**Review article** **Bimonthly published scientific journal**

INTERNATIONAL JOURNAL of Indigenous Herbs and Drugs

# A review on *Pediculus humanus capitis*: Based on life cycle, resistance, safety considerations and treatment

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**Abstract**

Head lice infestation or *Pediculosis capitis*, caused by *Pediculus humanus capitis*, is a common health concern. In the US, where *Pediculosis capitis* is the most prevalent parasitic infestation of children, 6 to 12 million people are affected every year. *Pediculosis capitis* remains confined to the scalp. Scalp pruritus is the cardinal symptom, although patients with lice can be asymptomatic. Pruritus with impetiginization should prompt the physician to look for lice or viable nits. All close contacts should be examined. Treatment directed at killing the lice and the ova should be considered only if active lice or viable eggs are observed. The three fundamental effective treatment options for head lice are topical pediculicides, wet combing and oral therapy. Spraying or fogging a home with insecticides or pediculicides is not recommended.

**Keywords:** *Pediculus capitis,* Life cycle of head lice, Transmission, Symptoms, Treatment

## Introduction

*Pediculosis capitis*, also known as head lice infestation, caused by *Pediculus humanus capitis*, is a frequent community health concern. Infestation occurs most commonly in children, with a peak incidence between 5 and 13 y of age. Although *P. humanus capitis* is not a vector of human disease and poses no significant health risk to infested persons, head lice infestation can cause substantial social distress, discomfort, parental anxiety, embarrassment to the child, and unnecessary absence from school and work. Lice egg sheaths, referred to as nits, are firmly glued to individual hairs. Eggs are 0.8 mm in length and are laid within 1 to 2 mm of the scalp surface. Rarely, nits can be seen along the length of the hair shaft.

One female can lay about 150 eggs during a 30 d life span. Young lice hatch within 1 w and go through 3 nymphal instar stages, growing larger and maturing to adults over a period of 7 d. The first and second instar forms are relatively immobile and therefore are not easily transmitted between individuals; most spread is related to the third instar forms and adults. Head lice can survive for up to 3 d off the host; nits can endure 10 d of separation from the host [1, 2].

## Characteristics of lice

The head louse, *Pediculus humanus capitis*, is a host-specific arthropod that is 1 to 3 mm long and is grayish-whitish in color. It has narrow sucking mouthparts concealed within the head, short antennae, and three pairs of clawed legs adapted for grasping hair. A louse feeds by sucking blood and simultaneously injecting saliva with vasodilatory and anticoagulation properties into the host. Head lice move at a speed of up to 23 cm/min and are incapable of jumping or flying. Lice egg sheaths, referred to as nits, are firmly glued to individual hairs. Eggs are 0.8 mm in length and are laid within 1 to 2 mm of the scalp surface. Rarely, nits can be seen along the length of the hair shaft.

One female can lay about 150 eggs during a 30 d life span. Young lice hatch within 1 w and go through 3 nymphal instar stages, growing larger and maturing to adults over a period of 7 d. The first and second instar forms are relatively immobile and therefore are not easily transmitted between individuals; most spread is related to the third instar forms and adults. Head lice can survive for up to 3 d off the host; nits can endure 10 d of separation from the host.

New bites may cause reactivation of already healed bites. The most likely cause of the bite reactions seems to be the inflammatory response to injected louse saliva or anticoagulant. At the time of the first lice infestation, pruritus may not be seen for 1 to 2 mon because it takes time to develop sensitivity. Therefore, by the time the patient is symptomatic, he or she may have been infested for at least 1 mon already [3].

## Epidermiologic characteristics

*Pediculosis capitis* affects about 6 to 12 million people every year. The prevalence of head lice remains high. No age or economic stratum is immune to *P humanus capitis*, although crowded living conditions tend to be associated with a higher prevalence of infestation. *P humanus capitis* is the most common parasitic infection of children. Head lice infestation is not influenced by hair length or frequency of shampooing or brushing. Girls are about twice as likely to get head lice as

**Bharti SN, Umekar MJ, Duragkar NJ. A review on *Pediculus humanus capitis*: Based on life cycle, resistance, safety considerations and treatment. Int J Ind Herbs Drugs 2017; 2(2): 27-36.**

boys. Infestations in the US are less common in blacks, due to physical characteristics of their hair shaft, which is more oval-shaped and is therefore more difficult to grasp.

Head-to-head contact is the most important mode of transmission. *Pediculosis capitis* can be transmitted by infested clothing, hats, hairbrushes, combs, towels, bedding and upholstery.

**Clinical manifestations**

Head lice infestations are characterized by nits attached to hairs approximately 0.7 cm from the scalp. Nits are often found in the occipital and retro-auricular portions of the head and are easier to observe than crawling adult lice. Pruritus is the principal symptom, although patients with lice can be asymptomatic. Bite reactions, excoriations, secondary impetiginization, pyoderma, cervical lymphadenopathy, conjunctivitis, fever and malaise are also possible manifestations. Pyoderma may be accompanied by alopecia. A morbilliform hypersensitivity rash can mimic a viral exanthema. In longstanding cases, dermatitis of variable severity can be seen, characterized by exudation and crusting, especially in the occipital region.

Uncommonly, in heavily infested and untreated patients, the hair can become tangled with exudates, predisposing the area to fungal infection. This results in a malodorous mass. Countless lice and nits can be found under the entangled hair mass.

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**Histopathologic characteristics**

The classic lesion shows a deep wedge-shaped intradermal hemorrhage with a perivascular infiltrate of lymphocytes, histiocytes and eosinophils within the dermis.

**Diagnosis**

The gold standard for diagnosing head lice is the identification of a live louse, nymph or a viable nit on the head. Because head lice avoid light and crawl quickly, visual inspection without combing is difficult. Using lice combs increases the chances of finding live lice and is a helpful screening tool. The diagnosis of lice infestation using a lice comb is fourfold more efficient than a direct visual examination.

The tiny nits are easier to observe, especially at the nape of the neck or behind the ears. Nits by themselves are not diagnostic of active infestation. However, if the nits are found within 0.7 cm of the scalp, active infestation is likely. Recognition can be facilitated by a magnifying glass. Wood's lamp examination reveals yellow-green fluorescence of the lice and their nits. Dermoscopy is also a possible aid in the diagnosis and follow-up of *Pediculosis capitis*. There are new generations of hand held dermoscopes that do not require direct contact, preventing the possible risk of transferal. Pruritus with impetiginization should alert the physician to look for lice or viable nits.

Dead eggs can empty eggs remain glued to the hair shafts for as long as 6 mon. Human hair grows at a rate of approxmately 1 cm/mon. As the hair grows, the cemented empty nits move away from the scalp. After 2 to 3 mon, these empty nits become more visible, especially on dark hair. This appearance of "nits" several months after a treatment can lead to a false-positive diagnosis of an active infestation because most people cannot differentiate between viable and, and assume that if eggs are present the child must also have lice. Therefore, the importance of identifying a live moving louse, nymph or viable nit on the head for correct diagnosis cannot be stressed enough.

**Life cycle of head lice**

Nits/eggs

Head lice begin their lives as eggs, or "nits." The female adult head louse may lay an average of five eggs per d. 4 eggs are attached singly to a hair shaft with a "glue" that is resistant to chemical and mechanical dislodgement (Figure 4). Eggs are normally cemented to the shaft of the hair very close to the scalp. Nits are oval or teardrop-shaped and may range in color from white, yellow, or tan to gray, depending upon age and whether or not the egg has hatched or been killed by head lice treatments. It is thought that eggs attached to hairs greater than one-quarter inch from the scalp have either already hatched, or will not hatch.

Nymphs

Eggs spend seven to ten d incubating close to the scalp before hatching to release the first nymphal stage (Fig. 5). Nymphal stage head lice look very much like a miniature adult louse (Figure 6).

The newly hatched nymph will crawl and seek a place to feed immediately. There are three nymphal stages punctuated by molting (the shedding of exoskeleton or "skin"). The three nymphal stages last about 8-12 d.

Adults

The final molt leads to an adult stage (Figure 6) where body growth stops and sexual maturation occurs. Adult head lice continue to feed on blood every three to six h. There are separate sexes in head lice and females must mate and be fertilized in order to produce viable eggs. A mated female can continue to produce eggs for the duration of her life, which is about 30 d. She can lay an average of five eggs daily during this period [4, 5].

Until recently, the life cycle of the human head louse has been difficult to quantify because of environmental variance and the unavailability of in vitro rearing systems. From a



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practical perspective, one can view the life cycle of *Pediculus humanus* var. *capitis*as follows:

(1) Egg without an eyespot (the eyespot indicating a developed nervous system)

(2) Egg from lay to hatch

(3) First nymphal (instar) stage to egg-laying adult.

In the context of a nonovicidal therapy, without considering pediculicide resistance, a"worst-case" scenario for therapy (or best case scenario for lice survival) is a life cycle with the longest time spent as an egg (12 d) and the shortest time spent as anon–egg-laying adult (8.5 d) [6-11].

**Figure 1: Infested Child**

**Figure 2: Head Louse**

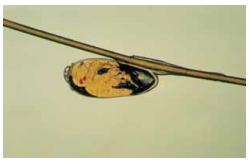

**Figure 3: Head louse nit**

Figure 4

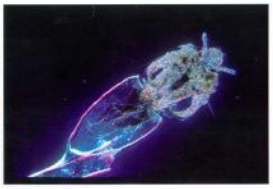

Figure 5

Adult louse actual Size

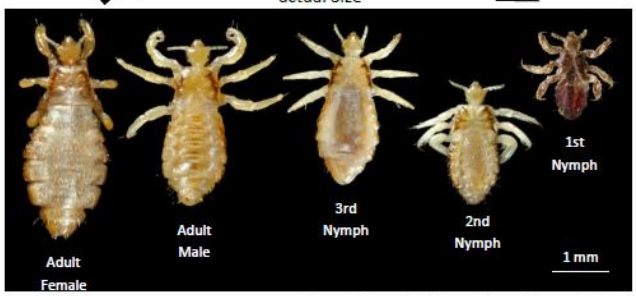


Figure 6

Image: Centers for Disease Control/James Gathany

**Figure 4: Head lice eggs, or nits, are attached singly to hair shafts close to the scalp. They may be confused with dandruff or dried particles of hair spray or gel; Figure 5: Head lice eggs will hatch into first stage nymphs in 7-10 days; Figure 6: Head lice progress through three nymphal stages into the sexually mature adult stage. All stages of head lice feed on blood.**

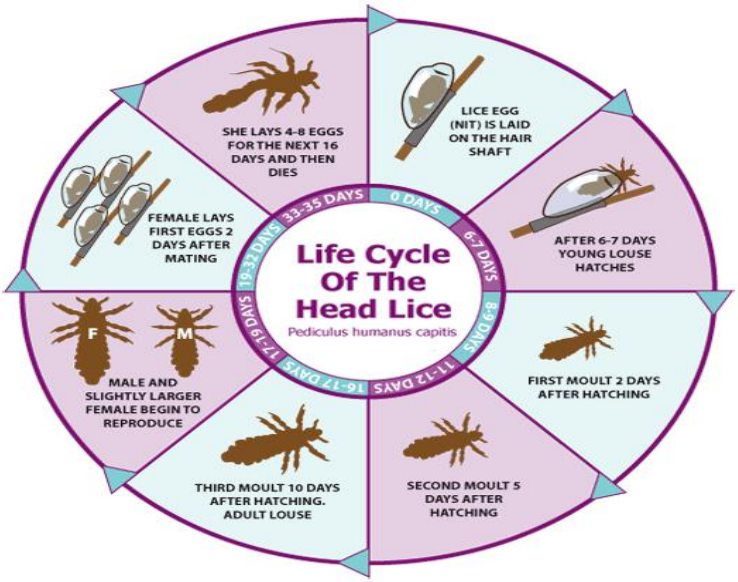


**Figure 7: Life cycle of lice**



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**Transmission of head lice**

Head lice are transmitted by

- Person-to-person transmission (direct contact) – The majority of transmissions of head lice occur by direct head-to-head contact with an infected person. Most of the time it is a close friend or relative.
- Vector transmission (indirect contact) – This type of transmission may occur through the sharing of bedding, or by using personal items such as combs, brushes, scarves, hair ornaments, or hats of an infected person. Although transmission via indirect contact is possible, it is rare.

Common ways of transmission through head-to-head contact include:

- Slumber parties
- Shared beds
- Sport activities
- Reading circles

Without head-to-head contact, these ways of transmission are highly unlikely:

- School buses
- Hats, helmets, or headphones
- Gym mats
- Sitting at a desk

Anyone can get head lice, but some people are at greater risk than others. Those people include:

- Children between the ages of 3 and 11 years
- Girls are more likely to get head lice than boys, possibly because of their play styles and sharing of personal items.
- People with long or short hair can contract head lice. Although all races can get head lice, studies show that children of African-American descent are less likely to become infested.

**Symptoms of head lice**

Parents, teachers, and other care givers should be aware of the signs and symptoms of a head lice infestation because young children may not be able to express their discomfort directly. The following symptoms should raise the level of suspicion for a head lice infestation:

- Itching (“pruritis”): Caused by an allergic reaction to lice bites. When lice feed, they inject a small amount of saliva into the skin. Over time, the host can develop an immune reaction to the saliva which results in inflammation and itching. It may take four to six weeks for this reaction to occur in people infested for the first time. However, itching may not be present in all cases.
- Sores on the head: Rarely, scratching can lead to abrasions on the skin, allowing bacteria to enter and possibly lead to infection. In severe cases, lymph nodes around the head, neck and underarms can become swollen.
- Tickling sensation: Lice movements in the hair may be felt by some infested individuals.
- Sleeplessness and irritability: Lice are more active at night, possibly disrupting sleep.

Some people with head lice infestations have no symptoms. A lack of symptoms does not mean a lack of head lice.

**Figure 8: Head lice infestation may sometimes be characterized by the presence of scabs or scars on the scalp from itching. In the above photo, nits are also evident on hair shafts**

**General therapeutic considerations**

Considerations in evaluating a lice therapy must include an understanding of a therapy’s mechanism of action and resistance, prevalence of resistance, and safety. Application instructions also bear significance in light of the head lice life cycle. In the face of highly prevalent resistance to a particular molecule, therapy would likely be successful in only a small proportion of patients with lice infestations. Repeat treatments of resistant lice with preparations to which they are resistant will not kill the lice. In addition to wasting money, the patient is unnecessarily exposed to any associated toxicity of the therapy.

Putting aside the issue of resistance, a perfectly ovicidal and pediculicidal agent that acts on the louse nervous system requires 2 treatments separated at least 7 d apart. On d 0, all lice and eggs with eye spots would be killed. Those eggs without eyespots would develop eyespots by day 7 and thus be susceptible at that time. A solely pediculicidal agent would require 3 applications separated by 7 d (Figure 1). On d 0, all lice would be killed, leaving only newly laid eggs and eggs just about to hatch. Therapy on day 7 would kill those eggs that hatched. These nymphs would not have had time to mature to egg-laying adult. What would remain are those eggs that are 7 d old but did not hatch. Therapy anytime between days 13 and 15 would kill the nymphs from those eggs, precluding development to egg-laying adult.

Using average, rather than extreme, values for egg hatch (8.5 d 10) and maturation time (9.7 d 5,10)lowers the demand for treatment by a solely pediculicidal agent to d 0 and 9 (Figure 2). Indeed, so long as the average time to hatch is less than the average time to mature to egg-laying adult, only 2 treatments are theoretically necessary. The challenge is to identify the time interval after which all eggs should be hatched but before which new eggs are laid. The assurance



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of successful therapy is now at the mercy of favorable population statistics. Provided there is no resistance, enough lice may be killed to allow for stochastic extinction. These considerations become somewhat less relevant in the presence of resistant lice, which are not expected to respond regardless of treatment schedule.

Worst-case scenario

Treatment at day 0 kills all lice not in eggs. We are left with eggs laid just before therapy and eggs just hatched after therapy is washed away. For non ovicidal therapies, treatment must occur before each batch of hatched eggs matures to egg-laying adult. So, choosing d 7 gives a good buffer to the first deadline, which is d 8.5. We are left with eggs aged 7 and 12 d. We must treat before day 15.5 to kill d 7 hatchlings before they mature to egg-laying adult. We must treat after d 12 to assure that all eggs have hatched before the last treatment. One could, theoretically, choose d 0 and 8 and then d 12 to 16.5, but treatment at d 0, w 1 and w 2 is easier to remember.

Average-times scenario

Treatment at day 0 kills all lice not in eggs. We are left with eggs laid just before therapy and eggs just hatched after therapy is washed away. For nonovicidal therapies, treatment must occur before each batch of hatched eggs matures to egg-laying adult. In this case, all eggs will have hatched by d 8.5, but none will have matured to egg-laying adult until at least d 9.7. This leaves day 9 as the second and final therapy [12-17].

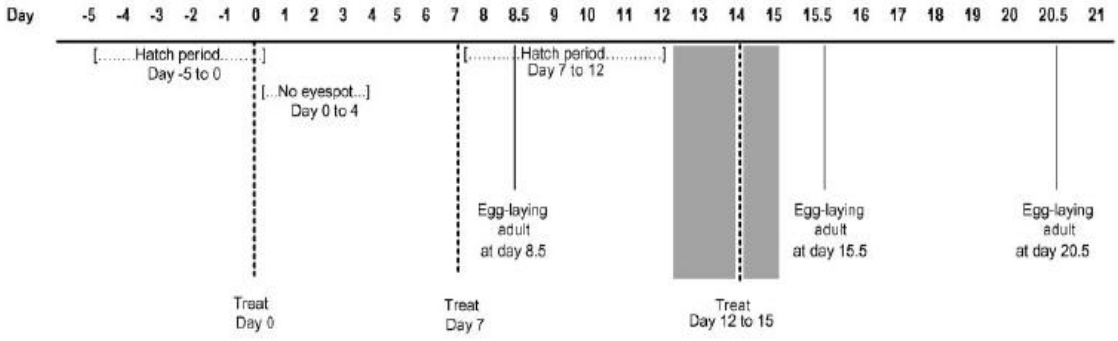


**Figure 9: Worst-case scenario**

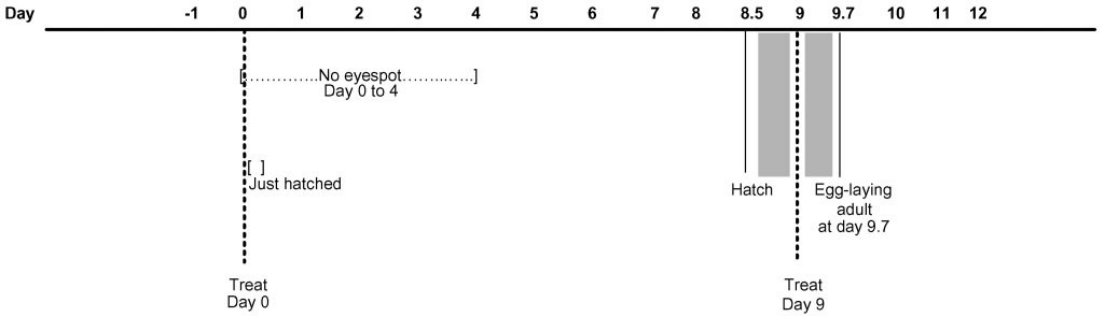


**Figure 10: Average-times scenario**

**Treatment of head lice**

Every member of the household and all other close contacts should be examined. Treatment should be considered only if live lice or viable nits are observed. All clothing, towels, bed linens, stuffed animals and cloth toys used by an infested child within 2 d prior to diagnosis should be washed in water hotter than 50 °C, or machine dried at the highest heat setting, for at least 30 min. Headgear, combs, headphones and helmets should be cleaned and disinfected with a pediculicide or isopropyl alcohol. If none of the aforementioned modalities are plausible, sealing the objects in a plastic bag for 2 w is also option to ensure decontamination.

Floors, rugs, play areas, pillows, carpet squares and upholstered furniture should be vacuumed to eliminate any shed hairs with viable eggs [18-20].

The treatment should be directed at killing the lice and the ova. There are two effective basic treatment options for head lice:-

Synthetic drugs

- Topical pediculicides
- Wet combing
- Oral therapy

Natural drugs

Pediculicides are the most efficacious treatment for *Pediculosis capitis*. Agents with long residual effects are more likely to be ovicidal. Treatment failures are often due to non



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compliance, improper application of pediculicides or reinfestation and rarely resistance to pediculicides. Pediculicides are not recommended for children younger than 2 y.

**Synthetic drugs**

Topical agents

Pyrethrin

The treatment of choice for head lice infestation in the US is a synthetic pyrethrin, 1% permethrin cream rinse. The hair is first shampooed with a non-conditioning shampoo and towel dried. Thereafter, a 1% permethrin cream rinse is applied left on for 10 min and then rinsed off. Permethrin acts as a neurotoxin by disrupting the sodium channel current; causing delayed repolarization and subsequent paralysis of the nerves in exoskeletal muscle that allows the lice to breathe. Permethrin is the only pediculicide with a residual activity lasting for over 2 w. It is both pediculicidal and ovicidal. Therefore, one treatment is generally adequate. However, a second course7 to 10 d later, ensures a 95% cure rate. Resistance to1% permethrin has been reported, but the prevalence of this resistance is unknown.

Pyrethrins plus piperonylbutoxide

These are manufactured from natural chrysanthemum extracts and are neurotoxic to lice. Natural pyrethrins have low mammalian toxicity, but could cause a reaction in individuals that are allergic to chrysanthemums or ragweed. These over-the-counter products are mostly shampoos that are applied to dry hair and left on for 10 min before rinsing out. None of the natural pyrethrins are completely ovicidal because newly laid ova lack a nervous system for the first 4 d. About 20% to 30% of the eggs remain available after the first treatment. This requires reapplication 7 to 10 d later to kill newly emerged nymphs hatched from eggs that survived. Resistance of adult lice to these products has been reported.

Malathion (0.5%)

This is an organophosphate (acetylcholinesterase inhibitor) that works by causing respiratory paralysis in the arthropod. This agent is a lotion that has to be applied to the hair, left to air dry and washed off after 8 to 12 h. Malathion has high ovicidal activity, but the product should be reapplied if live lice are seen in 7 to10 d. The major concerns are the high alcohol content of the product, making it highly flammable (hairdryers or curling irons should be avoided during treatment, and the risk of severe respiratory depressionin case of accidental ingestion. It should be used with extreme caution in cases in which resistance to other pediculicidal products is strongly suspected.

Permethrin (5%)

This is a cream, available only by prescription in the US. This product is usually applied overnight for scabies. It is not currently approved by the Food and Drug Administration for use as a pediculicide. It has anecdotally been recommended for the treatment of head lice that appear to be refractory to other treatments. It is applied to the scalp and left on for several h or overnight, after which it should be rinsed off. No case-control studies have reported efficacy to date. One study suggested that lice resistant to 1% permethrin will not succumb to higher concentrations.

Crotamiton (10%)

This is a lotion, available only by prescription in the US. It is not currently approved by the FDA and is used to treat scabies. A single study showed it to be effective against head lice when applied to the scalp and left on for 24 h before rinsing out. Safety and absorption in children, adults and pregnant women were not evaluated.

Carbaryl (0.5%)

This is a carbamate that binds to the same site on the acetylcholinesterase enzyme as organophosphates. In the UK in 1981, an open-label clinical study with 0.5% carbaryl lotion achieved a 100% cure rate in 81participants. In 2000, an *in-vitro* survey showed prolonged survival of head lice with carbaryl exposure inone UK regions. A follow-up, non-randomized, open label clinical trial showed an 89% cure rate in this region compared with a 100% cure rate in another region. Carbaryl use is falling out of favor; based in part on evidence that it might be carcinogenic. The Department of Health in the UK acknowledges that carbaryl has amutagenic potential and should continue to have restricted use only.

Lindane (1%)

This is an organochloride that has central nervous system toxicity in humans. Several cases of severe seizures in children using lindane were reported. The use of lindane for treatment of lice or scabies was banned by California in 2002 due to concern over water supply contamination. It is available by prescription only, as a shampoo that should be left on for no more than 10 min with repeated application in 7 to 10 d. It has low ovicidal activity and resistance has been reported worldwide for many years. It should be used very cautiously. Lindane is contraindicated for pregnant or nursing women, in patients with seizure disorders and in patients with hypersensitivity to the product. The FDA has issued a public health advisory on the safety of lindane products.

All topical pediculicides have to be rinsed from the hair over a sink, rather than in the shower or bath to limit exposure and with cool water, in order to minimize absorption due to vasodilatation [21-23].

Pediculicide resistance

None of the currently available topical pediculicidesis 100% ovicidal and resistance to all of them has been reported. A study conducted in the UK in 2000 concluded that there was high resistance to permethrin, phenothrin and malathion with an 87% failure rate for permethrin and a 64% failure rate for malathion with the topical treatment. There are no reports of wide spread malathion resistance in the US. The prevalence



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of resistance is not known. When faced with a persistent case of head lice, several additional possible explanations must be considered, including: misdiagnosis, noncompliance, re-infestation, lack of ovicidal or residual pediculicidal properties of the product, incorrect application, or resistance of lice to the agent.

Nit removal after treatment with a pediculicide

Because none of the pediculicides are 100% ovicidal, manual removal of nits with a fine-toothed nit comb after treatment with any product is recommended. Nit removal can be difficult and time consuming. Removal of nits with a lice comb is easier when the hair is wetted with water or after shampooing or treatment with a conditioner.

Some products are available that claim to loosen the “glue” that attaches nits to the hair shaft, making the process easier. Vinegar or vinegar-based products (ClearLice Egg Remover Gel) are intended to be applied to the hair for 3 min before combing out the nits. Noclinical benefit has been demonstrated. 8% formic acid applied to wet hair for 10 min before combing out the nits has been shown to have some benefit in one study. Acidic solutions (pH4.5–5.5) probably make the surface of the hair smoother, facilitating sliding the eggs off the hair. Neither of these products is recommended for use with permethrin because they may interfere with that product’s residual activity [24-26].

Wet combing

Mechanical removal of lice with the use of wet combing is an alternative to insecticides. The rationale behind it is the fact that lice cannot move to another host within 7 d after hatching and cannot reproduce within 10 days and all eggs hatch within 7 to 10 d. The combing procedure is done on wet hair with added lubricant (hair conditioner or olive oil) and continued until no lice are found (15 to 30 min per session or longer for long, thick hair). Combing is repeated once every 2 to 3 d for several w and should continue for 2 w after any session in which an adult louse is found. This approach cured 38% of children in a trial conducted in 2000 in the UK, in which the treatment was carried out by parents, but it was only half as effective as malathion treatment. However in 2005 a new trial was conducted in the UK comparing the effectiveness of a current BugBuster® kit with over-the-counter pediculicides containing malathion or permethrin. The cure rate for wet combing with conditioner employing the Bug Buster®kit was found to be significantly greater than that for the over-the-counter pediculicides (57% v 13%) [27].

Oral agents

Sulfamethoxazole/trimethoprim

These are used inotitis media doses was shown to be effective against head lice. This antibiotic is thought to kill the symbiotic bacteria in gut flora of the louse, there by interfering with its ability to synthesize vitamin B. Death ensues from vitamin. In a recent study, this antibiotic demonstrated synergistic activity when used in combination with permethrin 1% when compared with permethrin 1% or sulfamethoxazole/ trimethoprim used alone. However, the treatment groups were small. Severe life threatening allergic reactions, including Stevens Johnson syndrome and toxic epidermal necrolysis, despite being rare, make it an undesirable therapy if other alternatives exist. It is not currently approved by the FDA for use as a pediculicide. Several anti-helminthic agents including ivermectin, levamisole and albendazole may be effective treatments for *Pediculosis capitis*.

Ivermectin

This is an anti-helminthic agent structurally similar to the macrolide antibiotics, but without antibacterial activity. A single oral dose of 200 mg/kg, repeated in 10 d, was shown to be effective against head lice. This agent is also suggested as a good option for treatment of mass infestations. If ivermectin crosses the blood-brain barrier, it blocks essential neural transmission. Young children are at a higher risk for this adverse drug reaction. Therefore ivermectin should not be used for children that weigh less than 15 kg and in children younger than 5 y. This product is not currently approved by the FDA as a pediculicide.

Levamisole

A dose of 3.5 mg/kg once daily was suggested being effective against pediculosis upon administration for 10 d.

Albendazole

A single dose of 400 mg, or a 3 d course of albendazole 400 mg, is effective against *Pediculosis capitis*, with a repeated single dose of albendazole 400 mg after 7 d. No synergistic effect between albendazole and 1% permethrin was found. The use of these systemic treatments for head lice is only justified in severe infestation when topical treatments have failed or are ineffective [28-29].

Occlusive agents

The use of a “petrolatum shampoo,” consisting of standard petroleum jelly massaged on the entire surface of the scalp and hair and left on overnight with a shower cap, was suggested to be effective. Thorough shampooing is required for the next 7 to 10 d to remove the entire residue. This thick substance obstructs the respiratory spiracles of the louse, preventing efficient air exchange, as well as the holes in the operculum of the eggs, resulting in death by suffocation. Another interpretation is that the intense attention to hair grooming results in removal of all the lice and nits. Hair pomades are easier to remove than petroleum jelly, but may not kill the eggs, and treatment should be repeated weekly for 4 w. Other occlusive substances have been suggested (mayonnaise, tub margarine, herbal oils, olive oil), but to date only anecdotal information is available regarding their efficacy.

During the past year, two new products for treating head lice were released in the UK: 4% dimethicone (Hedrin®) lotion



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and Full Marks® solution. These products act by coating the louse and disrupting its ability to manage water. Hedrin® was found to cure at least 70% of cases in two clinical trials. There is no clinical evidence to support Full Marks® product effectiveness yet.

A recent study suggests that Cetaphil® cleanser can be used as a dry-on, suffocation-based pediculicide lotion (NUVO® lotion) and is effective in the treatment of *Pediculosis capitis*. However the study was anecdotal, not a well-designed randomized trial and did not use a proper method to make the diagnosis of head lice infestation [30].

Head lice repellents

The insecticide residues left on hair shafts probably act as insect repellents even if the louse is resistant to the lethal effects of the insecticide. Piperonal is available as a head lice repellent spray. Lavender, citronella and anise are also shown to be effective lice repellents in *in-vitro* studies. Citronella repellant formulation was found to be 3 to 4 times more effective than the placebo in protecting against head lice infestations.

Head lice infestation is associated with little morbidity, but causes much anxiety, d lost from school and work and millions of dollars spent on medications. *Pediculosis capitis* remains a prevalent disease that necessitates a multidisciplinary treatment approach. Adults should be aware of the signs and symptoms of head lice infestation; affected children should be treated promptly to minimize spread to others. The school or child care facility should be notified immediately so that additional cases can be detected and treated in a timely manner. Chemical pediculicides should be used rationally and in conjunction with nonchemical treatment modalities to prevent emergence of resistance. Therapy rotation may also slow the appearance of resistant species. Healthy children should not be excluded from school due to head lice. The “no nit” policies for return to school needlessly keep many children out of school and create significant financial difficulties for their parents. These policies should be discouraged because they usually result in many children with non viable nits being kept out of school while asymptomatic children with active infestation remain in the classrooms. Because most children with nits alone will not become infested, excluding these children from school and requiring them to be treated with a pediculicide is unwarranted. Due to the fact that most available pediculicides are incomplete ovicides, treating children with nits alone may not prevent subsequent infestation. Instead, children with nits alone should have regular follow-up examinations with a lice comb during the following 14 d. Children with more than 5 nits within 0.7 cm of the scalp are at higher risk of becoming infested and may need more frequent follow- up examinations. Parental education programs are helpful in managing head lice. Only through improved understanding of the biology and physiology of the head louse can we effectively employ new and existing treatment modalities [31].

**Natural drugs**

*Pongamia pinnata*

Various extracts of *Pongamia pinnata* leaves were tested against the head louse *Pediculus humanus capitis.* Finding revealed that petroleum ether extracts possess excellent anti-lice activity with values ranging between 50.3% and 100% where as chloroform and methanol extracts showed moderate pediculocidal effects. The chloroform and methanol extracts were also successful in inhibiting nymphs emergence and the petroleum ether extract was the most effective with a complete inhibition of emergence. Petroleum extract showed excellent activity due to the presence of triterpenoids.

*Dichrostachy scinerea*

*Dichrostachy scinerea* (Fam: Mimosaceae) known as Vurtuli in Hindi, Vidattalai in Tamil, Velantarah in Sanskrit and Sickle bush in English. The generic name ‘Dichrostachys’ means coloured spikes. It is a much-branched thorny shrub, sometimes a small tree up to 2m in height. It is distributed throughout the dry and warm parts of India. Brushed young shoots used in the treatment of ophthalmia, astringent, rheumatism and urinary calculi, the leaves are used as fodder. Antilice activity of aqueous and ethanolic extract of *Dichrostachy scinerea* was studied. To provide scientific basis for the traditional claim it was compared with the marketed sample preparation. The ethanolic extract showed 98% mortality in 90 min. *D. scinerea* can be used in the herbal formulation as pediculicidal agent.

*Calpurnia aurea*

The genus *Calpurnia* (Leguminosae) comprises some seven species which are widely distributed in South Africa. *Calpurnia aurea* (Ait.) Benth is a yellow-flowered small tree or shrub (*Natal Laburnum*) widely distributed in Africa from Cape Province to Eritrea and which also occurs in Southern India.

*Calpurnia aurea* is used for the treatment of amoebic dysentery and diarrhea in animals, killing head lice in humans and ticks in animals, syphilis, diarrhea, leishmaniasis, tapeworm, trachoma, tineacapitis, wound, scabies, elephantiasis and different swellings. In South Africa, Calpurnia leaves and powdered roots are used to destroy lice and to relieve itches. Unspecified parts are used to destroy maggots and the leaves are used to treat allergic rashes, particularly those caused by caterpillars. In East Africa, leaf sap is used to destroy maggots in wounds. In Nigeria, the seeds are used to treat abscesses. In Ethiopia it is used to treat stomach complaints, headache, eye diseases, amoebic dysentery, scabies (skin infection caused by ticks) and as an insecticide.

*Tagetes minuta*

*Tagetes minuta* belongs to the family Asteraceae. *T. minuta* is rich in many secondary compounds including monoterpenes,



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sesquiterpenes, flavonoids and thiophenes. Because of the presence of these secondary compounds, *T. minuta* posses both insecticidal and anti lice activity.

*Azadirachta indica*

Because topical compounds based on insecticidal chemicals are the mainstay of head lice treatment, but resistance is increasing, alternatives, such as herbs and oils are being sold to treat head lice. Seed extract of the neem tree was used and it was found to be the most effective than the other extracts of the neem tree.

Pyrethrin

The natural or synergized pyrethrins are a mixture of 6 active extracts from the flower heads of the ragweed relative *Chrysanthemum cinerariae folium*. Pyrethrins are usually available over the counter as a synergized formulation of 0.33% pyrethrin in 4% piperonylbutoxide. Pyrethrins blocks sodium channel repolarization of the arthropod neuron, leading to paralysis and death. Pyrethrins are unstable in heat and light and have no residual activity after rinsing. Two applications of pyrethrins, separated by 1 w, are generally required because these agents are not ovicidal. Even with appropriate application, treatment failure has occurred [32-35].

**Conclusion**

In light of the review of therapeutic modes of action, resistance considerations, and head lice biology the number of new commercially available natural products for head lice has expanded over the last decade to a much greater extent than products containing defined chemical insecticides. However, the evidence on the efficacy of these new products based on published results of *in vitro* and clinical trials is markedly deficient. Evidence on safety is also deficient. All over the counter natural products should be supported by *in vitro* data and well designed comparative therapeutic trials using head lice derived from the populations for whom the product is intended.

Since the prevalence and degree of insecticide resistance of head lice to pyrethrin, permethrin and malathion is expected to increase, alternative topical therapies for pediculosis are needed. It is possible that, on the long run, plant extracts, or their constituent compounds, will replace chemical insecticides on the market.

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Conflict of Interest: None declared,
Received: 28 February 2017, Revised: 09 March 2017, Accepted: 02 April 2017




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