Detection of scabies: A systematic review of diagnostic methods

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BACKGROUND: Accurate diagnosis of scabies infection is important for patient treatment and for public health control of scabies epidemics.

OBJECTIVE: To systematically review the accuracy of diagnostic methods.

METHODS: Using a structured search strategy, Medline and Embase databases were searched for English and French language articles that included a diagnosis of scabies. Studies comparing history, physical examination and/or any diagnostic tests with the reference standard of microscopic visualization of mites, eggs or fecal elements obtained from skin scrapings or biopsies were included for analysis. Data were extracted using standard criteria.

RESULTS: History and examination of pruritic dermatoses failed to accurately diagnose scabies infection. Dermatocopy by a trained practitioner has a positive likelihood ratio of 6.5 (95% CI 4.1 to 10.3) and a negative likelihood ratio of 0.1 (95% CI 0.06 to 0.2) for diagnosing scabies. The accuracy of other diagnostic tests could not be calculated from the data in the literature.

CONCLUSIONS: In the face of such diagnostic inaccuracy, clinical judgment is still practical in diagnosing scabies. Tests are used – the burrow ink test and handheld dermatocopy. The burrow ink test is a simple, rapid, non-invasive test that can be used to screen a large number of patients. Handheld dermatocopy is an accurate test, but requires special equipment and trained practitioners. Given the morbidity and costs of scabies infection, and that studies to date lack adequate internal and external validity, research to identify or develop accurate diagnostic tests for scabies infection is needed and justifiable.

Key Words: Diagnosis; Scabies; Systematic review

Scabies, caused by the mite Sarcoptes scabiei var. hominis, is one of the many causes of pruritic dermatoses. The discovery of S scabiei in 1687 showed for the first time that disease could be caused by a microorganism (1). Today, as many as 300 million people are infected with scabies annually (2). Children in resource-poor countries are disproportionately affected, and there is evidence that scabies has been a major risk factor for developing poststreptococcal glomerulonephritis (2-4). Globally, the prevalence of scabies is low, and its disease burden a major risk factor for developing poststreptococcal glomerulonephritis (5). The elderly are also at higher risk, particularly when living in long-term care facilities, where outbreaks can lead to substantial costs and morbidity (6). Secondary skin and soft tissue infections, and institutional outbreaks, add to the costs and suffering (5,6,7). Rapid diagnosis and immediate treatment of those affected are keys to effective eradication.

The probability of scabies transmission has been estimated to be between five and 15, but this can approach millions in cases of chronic infection (ie, crusted [Norwegian] scabies) (5,8). The pruritic response and secondary skin manifestations, which begin three to six weeks after initial infection, are mediated by inflammatory and allergy-like reactions to mite products (4). The burrow is a wavy line that is detectable most frequently in the finger webs, on the flexor surfaces of the wrists, on the elbows, in the axillae, on the buttocks and genitalia (5). Papules, nodules and vesicles are also described as secondary lesions that include excoriations, eczematous eruptions, crusting and infections (9).

Although history and examination of the morphology and the distribution of skin lesions can be clues, definitive diagnosis of scabies infection relies on identification of mites, eggs or feces in skin scrapings or biopsies. Diagnosis based on symptoms and an empirical trial of scabies treatment is problematic because it can lead to diagnostic error and frustration, as well as uncertainty when patients do not improve.

Skin scrapings are central to diagnosis and involve the application of one or two drops of mineral oil to a suspected lesion, which is then scraped or shaved with a scalpel or a microscope slide. The specimens are examined directly under a low-power light microscope (8). A small number of mites on an infected individual can often negate or delay a
diagnosis. A simple and often overlooked bedside test is the ‘burrow ink test’ (BIT), in which fountain pen ink is gently rubbed on a suspicious site. Excess ink is wiped off with an alcohol swab, making the burrow visible as a wavy ink-filled line in the stratum corneum where the mite has tunnelled. We use the BIT in our outpatient infectious diseases clinic to successfully diagnose infections (Figure 1). A published case series (10) reported that the best place to find a lesion was on the medial aspect of the hypothenar area of the hands and wrists.

Recently, in vivo mite identification by ‘epiluminescence microscopy’, using a dermatoscope, has been studied. This technique relies on identifying a triangular structure, which corresponds to the anterior section of the mite including the mouth part and the two pairs of front legs (11). Indirect diagnostic methods, such as serology have, to date, been unsuccessful in human infections (12). Complementary DNA libraries have been constructed for *S. scabiei* var. *hominis*, but commercial molecular diagnostic tests have not yet been developed (13,14).

Given its rapid spread in localized epidemics, effective scabies control necessitates rapid diagnosis and treatment. Consequently, we systematically reviewed history, physical examination and diagnostic tests for scabies infection to determine their precision and accuracy. The present study is, to our knowledge, the first systematic review of the diagnosis of scabies infection.

**METHODS**

**Search strategy**

One of the authors (VL) conducted a Medline search (1965 to 2009) on March 24, 2010, using PubMed. The Embase database was searched using OVID (1941 to 2009) for additional articles. These searches used the medical subject headings (MeSH) "scabies" and "diagnosis", and limited the results to human subjects, and English and French language articles. The reference lists of pertinent articles were reviewed to identify additional studies. A focused search was conducted using the same MeSH terms combined with other MeSH terms such as "medical history", "physical examination", "sensitivity", "specificity", "observer variation", "mass screening" and/or "self examination", and limited the results to human studies, and English and French language articles. A total of 340 abstracts were screened by one of the authors. The number of abstracts screened was less than the number of citations retrieved because some citations did not have abstracts. In these cases, attempts were made to retrieve the full-text article, but this was not possible in all cases.

**Selection criteria**

Abstracts were reviewed to identify those with primary data comparing scabies with a symptom, sign, bedside test or laboratory test. Articles meeting these criteria underwent full-quality assessment using an established methodological filter described in the literature (15). In summary, level 1 studies are independent, blinded comparisons with a reference standard among a large number (sufficient to have narrow confidence limits in the resulting sensitivity, specificity or likelihood ratio [LR]) of consecutive patients suspected of having the target condition. Level 2 studies are independent, blinded comparisons with a reference standard among a small number of consecutive patients suspected of having the target condition. Level 3 studies are independent, blinded comparisons with a criterion standard among nonconsecutive patients suspected of having the target condition. Level 4 studies are nonindependent comparisons with a criterion standard among convenience samples of patients who are considered to have the target condition plus, perhaps, healthy individuals. Level 5 studies are nonindependent comparisons with a criterion standard of uncertain validity among convenience samples of patients and, perhaps, healthy patients. Using this classification scheme, only articles that met or exceeded level 4 criteria were analyzed. The accepted criterion standard was microscopic evidence of scabies in skin scrapings or biopsies.

**Extraction of data**

One investigator reviewed all studies and extracted the data regarding test characteristics and study quality. If uncertainty arose, the second investigator independently extracted the data. However, this was not necessary for the review.

**Statistical methods**

Sensitivities and specificities for the various findings were calculated whenever possible. LRs were calculated when authors reported findings of patients suspected of being infected with scabies, with both positive and negative skin scrapings. 95% CIs were calculated according to the efficient score method (corrected for continuity) (16).

**RESULTS**

Fourteen full-text articles were retrieved (10 were original diagnostic research articles, but only one of these was a controlled trial: one was a review article, two were case series and one was a case report). None of the studies provided sufficient information to estimate inter- and intra-observer variability. Therefore, the results only focused on test accuracy.

**Accuracy of the history and physical examination for the diagnosis of scabies infection**

None of the studies reviewed evaluated the accuracy of history and physical examination for the diagnosis of scabies. Only one review article stated that a history of diffuse itching and visible lesions associated with at least two typical locations of scabies, or a household member with itching, has 100% sensitivity and 97% specificity (5). The primary source for the review lacked an acceptable reference standard, namely an undefined clinical diagnosis by a dermatologist (17). However, it is only fair to point out that the study was designed to improve treatment of a very large number of individuals in West Africa under conditions in which access to a microscope was limited or absent. In the setting of high prevalence, one could argue that a clinical diagnosis by an experienced clinician can be an appropriate reference standard. However, because the study did not meet the a priori inclusion criteria, it was excluded from the present analysis.

**Accuracy of specimen collection methods for the microscopic diagnosis of scabies infection**

The current literature supports the use of a blade (or the edge of a microscope slide) to scrape laterally across the skin (8). The specimen is then placed on a glass slide for examination. Two less-invasive techniques have been introduced and both attempt to remove the skin with glue. However, these studies did not meet criteria for inclusion in the present analysis. One technique involved applying cyanoacrylate glue to a glass slide and then pressing the slide onto the skin for 30 s followed by detachment (18). The other technique used Scotch tape (3M, USA) that is directly applied to a glass slide (19). The accuracy of these methods could not be calculated based on the information provided in the case series and report.

**Accuracy of dermatoscopic techniques for the diagnosis of scabies infection**

The studies comparing dermatoscopy with traditional microscopy are summarized in Table 1. Only one study met level 3 criteria (20).
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Although all level 4 studies applied the reference standard to all individuals, the evaluators were not blinded to the results (21-23). Data provided in these studies did not permit calculation of LRs. Two case reports examined the role of dermatoscopy, but none met the inclusion criteria for the present systematic review (11,23,24). The typical ‘jet with condensation trails’ pattern has been reported to be 93% to 100% sensitive and 100% specific in an article (11) that referred to studies by Brunetti et al (21) and Argenziano et al (22). However, in both studies, specificity could not be defined because they were non-independent comparisons, with all patients diagnosed with scabies. Although the prospective, nonrandomized trial using a hand-held dermatoscope showed a sensitivity and specificity of 91% and 85%, respectively, the specificity dropped to 80% when performed by inexperienced dermatoscopists (20). On a more pragmatic basis, Dapuy et al (20) found that if treatment was based on clinical diagnosis alone, 27% of their study population would have been left untreated and been potential disseminators, while 38% of patients would have been unnecessarily treated. This would have decreased to 10% and 12%, respectively, if treatment decisions were based on dermatoscopy (20). These results only apply to a population in which disease prevalence is 52%. Finally, one study (25) using high magnification (600×) videodermatoscopy boasted rapid and clear identification of mites, burrows and/or eggs in 62 of 100 patients examined. The authors did not perform the reference standard on any of the patients, claiming that it was not unnecessary because the structure of the mite could be well characterized in vivo. Of the 38 patients with negative findings, none had any clinical features of scabies after two weeks of follow up (25).

Accuracy of BIT for the diagnosis of scabies infection

One study used polymerase chain reaction followed by ELISA to detect S scabiei DNA from one patient (26). The methods used in this study did not meet the authors predefined quality assessment filter and, thus, the accuracy of this technique could not be calculated. Severe technical limitations have impeded the development of molecular studies on S scabiei.

DISCUSSION

The present review shows that the diagnosis of scabies infection is often imprecise or speculative. First, a high index of suspicion is needed to diagnose scabies infections because of the diversity of symptoms and presentations. Second, even with a high pretest likelihood, microscopic examination of skin scrapings will often fail to provide a definitive diagnosis because of a low number of mites present in classic scabies infection or due to sampling error. Third, presumptive therapy has been used as a diagnostic test, but this strategy is confounded by ineffective treatment due to scabies drug resistance; the need for repeated treatment due to drug resistance, nonadherence or inadequate environmental control; and variable delay until symptoms are resolved. Moreover, treatment cannot distinguish when a positive response is due to an erroneous diagnosis with spontaneous symptom resolution, or when a negative response is due to treatment resistance or improper treatment application.

The literature on the diagnosis of scabies has significant limitations affecting both internal and external validity. None of the reviewed studies met the criteria for high-quality (level 1 or level 2) evidence, based on established methodology filters. The best-available study and the only one that met level 3 criteria was based on a selected population with a scabies prevalence of 52% (20). Lack of independence between the reference standard and the diagnostic test being assessed, leading to verification bias, is a systemic problem in the literature.

Another methodological issue relates to the nature of the reference standard itself. Skin scraping or biopsy was not obtained for all patients suspected of having scabies in the reviewed studies. Furthermore, using the current reference standard (scraping or biopsy), there are problems associated with excluding cases with negative skin scraping results because this technique is far from being 100% accurate. Dermatoscopy was originally used for the assessment of pigmented skin lesions. Its use for in vivo detection of S scabiei was suggested by Kreusch (27) in 1992. Proponents of dermatoscopy suggest it permits rapid, noninvasive

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examination of many suspicious sites without causing pain or discomfort to patients. The practical limitations of dermatoscopy include training to recognize the typical ‘jet with condensation trail’ pattern (11). Use of a hand-held dermatoscope requires close contact which may include family members and sexual partners. Health care workers with a history of caring for patients with scabies should be considered at risk. Although the BIT has not been studied extensively, we believe that its minimal cost and adverse events, in addition to its rapid turnaround time, makes it a useful, but unproven diagnostic test. With experience, when the BIT is positive, treatment for scabies can be started without having to perform skin scrapings. For practitioners unfamiliar with the BIT, we recommend follow-up of BIT-positive lesions by skin scrapings or punch biopsies, until the practitioner is sufficiently skilled in recognizing a positive BIT. The present study confirms the lack of accurate and easily applicable methods for diagnosing scabies or for assessing the efficacy of treatment to eliminate mites. Nonetheless, when faced with uncertainty, one should still attempt to make a diagnosis. Hence, we include a practical algorithm to help diagnose scabies infection (Figure 2). This algorithm includes history, clinical examination and use of skin scrapings, BIT or dermatoscopy. It is important to remember, however, that a negative result from any of these tests does not necessarily exclude a diagnosis of scabies infection. In that situation, clinical experience and judgment come into play and this may even include, in some cases, a treatment trial.

CONFLICTS OF INTEREST: The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS: Victor Leung and Mark Miller conceived the idea for the study. Victor Leung reviewed all articles and drafted the manuscript. Victor Leung and Mark Miller critically revised the manuscript for important intellectual content, and both authors approved the final manuscript for submission.