

HUMAN PEDICULOSIS: A CRITICAL HEALTH PROBLEM AND WHAT ABOUT NURSING POLICY?

By

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Abstract

Lice infestation on the human body (also known as pediculosis) is very common. Cases number in the hundreds of millions worldwide. Three distinct presentations of lice infection exist and each is caused by a unique parasite. Head lice (*Pediculus humanus capitis*) is by far and away the most common infestation and favors no particular socioeconomic group. A genetically close "cousin," *Pediculus humanus corporis*, is responsible for body lice and is more commonly associated with poverty, overcrowding, and poor hygiene. Pubic lice (crabs) are caused by *Phthirus pubis* and is transmitted by intimate and/or sexual contact.

No doubt, human lice infestation is an increasing problem worldwide. Apart from being an irritating and a shaming human ecto-parasite, they transmit serious infectious diseases; epidemic or classical typhus, epidemic relapsing fever as well as Trench fever. Eradication of lice infestation prevents transmission of infectious diseases. People who live and work in close proximity to louse-infested individuals may secondarily acquire lice even if they regularly wash their clothes and have good hygiene. Thus, all louse-infested persons and workers in close contact with such persons should periodically inspected and use long-acting safe insecticides.

Human lice can be treated with agents such as DDT, malathion, and lindane, but reports of resistance to one or more of them have recently appeared. Pyrethroid permethrin when applied as a dust or spray to clothing or bedding is highly effective against lice and is the delousing agent of choice. Fabric treated with permethrin retains toxicity to lice even after 20 washings, thereby offering significant long-term passive protection against epidemic typhus. Itching may continue even after all lice are destroyed. This happens because of a lingering allergic reaction to their bites. Over-the-counter cortisone (corticosteroid) creams or calamine lotion may help.

Keywords: Human Pediculosis, Diagnosis, Clinical picture, Treatment, Prevention

Introduction

Three distinct varieties of lice are specifically parasitic for humans. Two

of them, *Pediculosis humanus capitis* (head louse) and *P. humanus corporis*

(body louse), are closely related variants of the same species, despite their different habits. The third is *Phthirus pubis*, pubic louse commonly known as the crab (Ko and Elston, 2004).

Pediculosis capitis:

The head louse is an adaptable creature that has been able to survive in the advanced societies of the Western world. Children are affected most commonly; with the exception of the common cold, pediculosis *capitis* affects a greater number of elementary school students in North America than all other communicable diseases combined. It has been estimated that in 1997 approximately one of every four elementary level students in the United States was infested (Price *et al*, 1999).

Interaction with playmates, cross transfer from articles of clothing on adjacent hooks in school cloak rooms, and shared combs, headphones, towels, and beds are important modes of disease spread (Burkhart and Burkhart, 2007). The incidence of head lice infestation varies only slightly inversely with socioeconomic level. The black children are affected much less frequently than whites and others, and males less than females; the reasons for these findings are not known. Hair length is not a factor.

Morphology and habits of *P capitis*:

The head louse is a gray-white, active insect 3 to 4 mm in length. The female is a little longer than the male. Both sexes are equipped with mouth parts adapted to sucking blood and legs adapted to grasping hairs. The life span of the female is about one month,

during which time she lays 7 to 10 eggs each day, cementing them firmly to the base of a host hair. The eggs, commonly called "nits," are oval lidded capsules that hatch in eight days, releasing nymphs that require another eight days to mature. After hatching, egg cases become white and more visible. Adults feed voraciously both on the scalp and adjacent areas of the face and neck.

Nits remain firmly attached to the hair shaft and move away from the scalp as the hair grows. The distance from the scalp is a measure of age, with one cm indicating about one month (Roberts, 2002). Thus, finding nits a distance from the scalp is not an indication of active infestation.

Adult lice can survive up to 55 hours without a host, although they probably dehydrate and become nonviable long before their death. Lice do not jump, fly, or use pets as vectors (Chunge *et al*, 1991).

Clinical manifestations:

Most lice infestations are asymptomatic; some children can harbor a surprisingly large colony of head lice with no apparent symptoms. Itching of the scalp, neck, and ears may occur as an allergic reaction to lice saliva, which is injected during feeding. Persistent or recurrent pyoderma about the neck and ears should always alert the examiner to search for lice. Cervical and nuchal lymph nodes are often enlarged, and febrile episodes associated with the secondary staphylococcal infection may occur (Maunder, 1993).

Diagnosis:

The diagnosis is made by demonstration of the louse or nits. The latter are often more easily discovered than the lice themselves, which are elusive and not always readily apparent. Under Wood's light the nits show a pale blue, which facilitates harvest for the microscopic examination. Unlike seborrhea scales, root sheath casts, and hair spray residue, nits are cemented securely to hair shaft and are difficult to dislodge.

Finding nits without lice does not necessarily mean that there is active infestation; nits may persist for months after successful therapy. The CDC states that the diagnosis can be made by finding many eggs within one-quarter inch (6.5 mm) of the scalp. However, even this criterion results in over-diagnosis. As an example, in a study in which 1729 elementary school children were screened for lice, 28 (1.6%) had active lice while 63 (3.6%) had nits without lice, of whom 50 completed follow-up (Williams *et al*, 2001). During two weeks of follow-up, only 9 of the 50 children who initially had nits alone (18%) converted to an active infestation. Having ≥ 5 nits within one-quarter inch of the scalp was associated with a higher conversion rate than fewer nits (32 versus 7%). These data have led some to recommend diagnosis based only upon finding a living, moving louse (Dodd, 2001).

Wet combing with a fine toothed nit comb better detects active louse infestation than visual inspection of the hair and scalp alone. The hair should initially be brushed or combed to remove tangles. The fine toothed comb is then inserted near the crown until it

gently touches the scalp, after which it is drawn firmly down and examined for lice after each stroke. The entire head should be combed systematically at least twice. A lubricant such as a commercially available hair conditioner is used for the wet-combing technique (Jahnke *et al*, 2009).

The diagnosis of lice can be traumatic to sensitive patients or parents and can lead to psychological disturbances such as delusions of infestation even after cure is complete. Tact, reassurance, and empathy on the part of the examiner will help to avoid problems of this sort. The parasite or a nit should be available under the microscope to demonstrate to doubters when necessary.

Treatment:

Topical insecticides, wet combing, and oral therapies have all been studied for the treatment of lice (Burkhart *et al*, 1998).

Topical insecticides are the initial treatment of choice for lice. A systematic review found that topical permethrin, pyrethrin, and malathion, are all effective in treating lice in more than 95% of cases. Benzyl alcohol 5% lotion is a newer treatment option (Burkhart, 2004).

Resistance to topical insecticides is emerging as a problem, however, one British study found an increase in resistance of head lice to permethrin, phenothrin, and malathion among elementary school children, as well as an emerging resistance to carbaryl (Downs *et al*, 2002).

The permethrin cream rinse 1% (Nix) is available over the counter, as are

lotions containing pyrethrins and piperonyl butoxide (Rid, A-200, Pronto, Clear). Made from a natural chrysanthemum extract, creams with pyrethrins and piperonyl butoxide are neurotoxic to lice, but have extremely low mammalian toxicity, and allergic reactions are rare. Permethrin creams are even less toxic and are considered first line agents despite emerging resistance.

The scalp should be saturated with the pediculicide after the hair has been washed with shampoo, rinsed with water, and towel dried. The preparation remains on the hair for ten minutes before rinsing off with water (Frankowski and Weiner, 2002). A second treatment is indicated in 7 to 10 days if live lice (not nits alone) remain; the CDC recommends everyone in the United States be treated with a second application because of current resistance patterns. One study of permethrin found lice-free rates of 83% on day two, decreasing to 46% on day eight before a second treatment, and then increasing to 78% on day nine after the second treatment and staying there on day 15. More than three applications of the same product within two weeks are not recommended. Prescription strength permethrin (5%) is also available, but is not more effective than the over the counter preparation (Frankowski and Weiner, 2002).

Malathion lotion 0.5% (Ovide) is available by prescription in the United States and over the counter in the United Kingdom. One study found that malathion was most effective at killing head lice, followed by topical pyrethrins, which killed between 82 and

100%, and lindane, which killed only 17%. However, initial treatment with malathion requires the lotion be left in place for 8 to 12 hours before washing off.

Lindane shampoo is not a drug of first choice because it has been associated with neurologic adverse effects and widespread resistance, as mentioned above (Meinking *et al*, 2002).

In 2009, US Food and Drug Administration approved benzyl alcohol 5% lotion (Ulesfia) for the treatment of pediculosis capitis for use in patients six months of age and older. Two unpublished randomized controlled trials revealed greater efficacy of benzyl alcohol over placebo for the eradication of live lice (76.2 versus 4.8%, and 75 versus 26.2%). The mechanism of action is thought to involve asphyxiation of lice through obstruction of their respiratory sphericles.

When treating *P. h. capitis*, benzyl alcohol 5% lotion is applied for 10 minutes with saturation of the scalp and hair, and then rinsed off with water. The treatment is repeated after seven days. Benzyl alcohol lotion may cause irritation of the skin, scalp, and eyes, as well as transient numbness at the site of application (Roberts *et al*, 2000).

Wet combing:

Mechanical removal of lice by wet combing is an alternative to insecticides, particular for children ages two and under in whom insecticides are not recommended.

Combing is performed with a fine toothed comb; the hair should be wet,

with an added lubricant such as hair conditioner, vinegar, or olive oil. Combing is done until no lice are found in each session, with repeat sessions every three to four days for several weeks, continuing for two weeks after any session in which a large, adult louse is found (Hill *et al*, 2005).

The relative effectiveness of wet combing and medical therapy is uncertain. In one study, it was only half as effective as treatment with malathion cure in 38 versus 78%, respectively. The wet combing was much more effective than a single treatment with either malathion or permethrin cure in 57 versus 13% (Dawes, 2005). But, there were significant methodologic issues with this latter study including unblinded allocation of patients, the use of an inadequate regimen of pediculicide, and different lengths of follow-up in the two arms of the study.

There is no evidence that over the counter nit removers or nit looseness hasten resolution when combined with medical therapy (Burkhart and Burkhart, 1999).

Oral agents:

Ivermectin (Stromectol) may be effective in cases resistant to all forms of topical therapy (CDC, 2002). This drug was used originally as a treatment for human onchocerciasis and has not been approved by the United States Food and Drug Administration for treatment of head lice. As a second line alternative to topical agents, the CDC recommends administering 200µg/kg as a single dose by mouth, with a repeat dose two weeks later.

The combination of topical permethrin (1%, applied for ten minutes with a repeat application after one week if necessary) plus oral trimethoprim-sulfamethoxazole (10 mg/kg/day trimethoprim in two divided doses for ten days) improves the cure rate slightly compared with permethrin alone, and should be reserved for resistant cases (Pearlman, 2004).

Physical agents:

A study of a lotion that is applied to the head and then dried, with a goal of suffocating lice, reported a 96 percent cure rate ; the author later reported that the lotion used in the study was Ceta-phil® cleanser (a synthetic detergent cleanser) (Pearlman, 2005). The study had significant flaws including lack of a control group, lack of blinding, and potentially inappropriate diagnostic criteria. Studies are indicated before recommending this finding (Burgess *et al*, 2005).

A silicone-based material, dimeticone, is believed to work by coating lice and disrupting their ability to manage water. A single blind equivalence trial compared dimeticone 4%, applied for eight hours or overnight, with the pediculicide phenothrin 0.5% in 214 children and 39 adults with head lice. Each treatment was applied twice, seven days apart, and cure rates were similar in the two groups (70 and 75%, respectively). The authors state that dimeticone and the volatile silicone base it was dissolved in (cyclomethicone) are extensively used in cosmetics and toiletries (Takano-Lee *et al*, 2004).

Oily home products (eg, olive oil, butter, petroleum jelly) are sometimes used in the hopes of suffocating lice (Resnik, 2005). Lice are difficult to suffocate, and a small study of such products concluded they are not effective (Goates *et al*, 2006).

Other:

A comb that uses an electric current generated by a AA battery to electrocute lice is marketed for the treatment of head lice. There are anecdotal reports of successful treatment with the device without knowledge of any published clinical trials demonstrating efficacy.

An unblinded study reported louse eradication with high volume heated air blown at the scalp for 30 minutes. Few patients overall received the high volume heated air treatments, and patients younger than age six were excluded. Heat-based treatments will be undergoing additional research in the near future. While awaiting the results of larger controlled trials that compare methods of delivering heat and assess cure, safety, training, and costs, such treatments cannot be recommended outside of clinical trials (Pollack *et al*, 1999).

Treatment failure:

The commonest causes of treatment failure are lack of compliance and continued contact with others infested and untreated, although resistance of head lice to topical treatments of one kind or another is becoming a troublesome problem in some geographic areas. Many resistant cases respond when alternative topical are applied. If

infestation recurs within one month after treatment a different topical insecticide should be used (Downs *et al*, 1999).

Return to school:

Many school districts have inflexible rules that forbid the return to school of even adequately treated children with nits in place. It is estimated that children in the United States lost 12 to 24 million days of school in 1998 because of no-nit policies.

Lice have frequently been present for weeks prior to detection. Furthermore, given that the majority of children with nits do not develop active infection, exclusion from school based on the presence of nits appears to be excessive. Children can return to school immediately after completion of the first application of a topical insecticide or after the first wet combing session.

Control of outbreaks in schools is facilitated by group examination of teachers and pupils under the Wood's light, and by assigning students individual wall hooks or lockers for storing caps and coats.

Household contacts:

The household members should be examined and treated if infested; bunkmates should be treated prophylactically.

It is reasonable to recommend the washing of the clothing, furniture, or carpeting that has been in contact with the head of an infested person 24 to 48 hours before he or she has been treated. Louse survival off the scalp beyond 48 hours is unlikely.

Lindane toxicity:

Lindane is an organochlorine insecticide that inhibits neurotransmission in parasitic arthropods. Neurologic toxicity resulting in seizures and death was reported in humans following topical lindane therapy. Most reports of these events have occurred after prolonged or repeated application of lindane, but in rare cases, have followed a single application.

Although the drug has been banned in some countries, lindane shampoo and lotion remain available by prescription in the United States. The US FDA has placed a black box warning on the drug labels, cautioning that Lindane shampoo and lotion should only be used as a second-line treatment in patients who cannot tolerate or have failed other therapies for the treatment of scabies or lice. Lindane is contraindicated in patients with skin disorders that may lead to increased systemic absorption (eg, atopic dermatitis, psoriasis). Other contra-indications for the use of this drug are addressed separately.

Lindane should be given only as single application; retreatment should be avoided. Other measures to be taken to minimize toxicity include: Prescribe one ounce of Lindane lotion or shampoo to treat an average adult; no more than two ounces should be prescribed. Lindane lotion should never be left on the skin for more than 8 to 12 hours. Lindane shampoo should be washed off after four minutes. Caregivers applying drug to patients should wear gloves that are less permeable to

Lindane (nitrile, latex, neoprene, or sheer vinyl). Natural latex gloves should not be used. Caregivers should thoroughly wash their hands after application (Raoult and Roux, 1999).

Pediculosis corporis:

Pediculosis corporis is largely a problem of the homeless in Europe and North America. The problem is significant in countries where poverty, crowding, and a low level of personal hygiene favor spread and multiplication of the parasite. In these areas large numbers of cases of louse-borne typhus, trench fever, and relapsing fever continue to occur. The communal bed is a major factor in the perpetuation of the problem.

The body louse is a little larger, but similar in morphology to the head louse. It lives in clothing, lays eggs along the seams, and visits the host skin to feed.

Clinical manifestations & diagnosis:

Itching is chief complaint, although some individuals do not seem to be troubled by the infestation. Signs may be limited to linear excoriations on the trunk and neck along with post inflammatory pigmentation. Close inspection sometimes reveals hemorrhagic punctae or wheals from fresh bites. Skin changes tend to be concentrated around the waist and in the axillary folds, areas where clothing seams contact the integument. The honey-like crusting and redness characteristic of secondary staphylococcal infection may also be present. Diagnosis is made by identification of the louse or its nits in the clothing.

Treatment:

The patient must be bathed thoroughly. Infested clothing and bed linen should be heat washed, dry cleaned, or discarded. This parasite can live as long as 30 days away from the host.

In most cases, the above methods are sufficient for the management of *P. corporis*. Occasionally, a few nits will be found on body hair. For these patients, treatment with a topical pediculocide such as permethrin cream may be useful. Lindane lotion should not be used as a first-line therapy due to the potential for severe adverse events with this drug.

Topical corticosteroid cream applied to pruritic and irritated areas twice daily for a few days after elimination of the lice provides symptomatic relief.

***Phthirus pubis*:**

Phthirus pubis, the crab louse, has adapted well to modern civilization. The increased sexual freedom associated with the past four decades has contributed to its success. Most crab lice infestations in young adults result from sexual contact. A thorough sexual history and possibly screening for the other sexually transmitted diseases is warranted.

The crab louse is a rounded, stubby parasite, 2 to 3 mm long, translucent and difficult to see unless filled with blood from a recent meal. Four of its six legs terminate in prominent crab-like claws, ideally suited to grasp and hold on tightly to pubic and other body hairs. The life span of the female is three to four weeks, during which time she lays a maximum of three eggs per

day for a total of 26 or more. The eggs are cemented firmly to the base of a hair, where they incubate six to eight days before hatching.

Clinical manifestations & diagnosis:

Itching is the chief complaint in adults, mainly in the pubic area, but also in the axillae. In hairy individuals no part of the pelage is immune to involvement, except the scalp. Pale bluish spots may develop at follicular orifices (maculae ceruleae) with prolonged infestation, the result of continual injection of louse anti-coagulant saliva during feeding.

Children exposed to heavily infested parents occasionally develop eyelash infestation (pediculosis ciliaris). The children complain of itching, burning, and eye irritation, and continually rub them. The blepharitis is usually bilateral. There is reddish crusting and matting of the lashes and an associated conjunctivitis is common. Preauricular and submental nodes may be enlarged. Involvement of eyebrows may occur in children, and in very young individuals a few lice may occasionally be found clinging to hairs at the periphery of the scalp.

The diagnosis is made by dejection of the louse or nits. Once a diagnosis is made, it is important to look for other possible sexually transmitted diseases.

Treatment:

Regimens recommended by the CDC for pubic lice include: Permethrin 1% cream rinse applied to the affected areas and washed off after 10 minutes. The pyrethrins with piperonyl butoxide

applied to the affected areas and washed off after 10 minutes.

Alternative regimens include: Malathion 0.5% lotion applied to the affected areas and washed off after 8 to 12 hours. Ivermectin 250 mcg/kg orally, repeated in two weeks.

Given its toxicity, the CDC (2002) recommended reserving use of lindane (1% shampoo applied to the affected areas and thoroughly washed off after four minutes) for the patients who do not tolerate or fail other regimens.

The skin should be cool and dry before topical application to minimize percutaneous absorption. Nits can be removed with fingernails, a nit comb, or tweezers. Patients who have continued symptoms one week after treatment should be evaluated for persistent or recurrent infection. Retreatment is indicated if lice are seen or if nits are found at the skin/hair junction.

CDC recommends that ivermectin not be used in pregnant or lactating women; there are not adequate safety data for ivermectin in children weighing less than 15 kg (Workowski, 2006).

It is important to treat all contacts (eg, sexual partners) at the same time to prevent cross reinfection. Bedding and clothing should be machine washed and dried in a hot dryer. Dry cleaning or bagging clothing for a minimum of 72 hours is an alternative.

Pediculosis ciliaris:

Phthirus pubis may also infest hair-bearing areas of the body outside the pubic area. Treatment for pediculosis ciliaris, involving the eyelashes, must be modified to protect the ocular area.

In mild infestations, the lice and nits can often be dislodged mechanically after twice daily application of ordinary petrolatum or an occlusive ophthalmic ointment to the eyelid margins for 8 to 10 days. Ivermectin also has been used successfully, with two doses (200 mcg/kg) by mouth given one week apart. The same cautions about ivermectin use discussed above apply. Secondary pyoderma and conjunctivitis can be managed in most instances by ophthalmic topical antibiotic preparations (Burkhart and Burkhart, 2000).

Information for Patients:

Educational materials on this topic are available for patients.

One encourages the patient to print or e-mail these topic reviews, or to refer patients to our public web site, www.uptodate.com/patients, which includes these and other topics.

Epidemic typhus:

Epidemic typhus is a potentially lethal, louse-borne, exanthematous disease caused by *Rickettsia prowazekii*. *R. prowazekii* is one of three members of the typhus group of *Rickettsia* known to cause human illness; the other two *Rickettsia* cause murine typhus and scrub typhus. Like all rickettsiae, *R. prowazekii* cannot be grown on cell-free media and specialized laboratory facilities are required to recover the organism from clinical specimens.

Throughout the middle-ages and into the early part of the 20th century, periodic epidemics of *R. prowazekii* infection killed millions of people. As an example, during the eight-year period from 1917 to 1925, over 25 million

cases of epidemic typhus occurred in Russia, causing an estimated three million deaths. It has been estimated that epidemic typhus has caused more deaths than all the wars in history (Weiss, 1988).

Epidemic typhus is now a rare disease, but two recent developments illustrate that an understanding of its epidemiology, clinical features, and treatment is still important to clinicians: A new sylvatic cycle of infection involving flying squirrels and their ectoparasites with secondary transmission to humans was recognized in the United States. More than 45,000 cases of epidemic typhus recently occurred in Burundi in association with civil war; body-louse infestation preceded outbreaks of both epidemic typhus and trench fever due to *Bartonella quintana* (Raoult *et al*, 1998).

The outbreaks of typhus in Africa illustrate that the words of Hans Zinsser are still applicable today: "Typhus is not dead. It will live on for centuries and it will continue to break into the open whenever human stupidity and brutality give it a chance as most likely they occasionally will" (Raoult *et al*, 1997).

Epidemic typhus is a vector-borne disease with a complex epidemiology. The principal vector is *Pediculus humanus* (the body louse) and *P. humanus capitis*, the head louse (Gross, 1996). The human louse was thought to be the sole vector of *R. prowazekii* and humans were thought to be the sole reservoir of infection until a report in 1975 demonstrated that *R. prowazekii*

infection occurred in flying squirrels in southeastern United States (Bozeman *et al*, 1975).

Subsequent studies revealed that both the squirrel flea (*Orchospes howardii*) and the squirrel louse (*Neohaemaphysalis sciuropteri*) are vectors for the transmission of *R. prowazekii* among flying squirrels. Although *N. sciuropteri* is host-specific and does not feed on humans, *O. howardii* will bite humans and transmit *R. prowazekii* if its principal host, the flying squirrel, is unavailable. Flying squirrels inoculated with *R. prowazekii* developed a rickettsemia that lasted for two to three weeks. Lice, fleas, and mites feeding on these experimentally-infected squirrels could be infected with *R. prowazekii* (Sonenshine *et al*, 1987).

Few papers about the epidemiology of *R. prowazekii* infection have been published in past decades. However, the available data suggests that reporting and detection biases probably exist. Epidemic typhus is likely to be misdiagnosed or completely undiagnosed in areas of the world where poverty, famine, war, and disease occur simultaneously. For example, seroprevalence studies of patients from North Africa and in homeless people from Marseilles, France suggest that *R. prowazekii* infection may be occurring far more often than is recognized (Letaief, 2006).

Mechanisms of transmission:

The body louse typically spends its life on the skin or clothes of humans. Eggs are laid on clothes and hatch in about eight days. After hatching, larva

molt three times before they become adults.

Lice require a blood meal during each of these three stages. The defecates of louse are highly infective feces at the site of its feeding during a blood meal. *Rickettsiae* present in louse feces may then be introduced into abraded or injured skin or mucus membranes by either scratching or hand contamination, since skin irritation commonly occurs at the site of a louse bite. Lice feces may remain infectious for as long as 100 days; as a result, human to human transmission can occur from sharing clothes or transfer of infective lice feces from one human to another.

P. humanus typically spends its entire life on the same host and does not leave unless manually removed or close contact allows transfer to a second human host. However, infected lice rapidly leave a dying human host and seek a blood meal on an alternate host. The cumulative effect of all these factors is that transmission of epidemic typhus typically occurs in crowded, cold, and unhygienic environments.

The mechanics of louse infection following feeding on an infected host were explored in an experimental model of human body louse infection with *R. prowazekii*. The following findings were noted: the *R. prowazekii* initially invaded the stomach epithelial cells of lice. *Rickettsia* first appeared in the feces of infected lice on the fifth day of infection. *Rickettsia* replicated in the stomach epithelial cells, causing cell rupture six to seven days post-infection. Erythrocytes entered hemo-

lymph of infected lice following cell rupture, causing the lice to become bright red and die within four hours. Infected lice did not transmit infection to their progeny. The life span of infected lice was shortened by 20 to 23 days compared to uninfected controls.

Lice infected via human infection may have a lower inoculum of *Rickettsia*, which can alter the time sequence. But, the rapid death of lice after infection makes it unlikely that lice are an effective reservoir for human infection (Houhamdi *et al*, 2002).

In contrast, transmission of the sylvatic form of epidemic typhus to humans occurs only when humans have direct contact with infected squirrels or when squirrels which are nesting in the attics of homes are removed or killed and the lice inhabiting their nest are forced to seek alternate hosts.

Geographic distribution:

Only a few foci of epidemic typhus still exist in the world today. During the past 20 years, cases of epidemic typhus have been reported from Burundi, Rwanda, Ethiopia, and in a few remote rural regions of the mountains of South and Central America and the highlands of Algeria (Mokrani *et al*, 2004). Except for a single case reported from California, almost all cases of epidemic typhus in the United States until 2001 occurred east of the Mississippi River within the range of the eastern flying squirrel (*Glaucomys volans*). However, in 2001, a patient from New Mexico, who presented with fever and signs and symptoms of meningitis without skin rash, was sub-

sequently found to have acute infection with *R. prowazekii* using PCR amplification of the 17-kDA antigen gene and DNA sequencing of the amplified product (Massung *et al*, 2001).

Pathogenesis:

After transcutaneous entry of infective louse tissues or feces, *R. prowazekii* spreads throughout the body via the blood stream or lymphatics. Once inside the human host, typhus rickettsiae, like *R. rickettsii*, enter endothelial cells and proliferate by binary fission.

The precise mechanism by which *R. prowazekii* produces cellular injury is still uncertain, but experimental studies suggest that a complex and multifactorial sequence of events results in endothelial injury via both cellular swelling and necrosis. Secondary immune and phagocytic responses to *R. prowazekii* involve both lymphocytes and macrophages but *R. prowazekii* can also injure cells directly in the absence of immune and inflammatory responses. Attachment of *R. prowazekii* to cell membranes directly increases phospholipase activity, which in turn injures host cell membranes. *R. prowazekii* may accumulate in vast numbers in individual endothelial cells prior to sudden "burst release" which results in death of the host cell (Winkler and Miller, 1981).

The consequence of the above series of cellular events is the pathologic hallmark of epidemic typhus infection: widespread vasculitis with increased vascular permeability, edema, and activation of humoral inflammatory and

coagulation mechanisms. This rickettsia-induced vasculitis may be accompanied by mural and intimal thrombosis and microscopic areas of hemorrhage. Involvement of the micro-circulation can produce diffuse myocarditis as well as damage to muscle, spleen, kidneys, and brain. Central nervous system involvement may result in characteristic "typhus nodules" composed of perivascular infiltrates consisting of lymphocytes, macrophages, and plasma and mast cells.

The molecular basis for Brill-Zinsser disease, defined as the recrudescence of epidemic typhus years after the initial episode, remains unclear. In particular, the mechanism by which *R. prowazekii* remains latent in humans for decades has not been established (Walker *et al*, 2003).

Acute *R. prowazekii* Infection:

R. prowazekii infection produces two distinct clinical syndromes: an acute potentially severe infection that occurs 7 to 14 days after exposure to infected lice; and a recrudescence form called Brill-Zinsser disease that may occur 10 to 50 years after primary infection.

Symptoms:

The majority of patients with epidemic typhus or sylvatic typhus infection experience the abrupt onset of fever, severe headache, and malaise. The infected patients may also complain of a number of other nonspecific symptoms including cough, abdominal pain, nausea and diarrhea. Relative frequency with which these symptoms occur can be illustrated by the findings of two studies of 104 patients (Mato-ssian *et*

al, 1963). Fever-100%, Headache-91 to 100%, Tachypnea-97%, Chills-82%, Muscle tenderness-70%, Rash-64%, Abdominal tenderness-60 %, Arthralgias-50%, Cough-38%, and Nausea-32%

Rash:

The rash of epidemic typhus classically begins several days after the onset of symptoms, appearing as a red macular or maculopapular eruption on the trunk that later spreads centrifugally to the extremities. The rash, which may be difficult to see in dark-skinned individuals, is classically described as sparing the palms and soles, but many exceptions to this rule occur. In severe cases, the rash may become petechial; gangrene of the distal extremities necessitating amputation is a rare complication.

The rash is usually present on both the trunk and extremities but may be limited to one or the other site in selected patients. The incidence of the rash becoming petechial is variable, ranging in these two reports from 18 to 55% (Mc-Dade *et al*, 1980).

Rash may or may not be present in patients with sylvatic typhus. In two separate series describing a total of 15 patients, rash occurred in seven and was petechial in two (Duma *et al*, 1981).

Central nervous system manifestation:

The majority of epidemic typhus patients manifest one or more abnormalities in central nervous system function. Common neurologic symptoms include confusion and drowsiness. Coma, seizures, and focal neurologic signs may develop in a

minority of patients. In an outbreak of epidemic typhus in a jail in Burundi, seven of nine patients had one or more neurologic signs or symptoms, including seizures in one and coma in three. Similar symptoms can occur with sylvatic typhus (Murray *et al*, 1950).

Laboratory abnormalities:

Jaundice, elevated serum aminotransferases, and thrombocytopenia are common findings in patients with epidemic typhus. Clinical and laboratory evidence of myocarditis and diffuse or focal pulmonary infiltrates on chest x-ray occurs in a small percentage of patients.

Brill-Zinsser Disease:

It is defined as the recrudescence of epidemic typhus years after the initial episode. In contrast to acute primary infection, Brill-Zinsser disease is generally a mild illness. Severe symptoms and death are rare, primarily occurring in elderly and debilitated patients. The onset of Brill-Zinsser disease is typically abrupt with chills, fever, headache, and malaise. The nonspecific gastrointestinal and pulmonary symptoms are also present in many patients. Because patients with Brill-Zinsser disease are often elderly, symptoms such as confusion, dyspnea, or lethargy may be erroneously attributed to pre-existing or coexistent cardiac, cerebrovascular, or pulmonary disease (Tonge, 1959).

Rash is present in most patients with Brill-Zinsser disease, typically beginning four to six days after the onset of symptoms. The rash is often scant or evanescent and is only rarely petechial.

Diagnosis:

Serologic tests are the mainstay of diagnosis since isolation of *R. prowazekii* is generally impractical. Two serologic tests are widely available: an indirect immunofluorescent antibody test and an immunoblot technique. But, neither can reliably separate acute primary infection from Brill-Zinsser disease. Both forms of *R. prowazekii* infection are associated with a fourfold antibody response occurring 10 to 21 days after onset of symptoms (Eremeeva *et al*, 1994).

These tests are available in most state health departments, the CDC, and a few specialized research laboratories. The polymerase chain reaction has been used to diagnose one case of acute typhus infection but the reagents and facilities for this technique are rarely available in locations in which epidemic typhus is likely to occur.

Treatment:

Tetracycline and chloramphenicol are the only effective agents for epidemic typhus. The drug of choice is doxycycline. In a recent small study from Rwanda, for example, a single 200 mg oral dose of doxycycline cured 35 of 37 patients; the two remaining patients had a relapse six and seven days after initial response.

However, medical facilities are often inadequate in areas of the world in which epidemic typhus is seen. An alternative to doxycycline when the diagnosis cannot be made serologically is the empiric administration of chloramphenicol 500 mg orally or intravenously four times daily for five days.

This regimen is highly effective in epidemic typhus and simultaneously covers the possibility of meningococcemia and typhoid fever, infections that can mimic many or all of the clinical features of *R. prowazekii* infection.

Most patients treated with doxycycline or chloramphenicol improved markedly within 48 hours following the initiation of therapy. In the series from Rwanda, 29/ 37 patients were afebrile 48 hours after therapy was started. Supportive care, including fluids, vasopressors, oxygen, and even dialysis, may be required in patients with severe illness (Carl *et al*, 1990).

Prognosis:

The prognosis is dependent upon a number of factors including the age and underlying nutritional status and health of the patient and the speed with which therapy is administered. In the preantibiotic era, the mortality rates for epidemic typhus were related to age and sex, being higher in older patients and males. In the modern era, mortality is uncommon if either tetracycline or chloramphenicol is given. In a recent series of 60 hospitalized patients, for example, none of those treated with chloramphenicol or tetracycline died. Most patients remained ill during the first 48 hours of therapy but rapidly improved thereafter. But, in another report of an outbreak of epidemic typhus, two of nine patients died despite given chloramphenicol therapy.

Prevention:

Eradication of human infestation with lice will prevent transmission of epidemic typhus. As noted above, people

who live and work in close proximity to louse-infested individuals may be secondarily acquired lice even if they regularly wash their clothes and have good hygiene. Thus, all louse-infested persons and workers in close contact with such persons should use long-acting insecticides.

Human lice can be treated with agents such as DDT, malathion, and lindane, but reports of resistance to one or more of these agents have recently appeared. Pyrethroid permethrin when applied as a dust or spray to clothing or bedding is highly effective against lice and is the delousing agent of choice. Fabric treated with permethrin retains toxicity to lice even after 20 washings, thereby offering significant long-term passive protection against epidemic typhus (Sholdt *et al*, 1989).

Prophylaxis:

The use of chloramphenicol or tetracycline for prophylaxis may be highly effective in interrupting typhus outbreaks. Since even a single dose of doxycycline protected against epidemic typhus, some experts recommend the use of one 200 mg dose of doxycycline once weekly by travelers or health care workers residing in areas in which epidemic typhus is present. Prophylaxis is generally continued for one week after leaving such areas.

Vaccination:

Studies performed over 20 years ago showed that an inactivated vaccine gave a moderate degree of protection against experimental *R. prowazekii* infection. Besides, a reduced incidence of typhus occurred among individuals

vaccinated with both inactivated and an experimental E-strain vaccine. However, because of licensing concerns and additional concerns that spontaneous reversion of live E-strain may revert to a more virulent strain, the E-strain vaccine is not currently available or in use in any field studies.

What about Egypt:

In Egypt, many authors dealt with lice (Morsy *et al*, 1899b; Morsy *et al*, 2001; El Sahn *et al*, 2000; El-Sherbini *et al*, 2008 and others). el-Safy *et al*. (1991) detected pediculosis lymphadenopathy in Egyptian children, Abou-Gamra *et al*. (1992) correlated between lice infestation and asthmatic bronchitis, Abdel Fattah *et al*. (1994) found that pediculosis in female children caused cervical lymphadenopathy and Morsy *et al*. (1996b) reported abnormal distribution of the histocompatibility antigens (HLA) in lousy children.

The pubic or crab louse is small (2 to 3 millimeters, or 0.08 to 0.12 inches) and round, difficult to see unless it is filled with blood from a recent feeding. Four of its six legs have crab-like claws which allow it to grasp tightly onto hairs. Female lice live for three to four weeks, during which time she lays up to three eggs per day. The eggs hatch after about eight days. The crab louse may also be found on other areas of the body (eyebrows, armpits, beard, and mustache), but not found on the head. Animals do not carry or spread pubic lice. However, pubic lice apart from sexual intercourse transmission can move and may be spread from one person to another on clothing, bed-

sheets, towels, or other shared items. Most people infested with pubic lice complain of itching in the pubic or genital area. Other parts of the body, such as the armpits, may also be itchy if lice are present. Pale bluish spots may be seen on the skin a result of repeat feedings in the same area.

The children of parents infested with pubic lice occasionally develop an infestation of the eyelashes or eyebrows. This can cause an itching or burning sensation in the eyes, and the eyelids may appear red and irritated.

Anyone with pubic lice should notify their sexual partners and tested for other sexually transmitted infections. Clothing, towels, and bedding used within 72 hours pre-treatment should be washed and dried in an electric dryer on the hot setting or dry cleaned. Pubic lice are diagnosed by examining the genital area for lice or their eggs. Because pubic lice are a sexually transmitted infection (STI), testing for other as gonorrhea, chlamydia (Golden *et al*, 2005) and HIV (Wright and Katz, 2006) is often indicated.

The recommended treatment for the pubic lice is an insecticide lotion or cream that is applied to the skin. The most commonly used ones include: Permethrin (Nix[®], Rid[®]) Pyrethrin (A-200[®], Pronto[®], Tisit[®]). But, permethrin resistance was reported (Speare and Koehler, 2001). Morsy and El-Ghazali (1999) treated a four years old girl with pubic infestation in the scalp, eyelids, eyelashes, neck and shoulders, who had fever, severe itching, allergic reaction and anxiety with 2.5% permethrin

cream. Infested the eyelids and eyelashes was carefully removed by a fine forceps. Ayoub *et al*. (2008) used oral albendazole for pubic louse. Ma and Vano-Galvan (2010) removed pubic lice from the eyelashes with fine forceps, and petrolatum was applied twice daily. The pubic area was shaved and treated with 10% sulfur ointment once daily for three days. The patient was advised to wash all clothing and fomites. Her husband was treated simultaneously. Zvandasara and Lam (2010) recommended patients to present to eye casualties with a red eye and where treatment has already been started by the general practitioner, usually in the form of antibiotic drops or ointment for presumed bacterial/viral conjunctivitis.

Occasionally, the diagnosis is not simply a bacterial conjunctivitis and this can only be clarified by close ocular inspection for pubic louse. Scott *et al*. (2011) mentioned that diagnosis crab louse is usually clinical and screening for other STIs. While most evidence is extrapolated from studies of head lice treatments, topical pediculicides are recommended and treatment of sexual contacts is indicated.

Alternately, the person may take a pill (Ivermectin/Stromectol[®]), which is taken once and then repeated two weeks later. The skin should be cool and dry to minimize absorption of the insecticide through the skin. The lotion/cream is usually applied to the skin and hair in the pubic area, but not inside the vagina or rectum. The lotion should be left on for 10 minutes and then rinsed off. For treatment of head

lice many regimens were recommended. Among them was Co-trimoxazole (Morsy *et al*, 1996a), Ivermectin as topical application (Youssef *et al*, 1995) or orally (Nofal, 2010). Abou el-Ela *et al*. (2000) by evaluating LT₅₀ found that 3 minutes was least time to kill all lice with malathion, and the least dose was those of benzanil (1%=0.025) and malathion (1%=0.57). Abou El-Ela *et al*. (2004) found that Quick (0.5% malathion) was the most potent formulation against head lice, while Para plus was the least potent.

Many medicinal plants were tried. El-Basheir and Fouad (2002) used cream from plants *Lawsonia alba* (Al-henna). *Trigonella faenum-gracatum* (fenugreek), *Hibiscus cannabinus* (hibiscus) and *Artemisia cina* (worm-seed) and recommended henna mixed with aqueous extract of Al-sheah (100%) or Al-helba (75%) or Al- Al-karkadah (50%). Abdel-Ghaffar *et al*. (2010) applied grapefruit extract on head lice. Besides, Neem extract were highly recommended (Morsy *et al*, 2000; Abdel-Ghaffar and Semmler, 2007; Abdel-Ghaffar *et al*, 2012).

Morsy (2012) stated that most insect bites cause local inflammatory reactions that subside within a few hours. Nevertheless, more severe local symptoms, transmission of a disease-causing pathogen, and systemic allergic reactions are also possible. Mosquito bites can cause varying degrees of local swelling, papular urticaria in children, and rare systemic allergic reactions, including anaphylaxis. The papular urticaria is a hyper-sensitivity reaction most often seen in children following

mosquito and flea bites, although a variety of other bites have been implicated in smaller numbers of reports. Systemic allergic reactions can occur in response to the bites of mosquitoes, several types of blood-sucking flies, fleas, kissing bugs, lice, and ticks.

Conclusion and Recommendations

Head lice are spread most commonly by direct head-to-head (hair-to-hair) contact. However, less frequently they are spread by sharing clothing or belongings onto which lice have crawled or nits attached to shed hairs may have fallen. The risk of getting infested by a louse that has fallen onto a carpet or furniture is very small. Head lice survive less than 1-2 days if they fall off a person and cannot feed; nits cannot hatch and usually die within a week if they are not kept at the same temperature as that found close to the scalp. The following are steps to help prevent and control of head lice:

Avoid head-to-head contact during play and other activities at home, school, hospital, sports clubs, and elsewhere (CDC, 2010).

Do not share clothing such as hats, scarves, coats, sports uniforms, hair ribbons, or barrettes.

Do not share the combs, brushes, or towels. Disinfest combs and brushes used by an infested person by soaking them in hot water (at least 130°F) for 5-10 minutes.

Do not lie on beds, couches, pillows, carpets, or stuffed animals that have been in contact with an infested person.

Machine wash and dry clothing, bed linens, and other items that an infested

person wore or used during the 2 days before treatment using the hot water (130°F) laundry cycle and the high heat drying cycle. Clothing and items that are not washable can be dry-cleaned OR sealed in a plastic bag and stored for 2 weeks.

Vacuum the floor and furniture, particularly where the infested person sat or lay. However, spending much time and money on housecleaning activities are not necessary to avoid lice or nits that may have fallen off the head or crawled onto furniture or clothing.

Do not use fumigant sprays or fogs; to control head lice, they are toxic if inhaled or absorbed through the skin.

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