EDUCATIONAL COMMENTARY – SCABIES TESTING AND DIAGNOSIS

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LEARNING OBJECTIVES

On completion of this exercise, the participant should be able to

- discuss the epidemiologic features and clinical significance of infestation with *Sarcoptes scabiei*.
- describe the life cycle and physical appearance of *S scabiei*.
- explain why scabies can be difficult to diagnose.
- describe current and emerging diagnostic techniques.

Introduction

First identified by Aristotle, the “itch mite” *Sarcoptes scabiei var. hominis* has been estimated to infest as many as 300 million persons annually worldwide.\(^1\)\(^,\)\(^2\) The characteristic itchy skin lesions result from inflammatory and allergic reactions to mite products introduced when the mite burrows under the skin. Although the lesions can occur anywhere on the body, they most often occur on the wrists, elbows, ankles, and periumbilical skin; in the webbed spaces between the fingers; on the penis; and on the periareolar skin in female patients. Diagnosis of scabies can be difficult because the lesions can mimic almost any skin condition that produces an itchy rash. Also, scratching may destroy characteristic burrows, mites, and mite products.

Despite intense itching, most persons with ordinary scabies harbor approximately 10 to 12 mites.\(^2\) However, infestation with large numbers of mites can occur. This severe form of the disease is termed *crusted scabies* because it produces crusty skin lesions or *Norwegian scabies* because it was first described in Norway in patients with leprosy. Crusted scabies is characterized by large numbers of mites (which may exceed 1 million in severe cases), high immunoglobulin (Ig) E levels, peripheral eosinophilia, and hyperkeratotic skin lesions. Risk factors for the development of crusted scabies include leprosy, immunosuppressant drugs, and infection with human T-cell leukemia virus type 1 (HTLV-1) and human immunodeficiency virus (HIV). Although persons with HIV are at increased risk for crusted scabies, there is no evidence that the mites can transmit HIV.\(^1\) Crusted scabies also sometimes occurs in persons who appear otherwise healthy and in persons who have been successfully treated for leprosy, which suggests that an immune defect may play a role in the development of both crusted scabies and leprosy.\(^2\)
For most persons, scabies is mostly an uncomfortable nuisance. However, scabies is associated with secondary infections with group A streptococci or *Staphylococcus aureus*, which may be introduced when the skin is traumatized by scratching. Repeated infestation with *S. scabiei* and associated bacterial infections have been identified as cofactors in higher rates of heart and kidney disease in communities in Australia and India where scabies is endemic.²

Host-specific varieties of *S. scabiei* cause mange in companion animals, livestock, and wildlife. Mange in livestock can cause substantial economic losses, and it is a significant cause of mortality in foxes and coyotes.² Mites from animals may occasionally infect humans, but disease acquired from animals tends to be of shorter duration because the mites are not adapted to a human host.³

**Life Cycle, Description, and Transmission**

The life cycle of the scabies mite consists of five stages: egg, larva, protonymph, tritonymph, and adult.²⁴ The cycle begins when the fertilized female mite burrows through the skin and deposits two to three eggs per day throughout her life (1-2 months). Three or four days after being deposited, the eggs hatch and the larvae migrate to the surface of the skin, where they burrow into the stratum corneum and construct molting pouches. At this stage, the mite larvae have three pairs of legs. After another three or four days, the protonymphs emerge; at this stage the mite nymphs have four pairs of legs. The protonymphs molt into slightly larger tritonymphs, which finally molt into adult mites. The total time required for an egg to develop into an adult is approximately two weeks. Fewer than 10% of eggs develop into adult mites.²⁴

In mating, the adult male mite penetrates the molting pouch of the adult female. A single mating renders the female fertile for life. After mating, the female crawls around on the host’s skin until she finds a suitable place to burrow and lay eggs, and the life cycle begins anew.

Adult *S. scabiei* mites have a round translucent or creamy white body with brown legs. Females are approximately 0.3 to 0.5 mm long and 0.3 mm wide. Male mites can be distinguished from females by their smaller size (slightly more than half the size of a female mite) and darker color. Both sexes of adult mites have four pairs of legs. The two most anterior pairs of legs have sucker-like pads on the feet, termed *pulvilli*, that grip the host’s skin. Both sexes of mites also have claws on the remaining legs and six or seven pairs of spine-like projections on their backs.

Transmission of scabies occurs primarily through direct skin-to-skin contact with an infested person. Thus, it occurs most often among family members and in institutional settings such as day care centers and elder care facilities. Indirect transmission via clothing or bedding is uncommon, but it does occasionally occur. Also, because crusted scabies is characterized by large numbers of mites, this form of the disease is more infectious than ordinary scabies and has been implicated in outbreaks in hospitals.
Studies have shown that transmission of scabies is not influenced by hygiene; rather, it is associated with overcrowding and poverty.²

**Diagnosis**

In clinical practice, health care practitioners often presumptively diagnose scabies based on the presence of itchy papules and snakelike burrows and a history of contact with other persons with scabies. India ink, a felt-tip marker with washable ink, or topical tetracycline can be used to find burrows.²,⁵ The ink or topical tetracycline is first rubbed over the skin and then wiped off with alcohol. The ink penetrates the burrows, which appear as thin, snakelike lines. If tetracycline is used, the skin is examined with a Woods lamp. The tetracycline remaining in the burrows fluoresces in a greenish color, revealing the burrow.⁵

At present, definitive diagnosis of scabies is made by finding adult mites, ova, larvae, nymphs, or feces in skin scrapings. Samples should be taken from the ends of fresh burrows, because this is where mites are most likely to be found. Also, because patients with ordinary scabies typically harbor few mites, multiple burrows should be scraped to improve the probability of finding a mite.

Experts differ in their recommendations regarding the use of potassium hydroxide (KOH) to prepare the sample for microscopy. Some recommend the use of 10% to 20% KOH to clear the sample of debris.²,³ Other practitioners recommend against using KOH because this substance can dissolve the mite and its products, yielding a false-negative result.¹,⁵,⁶ Instead, mineral oil can be used to collect and prepare the sample. Because mites adhere to the oil, they are less likely to be lost when the sample is collected and transferred to a slide. In addition, the refractile difference between the oil and the mite is greater than that between KOH and the mite, and oil does not dissolve mite fecal material. Garcia⁶ describes a procedure in which mineral oil is applied to the scalpel blade before scraping the skin. After the oil and skin scraping are transferred to a slide, one or two extra drops of mineral oil are added and mixed with the specimen. A coverslip is placed on the slide, and the slide is examined under low power (magnification ×100). The high dry objective (magnification ×400) may be used to confirm the presence of a mite or its products.

A plastic box or Petri dish method may reveal mites that microscopy fails to detect.⁶ In this method, skin scrapings are placed in a plastic box or Petri dish, which is then left at room temperature for 12 to 24 hours. During this time, the mites will drop to the bottom of the container and can be viewed with a magnifying glass or dissecting microscope.⁶

A major disadvantage of relying on clinical signs and microscopy to diagnose scabies is that the sensitivity of these techniques is less than 50%.² Successful microscopy requires a high level of expertise. Also, most patients with scabies are infested with only a few mites, and these can be easily missed when the sample is taken. Finally, patients may destroy burrows and mites by scratching the
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lesions. Thus, although detection of mites can confirm a diagnosis of scabies, a negative microscopy result does not rule it out.

Owing to the inherent difficulties with conventional microscopy, better diagnostic methods are needed. Four methods being investigated are dermatoscopy, polymerase chain reaction (PCR) followed by enzyme-linked immunosorbent assay (ELISA) or DNA fingerprinting, intradermal skin test, and detection of IgG antibodies.\textsuperscript{1,2} Of these, dermatoscopy is most promising because it is noninvasive and allows detailed examination of the skin. However, no large-scale studies have yet been performed to confirm the usefulness of this method, and the high cost of the equipment is a substantial barrier to its use.\textsuperscript{2} A major limitation of PCR is that, like microscopy, it relies on the presence of a mite or mite products. Consequently, because most patients harbor few mites, PCR is insufficiently sensitive to be practical for widespread use.\textsuperscript{2} Polymerase chain reaction followed by ELISA has been suggested to improve sensitivity, but this is labor intensive and time consuming.\textsuperscript{2} Likewise, the intradermal skin test is not feasible because it is not yet possible to culture sufficient quantities of \textit{S scabiei} to produce whole-mite extract.\textsuperscript{2} Finally, detection of IgG antibodies is insufficiently sensitive because currently available assays use antigen preparations made from \textit{S scabiei} varieties specific for pigs and red foxes.\textsuperscript{2}

In recent years, databases of DNA sequences from \textit{S scabiei var. hominis} and \textit{S scabiei var. vulpes} have been constructed. Researchers are optimistic that this information will ultimately lead to the development of an immunodiagnostic assay for scabies that is more sensitive and efficient than methods currently available.\textsuperscript{2}

Conclusion

Because intense itching and papules occur in many conditions, clinicians may not immediately suspect scabies. If scabies is suspected, conventional microscopy may fail to detect the mite, leaving the diagnosis in doubt. Although researchers are working to develop more sensitive tests to detect scabies, none of the emerging methods has proven superior to microscopy. Microbiologists can help clinicians make the correct diagnosis by remaining alert to the possibility of scabies in high-risk patients. For example, Garcia\textsuperscript{7} describes a case in which skin samples from a resident of a long-term care facility were submitted for fungal culture. Clinical microbiologists noted snakelike tracks on the surface of the Sabouraud dextrose agar, and this led to a diagnosis of crusted scabies.
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References


