzyl benzoate lotion,[147] permethrin cream,[59,61,148] and oral ivermectin[60,61,147] have decreased scabies prevalence in endemic regions. In the only controlled study published, 2051 participants in Fiji were randomized at the island-level to receive standard care (individuals diagnosed with scabies and their contacts referred for permethrin treatment), permethrin MDA, or ivermectin 200 μg/kg MDA. In the MDA groups, those diagnosed with scabies at baseline received a second dose of either permethrin or ivermectin 7 to 14 days later. Of these 3 interventions, ivermectin MDA most effectively reduced scabies prevalence (by 94%, from 32.1% to 1.9%) at 12 months.[61] Similar results were demonstrated in 2 other trials of ivermectin-based MDA in the Solomon Islands.[62,149] Along with scabies, impetigo prevalence falls with ivermectin MDA[60,61] and permethrin MDA.[59] Similarly, long-term renal sequelae of streptococcal superinfection are suspected to decline with MDA given reduced hematuria prevalence in children in the Solomon Islands after ivermectin MDA.[60] While MDA shows promising results in high-prevalence island settings, efficacy may be lower in areas with lower prevalence.[150] Highly transmissible crusted scabies cases also limit MDA effectiveness.[151] Routine surveillance and case identification after MDA is needed to ensure sustained responses. MDA has been used for scabies control in institutional outbreaks and refugee and migrant centers/camps, but fewer data exist to guide recommendations.[30,142,144]

Scabies as a World Health Organization neglected tropical disease

To highlight the need for global scabies control, WHO added scabies to its list of neglected tropical diseases, a group of primarily communicable diseases in tropical/subtropical regions.[152] Achieving scabies control requires dedicated groups of health personnel worldwide. In 2012, a worldwide collaboration of clinicians, researchers, and public health practitioners formed the International Alliance for the Control of Scabies to improve scabies control and promote the wellbeing of those affected.[153] A multidisciplinary approach involving dermatologists is essential to achieving successful scabies control worldwide.

In conclusion, scabies remains a public health priority globally. Novel diagnostic techniques and therapeutics may improve scabies management. In the global scabies control effort, dermatologists play a key role in diagnosing and treating scabies and its highly morbid complications.

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