Rapid review

Ectoparasites—the underestimated realm

Jörg Heukelbach, Hermann Feldmeier

Context Ectoparasitoses (infestations with parasites that live on or in the skin) can cause considerable morbidity. Whereas pediculosis and scabies are ubiquitous, cutaneous larva migrans and tungiasis (sand-flea disease) occur mainly in hot climates. The prevalence of ectoparasitoses in the general population is usually low, but can be high in vulnerable groups. Scientific knowledge on how to deal best with parasitic skin diseases in different settings is scanty, and evidence-based measures for control are not available. For head lice and scabies the situation is daunting, because resistance of *Pediculus humanus capitis* and *Sarcoptes scabiei* to insecticides is spreading and unpredictable.

Starting point J Hunter and S Barker reported different patterns of resistance in schoolchildren in Brisbane, Australia: full resistance to malathion, permethrin, and pyrethrum in two schools, whereas head lice were susceptible to malathion and, to a lesser extent, to pyrethrums in three other schools (*Parasitol Res* 2003; **90:** 476–78). K Yoon and colleagues found different resistance patterns in the USA and Ecuador (*Arch Dermatol* 2003; **139:** 994–1000). Head lice from Florida were less susceptible to permethrin than those from Texas, and parasites from Ecuador were susceptible to both insecticides tested.

Where next? The occurrence of resistant pediculosis and scabies is expected to increase numerically and geographically. Clinicoepidemiological studies are urgently needed to identify the factors which govern the emergence and spread of strains of *P humanus capitis* and *S scabiei* that are resistant to insecticide or acaricide. Oral treatment with ivermectin could substitute for topically applied compounds, particularly in resource-poor communities where polyparasitism is common. A better understanding of local epidemiology is required to develop control measures. This knowledge has to be applied in combination with environmental sanitation, health education, and culturally acceptable interventions that are affordable by the underprivileged.

Ectoparasitoses (infestations with parasites that live on or in the skin) are usually considered as vexing disorders and do not attract much clinical attention. But depending on the socioeconomic setting, these infections can carry substantial morbidity and affect much of a population. Ectoparasitic infestations can be sporadic, endemic, or epidemic. The prevalence of ectoparasitoses in the general population is low, but can become high in vulnerable groups. For example, tungiasis usually affects usually less than 1% of the population in an endemic area, but in economically disadvantaged communities prevalence in children can reach 76%.[1] In some indigenous populations in the Amazon rain forest nearly all individuals have head lice.

The occurrence of parasitic skin diseases is influenced by meteorological variables. In the semi-arid climate of Northeast Brazil, for instance, the incidence of the four major ectoparasitoses varies by season. In temperate climates, the incidence of scabies increases in the winter.[2]

In developing countries, particularly in poor people, polyparasitism is frequent. Even when common, parasitic skin diseases are easily overlooked. In a primary health-care centre serving a poor neighbourhood with an overall prevalence of ectoparasitoses of 63%, the physicians did not recognise scabies in 52%, tungiasis in 94%, and pediculosis in 100% of those infested by the corresponding ectoparasite.[3] Carriers of ectoparasites are likely to be stigmatised, depending on the sociocultural setting.

Although ectoparasites elicit various types of immune responses, there is no evidence for protective immune mechanisms in the human host.

Pediculosis

Of the three lice species affecting humans, the head louse (*Pediculus humanus capitis*) is the most important. Pediculosis of the head infests millions of school-age children in industrialised countries. For instance, in the UK, 58% of 7–8-year-old schoolchildren were found infested.[4] In developing countries attack rates are higher, with prevalences over 50% in the general population.

Transmission occurs person to person between infested individuals and indirectly through hats, clothes, or pillowcases. Persistent infection is often associated with secondary infection of the scalp and is an important cause of impetigo in developing countries.[5] Because of pruritus and subsequent sleep disturbances and difficulties in concentration, infested children may perform poorly in school.

Pediculicides remain the mainstay of head-lice management (table). Physical removal by wet combing or bug-busting is suboptimal. Topical application of an insecticide with adjunctive combing does not improve cure rates.[6]

Body lice (*Pediculus humanus corporis*), which attach to clothes, occur when clothes are not washed or changed regularly, and usually affect homeless people, displaced persons, or prisoners in poor conditions. This louse is feared as a vector for epidemic typhus, relapsing fever, and trench fever. *Pthirus pubis* infests pubic hair and occasionally other hairy areas, such as eye lashes. Pubic lice are usually transmitted during sexual intercourse. Treatment must therefore include the patient's partner. Rash and pruritus are the most frequent symptoms.

Scabies

Scabies, caused by the mite *Sarcoptes scabiei var hominis*, is transmitted by person-to-person contact. Infestation from contaminated fomites (eg, clothes, towels) can occur. In

Lancet 2004; **363:** 889–91

Mandacaru Foundation and Department of Community Medicine, Federal University of Ceará State, Fortaleza, Brazil (J Heukelbach MD)**; and Institute for International Health, Charité-University Medicine Berlin, Campus Benjamin Franklin, 12203 Berlin, Germany** (Prof H Feldmeier MD)

Correspondence to: Prof Hermann Feldmeier (e-mail: Feldmeier.fuberlin@t-online.de)

Ectoparasitosis	Agent	Geographical distribution	Vulnerable groups	Diagnosis	Standard treatment	Complications*
Pediculosis	*Pediculus humanus capitis* *Pediculus humanus corporis* *Pthirus pubis*	Ubiquitous	Schoolchildren, homeless persons, refugees, inhabitants of poor neighbourhoods	Clinical inspection (nits, nymphs, adult parasites) Combing with lice comb (nymphs, adult parasites)	Topical pediculicides (pyrethroids, lindane, malathion, etc)	Secondary infection (impetigo)
Scabies	*Sarcoptes scabiei var hominis*	Ubiquitous	Infants, homeless persons, refugees, inhabitants of poor neighbourhoods	Clinical inspection (burrows, erythematous papular, vesicular, pustular, and/or bullous lesions) Microscopical examination of skin scrapings Burrow ink-test	Topical scabicides (pyrethroids, lindane, malathion, crotamiton, benzyl benzoate) Oral ivermectin (200 μg/kg, repeat after 7–12 days)	Secondary infection (impetigo, cellulitis, lymphangitis, acute glomerulonephritis)
Cutaneous larva migrans	*Ancylostoma braziliensis*, *A caninum*, and other animal hookworm species	Tropical and subtropical countries; sporadically in temperate climates	Small children, inhabitants of poor neighbourhoods and small villages, travellers to tropical beaches	Clinical inspection (elevated linear or serpiginous lesion)	Topical thiabendazole (5–15%) Oral albendazole (400 mg a day for 3 days) Oral ivermectin (200 μg/kg single dose)	Secondary infection Loeffler's syndrome (rare)
Tungiasis	*Tunga penetrans*	Latin America, Caribbean, sub-Saharan Africa, single cases in India	Inhabitants of poor neighbourhoods and small villages, rarely travellers to and expatriates in endemic areas	Clinical inspection (embedded female flea)	Removal of embedded flea with sterile needle and antibiotic dressing	Secondary infection, ulcer, chronic lymphoedema, nail deformation or loss, tetanus

*All are associated with sleep disturbance due to severe itching.

Epidemiological and clinical characteristics of the four major ectoparasitoses

developing countries the ectoparasitosis is endemic in impoverished communities. In children in a Brazilian slum where polyectoparasitism was common, scabies occurred in 9% of the population and in 19% of those attending a primary health-care centre.[3] In industrialised countries, outbreaks occur in hospitals, old people's homes, and other institutions. Pruritus almost always occurs and scratching leads to secondary infection. Acute glomerulonephritis caused by nephritogenic strains of streptococci has been described.[2]

Currently available topical drugs are messy and need prolonged application over the whole body, which leads to poor adherence. In crusted scabies, sole treatment with a topical scabicide is usually not sufficient.

Cutaneous larva migrans

Cutaneous larva migrans is caused by penetration of animal hookworm larvae, such as *Ancylostoma caninum* and *A braziliensis*, into the skin of humans beings. The disease is endemic in many deprived communities in tropical and subtropical regions; sporadic cases also occur in temperate zones. This ectoparasitosis has been reported as the most common skin disease in returned travellers.[7]

Human infestation occurs after skin contact with soil or by objects such as towels or clothes contaminated with faeces from infected animals.[8] Larvae can migrate in the epidermis for several months. Severe itching ensues, making the condition uncomfortable and often disturbing sleep. Secondary superinfection is common. Sometimes larvae migrate to the viscera and cause Loeffler's syndrome.

Tungiasis

Tungiasis is caused by the female sand-flea, *Tunga penetrans*. In the tropics this ectoparasite is widely distributed, although human infestation occurs mainly in poor neighbourhoods in urban agglomerations, and villages at the beach or in the rural hinterland. Tungiasis is a zoonosis and affects a broad spectrum of domestic animals (dogs, cats, pigs) and peri-domestic rodents,[9] and is a typical disease of extreme poverty. Travellers are rarely affected.[7] In endemic areas, tungiasis is often associated with debilitating morbidity.[10] If embedded sand-fleas are not taken out soon after penetration, superinfection is the rule, eventually leading to suppuration or ulceration; in non-vaccinated individuals, tetanus can follow. Fleas located at ectopic sites are easily overlooked. The standard therapy is careful surgical extraction of the embedded parasite.

Resistance

In clinical practice, patients are often seen with persisting head-lice infestation despite repeated and prolonged treatments. Poor compliance, reinfestation, or resistance to the pediculicide used are probable reasons. Head lice are increasingly resistant to standard over-the-counter therapies and resistant head-lice infestations are probably commoner than generally realised.[11–13] There is now evidence of double resistance (eg, permethrin and malathion) and cross-resistance. In Argentina, for example, head lice resistant to permethrin, d-phenothrin, deltamethrin, and β-cypermethrin have been isolated.[14] Interestingly, β-cypermethrin has never been sold commercially as a pediculicide.

The reasons for this increasing resistance are difficult to disentangle. Presumably, widespread use of insecticides with inadequate treatment methods are the main driving forces. But, in fact, resistance is particularly frequent in countries where pediculosis is treated aggressively and extensively with insecticides. Several studies show higher levels of resistance in the USA compared with Panama, Ecuador, and Indonesia, countries where the attitude of the population towards parasitic skin diseases is laxer.[12,13,15]

If treatment failure due to resistance is assumed, laboratory confirmation is needed. Unfortunately, the techniques are available only in a few specialised laboratories and, because the assays in use are not standardised, results are difficult to compare.[13]

It is important clinically that occurrence of resistance is unpredictable.[12] For example, J Hunter and S Barker[16] recently observed different patterns of resistance in school-

children from five schools in Brisbane, Australia. They detected almost complete resistance to malathion, permethrin, and pyrethrum in two schools, whereas in three other schools head lice were susceptible to malathion and, to a lesser extent, to pyrethrums. Such a finding leaves the clinician at a loss to which pediculicide to prescribe.

The situation is less dramatic for crab and body lice. Resistant scabies has been observed in different countries, although presumably the resistance pattern is simply dragging behind that of the head louse.

Ivermectin

Ivermectin is a safe broad-spectrum anthelmintic and has been used in millions of individuals without major adverse events.[17] It is highly effective against intestinal helminths and ectoparasites in polyparasitised patients.[18–20] Single-dose use makes the drug particularly useful for control measures in endemic communities. In a village in Papua New Guinea, where scabies was hyperendemic, the disease was controlled successfully with a single dose.[21] Because ivermectin is not ovicidal, a second dose after 7–12 days may be necessary for scabies and pediculosis.

In many countries ivermectin is only approved for certain nematode infections. However, off-label use for scabies, pediculosis, and cutaneous larva migrans is widespread.[17] So far, the use of ivermectin is restricted to children aged 5 years or older.

Natural remedies

Increasing resistance and safety and compliance problems explain why considerable efforts are invested in the development of alternative therapies, such as plant extracts. They generally have no side-effects and act against different ectoparasite species. Cultural acceptance is high in the different social settings in which plant oils have been tested.

In small open trials, a combination of paw paw, thymol, and tea-tree oil was 100% effective,[22] and a combination of coconut oil, anise, and ylang ylang was 92% effective against head lice.[23] In Mumcuoglu et al's study[23] the natural remedy did as well as a combination of permethrin, malathion, and piperonyl butoxide. An extract of neem and turmeric cured 790 of 814 (97%) patients with scabies.[24] However, studies so far on plant extracts do not fulfil requirements for evaluation of effectiveness.

Plant extracts can also have repellent activities. In a small open trial daily topical application of a combination of coconut and jojoba oil decreased attack rates of *T penetrans* to zero.[25] Simultaneously, clinical signs around embedded fleas regressed, probably due to anti-inflammatory substances in the plant oils.

Conclusions

The best strategies against parasitic skin diseases need to be tailored to different scenarios. In industrialised countries the patient is usually lightly infested with a single ectoparasite species, and there is no or little risk of reinfestation and good compliance can be anticipated. In such a case a topically applicable insecticide could be the treatment of choice for pediculosis and scabies, provided resistance is not a problem in the area. In developing countries population groups are simultaneously infested with several ectoparasite species, the parasite burden and risk of reinfestation are high, and compliance for prolonged and/or repeated treatment is poor. Here, repeated oral treatment with a broad-spectrum antiparasitic such as ivermectin would be the ideal solution.

To achieve control of parasitic skin diseases in developing countries, local epidemiology has to be better understood. Also, health-care providers have to be sensitive to the medical needs of the very poor,[26] including the need for sanitation, health education, and cheap and culturally acceptable interventions.

JH is supported by a grant from the CAPES/DAAD/PROBRAL Programme. We thank Michi Feldmeier for secretarial assistance. We have no conflict of interest to declare.

References

1 Muehlen M, Heukelbach J, Wilcke T, Winter B, Mehlhorn H, Feldmeier H. Investigations on the biology, epidemiology, pathology and control of *Tunga penetrans* in Brazil II: prevalence, parasite load and topographic distribution of lesions in the population of a traditional fishing village. *Parasitol Res* 2003; **90:** 449–55.

2 Burgess IF. *Sarcoptes scabiei* and scabies. *Adv Parasitol* 1994; **33:** 235–92.

3 Heukelbach J, van Haeff E, Rump B, Wilcke T, Moura RC, Feldmeier H. Parasitic skin diseases: health care-seeking in a slum in north-east Brazil. *Trop Med Int Health* 2003; **8:** 368–73.

4 Downs AM, Stafford KA, Coles GC. Head lice: prevalence in schoolchildren and insecticide resistance. *Parasitol Today* 1999; **15:** 1–4.

5 Burgess IF. Human lice and their management. *Adv Parasitol* 1995; **36:** 271–342.

6 Meinking TL, Clineschmidt CM, Chen C, et al. An observer-blinded study of 1% permethrin creme rinse with and without adjunctive combing in patients with head lice. *J Pediatr* 2002; **141:** 665–70.

7 Caumes E, Carriere J, Guermonprez G, Bricaire F, Danis M, Gentilini M. Dermatoses associated with travel to tropical countries: a prospective study of the diagnosis and management of 269 patients presenting to a tropical disease unit. *Clin Infect Dis* 1995; **20:** 542–48.

8 Heukelbach J, Wilcke T, Feldmeier H. Cutaneous larva migrans (creeping eruption) in an urban slum in Northeast Brazil. *Int J Dermatol* (in press).

9 Heukelbach J, Costa ALM, Wilcke T, Mencke N, Feldmeier H. The animal reservoir of *Tunga penetrans* in poor communities in Northeast Brazil. *Med Vet Entomol* (in press).

10 Feldmeier H, Eisele M, Sabóia Moura RC, Heukelbach J. Severe tungiasis in underprivileged communities: case series from Brazil. *Emerg Infect Dis* 2003; **9:** 949–55.

11 Burkhart CG, Burkhart CN, Burkhart KM. An assessment of topical and oral prescription and over-the-counter treatments for head lice. *J Am Acad Dermatol* 1998; **38:** 979–82.

12 Downs AM, Stafford KA, Hunt LP, Ravenscroft JC, Coles GC. Widespread insecticide resistance in head lice to the over-the-counter pediculocides in England, and the emergence of carbaryl resistance. *Br J Dermatol* 2002; **146:** 88–93.

13 Elston DM. Drug-resistant lice. *Arch Dermatol* 2003; **139:** 1061–64.

14 Picollo MI, Vassena CV, Mougabure Cueto GA, Vernetti M, Zerba EN. Resistance to insecticides and effect of synergists on permethrin toxicity in *Pediculus capitis* (Anoplura: Pediculidae) from Buenos Aires. *J Med Entomol* 2000; **37:** 721–25.

15 Yoon KS, Gao JR, Lee SH, Clark JM, Brown L, Taplin D. Permethrin-resistant human head lice, *Pediculus capitis*, and their treatment. *Arch Dermatol* 2003; **139:** 994–1000.

16 Hunter JA, Barker SC. Susceptibility of head lice (*Pediculus humanus capitis*) to pediculicides in Australia. *Parasitol Res* 2003; **90:** 476–78.

17 Elgart GW, Meinking TL. Ivermectin. *Dermatol Clin* 2003; **21:** 277–82.

18 Leppard B, Naburi AE. The use of ivermectin in controlling an outbreak of scabies in a prison. *Br J Dermatol* 2000; **143:** 520–23.

19 del Giudice P, Chosidow O, Caumes E. Ivermectin in dermatology. *J Drugs Dermatol* 2003; **2:** 13–21.

20 Orion E, Matz H, Ruocco V, Wolf R. Parasitic skin infestations II, scabies, pediculosis, spider bites: unapproved treatments. *Clin Dermatol* 2002; **20:** 618–25.

21 Bockarie MJ, Alexander ND, Kazura JW, Bockarie F, Griffin L, Alpers MP. Treatment with ivermectin reduces the high prevalence of scabies in a village in Papua New Guinea. *Acta Trop* 2000; **75:** 127–30.

22 McCage CM, Ward SM, Paling CA, Fisher DA, Flynn PJ, McLaughlin JL. Development of a paw paw herbal shampoo for the removal of head lice. *Phytomedicine* 2002; **9:** 743–48.

23 Mumcuoglu KY, Miller J, Zamir C, Zentner G, Helbin V, Ingber A. The in vivo pediculicidal efficacy of a natural remedy. *Isr Med Assoc J* 2002; **4:** 790–93.

24 Charles V, Charles SX. The use and efficacy of *Azadirachta indica* ADR (Neem) and *Curcuma longa* (Turmeric) in scabies. *Trop Geogr Med* 1992; **44:** 178–81.

25 Schwalfenberg S, Witt LH, Kehr JD, Feldmeier H, Heukelbach J. Prevention of tungiasis by a biological repellent: a small case series. *Ann Trop Med Parasitol* 2003; **98:** 89–94.

26 Estrada B. Ectoparasitic infestations in home children. *Semin Pediatr Infect Dis* 2003; **14:** 20–24.