

Biology and epidemiology of scabies

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Only recently have attempts been made to develop techniques for the early identification of scabies infections and to identify the genome of the mites. Most work with scabies employs rudimentary technology and requires skill for accurate diagnosis. Many countries still have no widely available dermatology service to deal with this infection and its sequelae.

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Abbreviation

SPT skin prick test

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Introduction

Clinical scabies has long been recognized as the immune response to cutaneous infestation by the parasitic mite *Sarcoptes scabiei*. Clinical signs do not usually appear in naïve individuals until some weeks have elapsed after the initial infective contact. Consequently, the aetiology of each case may be difficult to identify, and the variable presentation of the clinical forms often hinders diagnosis. Much of Europe has recently experienced one of the periodic upsurges in the prevalence of the disease. Why such events occur is still a matter of conjecture but so far such observations have been limited to countries where the level of endemicity is low.

Biological considerations

S. scabiei occupies a special niche in the history of public health, in being the first organism to be specifically identified as the causative agent of a clinical condition. Scabies was recognized in ancient times, and the mite itself had been referred to in clinical texts as early as the twelfth century, but it was in 1687 that the first publication linking the animal with the disease was released. The story of the discovery of this link, the description of the mite and its behaviour, and the principles of treatment, first published in the now famous letter from Giovan Cosimo Bonomo to his mentor Francesco Redi, is retold in a dermatological reminiscence by Marcia Ramos-e-Silva [1**]. In spite of such compelling evidence, and despite a translation of the text into English 16 years later, the discovery was largely discounted and forgotten for nearly 200 years. What is remarkable about Bonomo's discovery is not that he made it at such an early date, but that most of what he wrote is still relevant today and it is significant that it is still often forgotten in the basic clinical management of scabies. Consequently, it is not surprising that general articles stating basic facts of biology and control are still needed by clinicians, even in countries where scabies is endemic [2,3*,4*]. Unfortunately, some of the observations made by Bonomo have been forgotten so patients are often not given the best advice.

One of the most important observations made by Bonomo was that juvenile stages of the mites wander around on the skin surface some of the time, and could transfer from there to another host to establish a new infection. Whether they are able to transfer in this way has been a bone of contention for some time. In 1919, Munro [5] claimed to have succeeded in starting new infections by physically transferring larvae and nymphs,

whereas 20 years later Mellanby [6] failed in a similar attempt and thus concluded that only recently fertilized females could achieve this, in contradiction of some of his other observations made at the time.

Recent work aimed at identifying genetic markers for scabies mites by the extraction of genomic DNA may be able to throw some light on this question [7*]. First, highly repetitive guanine and adenosine nucleotide (GA)_n sequences were identified, and after designing primers from the unique sequences flanking microsatellite loci, the repeat blocks were amplified using polymerase chain reaction autoradiography. After sequencing on polyacrylamide gels it was possible to identify extracts from individual mites by a high level of allelic variability at three loci. In practice it was possible to indicate that the mites from one patient showed a diverse genetic background and thus the infestation had arisen from multiple infective events, which could be interpreted as numerous juvenile stages moving onto the host from one or more sources. In contrast the mites from another patient showed close genetic affinity, which could either be interpreted as infection by a single matriarchal mite that engendered all the specimens infesting that person, or alternatively it is equally possible that the person was multiply infested by mites from a single contact but on whom the mites all held the same lineage. Further work on this DNA fingerprinting system may be highly informative in epidemiological and taxonomic studies.

Making an accurate diagnosis is of paramount importance clinically and in epidemiology. Finding mites in burrows is difficult, although the identification of mites is reported to be easier using epiluminescent microscopy [8*,9*], and in many cases is dependent upon the clinical skills of physicians in correctly identifying the infection from symptomatology and case histories. The task would be greatly facilitated by a good immunological test. Morgan and colleagues [10**] at Wright University, Dayton, OH, USA, have been working on a procedure using skin prick tests (SPTs) and radioallergosorbent tests. The development of a simple test has not been easy because scabies mites share several immunogens with the closely related house dust mites of the genus *Dermatophagoides*.

Morgan *et al.* [10**] compared SPT and serology of nine people who had been successfully treated for scabies within the previous year with those of 16 scabies patients. Curiously, only 13 of those with active scabies showed a positive SPT, all but one of whom also showed a positive reaction, by skin prick or serology, to house dust mites. Six of the patients were found to have circulating IgE directed at both *S. scabiei* and *Dermatophagoides*, one had scabies-specific IgE and one was specific for house dust mites. Only two of those cured of

the infection showed IgE to these antigens. The authors found that several of the antibodies directed against scabies also bound to house dust mite antigens but, when these were absorbed out, some *S. scabiei*-specific antibodies could be detected. Identification of the specific antigens involved will assist in developing a practical diagnostic test.

Epidemiological considerations

Evaluating the epidemiology of scabies has never been easy. At various times in European countries such as Denmark, the former Czechoslovakia and the UK, it has been a notifiable condition, and this has greatly facilitated our understanding of its transmission [11–13]. Such studies showed that the majority of infections are brought into the household by children from elementary school age to the late teens, and that elderly people in the community are least likely to contract the infection. In care facilities for the elderly, however, there has been an increased incidence of scabies during the past 20 years. An analysis of reported outbreaks [14*] found that poor diagnosis was a major factor in prolonging such outbreaks, coupled with poor epidemiological and post-treatment monitoring. These in turn tended to lead to a more extensive spread of infection in the close community of the institution and a greater risk of hyperkeratotic cases developing.

Although the relationship between age and scabies was not stated in such specific terms, it was recognized in the 1940s by Mellanby [6], who somewhat played down the role of sexual transmission of the infection. For members of the Israeli Defence Force, however, this is no doubt a major source of infection. In the Israeli Defence Force scabies is a notifiable condition and survey data from 1968 to 1996 showed a low level of incidence for the first 13 years followed by 2.3-fold annual increase between 1981 and 1985, with a subsequent slow decline through to the end of the survey period [15*]. Another recent epidemiological aberration has been caused by the increase in 'sex tourism', which has resulted in exposure of the participants to populations in which scabies is endemic, with the resultant infection of families when the 'tourists' return to their home country [16*].

The majority of scabies cases still affect developing countries. In Africa there have been several initiatives in recent years to 'bring dermatology to the people' as part of the recognition that in most countries dermatology services are poor and skin conditions result in a considerable morbidity and a drain on income for many poorer families. Results of surveys vary considerably depending upon whether the case gathering is active or passive. Self-reporting is generally considered to disclose a higher proportion of diseases such as scabies, because

the itch causes so much distress and locally obtained treatments, whether from local healers or modern clinics, are not successful in curing the infection.

A high proportion of the population of two localities, examined in a community survey in Ethiopia [17*], was reported to have scabies, especially children under 1 year of age, but no actual figures were provided for this infection. This somewhat unusual age distribution was attributed to mothers cuddling their infants closely during cold nights in the highlands. In the communities generally, 59% of those infected with scabies slept with others on the floors of their houses. Pyoderma was common, and 33% was caused by secondarily infected scabies.

A similar study conducted in rural Tanzania [18*], to identify dermatological needs in the community, also identified scabies as a major problem (no figures given again), but in this population the highest prevalence was in children between 6 and 17 years of age. A similar study in Kenya [19*], which had progressed to the stage of using community health workers for the treatment of basic dermatological conditions, found that although scabies affected approximately 8% of school children examined (478 cases), compliance with treatment was poor and some 46% did not even bother to collect free medication. Consequently, 2 years after the initiation of the programme, the prevalence of scabies had actually increased to approximately 10%, whereas all other major skin problems had decreased.

In specialist dermatology centres in developing countries, scabies is second only to pyoderma as a reason for seeking a consultation [20*]. In Bamako, Mali, 16.6% of 10 575 new outpatients seen in 1993 had scabies; mostly children under 15 years of age. This sample can be placed in context because a survey of schools selected from different socioeconomic areas in the same city [21*] found that the prevalence of scabies varied from 1.8% in the most affluent area to 5% in the poorest. In that survey, crowding and sharing beds was correctly identified as a factor influencing the risk of infection, but the availability of water was misidentified as being important, as has been the case in many other studies, simply because the rate of infection in individuals with private water supplies was approximately a third of that for families using public taps. Palicka [12] found that water and personal hygiene made no difference to infestation rates, but regular bathing did delay the onset of symptoms, presumably because many of the development stages, which would otherwise have survived, were washed from the skin in the process.

In contrast with Mali, the prevalence of scabies observed during a leprosy survey in Malawi [21*],

conducted in over 60 000 people during the late 1980s, was only 0.7%, with the highest rates in the under 20s. Figures obtained in Cambodia during a similar survey in 1994 [21*] showed an overall prevalence of 4.3%. Children from rural areas were most likely to be infected (6.5%), whereas in their peers from the town the rate was only 0.7%. Puzzling features of this community were that, unlike other places, women were almost twice as likely to be infected and the elderly were more likely to be infected than any other group, except those under 20 years of age. These differences were attributed to occupational behavioural differences, with men travelling away from the home for long periods on fishing trips.

In all the studies, pyoderma caused by chronic scabies is seen as a major health factor because of the risk of nephritogenic bacterial strains. A survey of 150 patients in Ghana [22*] found 105 bacterial strains from scabies lesions; of which 66 were aerobes and 39 were anaerobes. Most bacterial types were found in the majority of the body sites examined, although *Clostridium* and *Bacteroides* organisms commonly found in the gut were predominantly seen on the buttocks, and presumably invaded as a result of faecal contamination of the skin. Only *Pseudomonas* spp. showed a high antibiotic tolerance, and virtually all streptococci and staphylococci were susceptible to erythromycin or amoxycillin/clavulanic acid.

Comparison of infection rates in communities in different countries is not easy. One survey conducted at the Institute of Dermatology of the University of Rome [23*] found that the comparison of 'immigrants', including students, with matched native Italians showed 8% of the foreigners to have scabies compared with 2% of the Italians. However, when a comparison was made of the proportion of the two groups who were employed, the rates for scabies infection were the same [23*].

Conclusion

Scabies remains a widespread infection causing morbidity throughout the developing world, and showing periodic upsurges in countries where the healthcare system is able to provide adequate treatment facilities. A simple understanding of the fundamental biological processes involved in the infection counts more than the actual treatment procedures in the control of the parasite. Nevertheless, studies in less developed countries indicate that control is not successful as a result of ineffective treatments and the relative cost to the family. In developed countries improved diagnostic procedures, which do not rely on the skill of the clinician to identify obscure symptoms, will assist significantly in limiting outbreaks.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

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A basic description of the biological, clinical and control aspects of scabies that repeats older articles that are somewhat out of date.
- 4 Olanode OA, Onayemi O. Scabies: revisit in a depressed economy. *Central Afr J Med* 1998; 44:18-21.
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A first study endeavouring to identify clonal DNA sequences that may be used for the identification of scabies mites in field studies.
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A literature survey indicating that inadequate monitoring is a principal component in the failure of authorities to prevent and manage institutional outbreaks of scabies.
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A summary of data showing a 15 year 'peak' of infestation after a period of low incidence.
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