

# What's Eating You? Head Lice (*Pediculus humanus capitis*)



Alicia T. Dagrosa, MD; Dirk M. Elston, MD

## PRACTICE POINTS

- Transmission of head lice occurs most frequently from direct head-to-head contact; however, head lice can survive up to 4 days on fomites.
- Patients present with scalp pruritus and bite reactions (papules or wheals), but pediculosis can be asymptomatic, particularly with the first exposure before the immune system has developed sensitivity to the louse saliva.
- Topical pyrethroids are available over-the-counter and are considered first-line therapy; however, resistance to pyrethroids has become an important problem in the United States and worldwide.
- Newer topical treatments such as benzyl alcohol lotion 5%, spinosad topical suspension 0.9%, and ivermectin lotion 0.5% can be prescribed as alternative therapies, particularly if resistance to pyrethroids is a concern.

The head louse (*Pediculus humanus capitis*) is a blood-sucking arthropod of the suborder Anoplura. Infestation continues in epidemic proportions in children of all socioeconomic groups. Although not implicated as a disease vector, infestation can lead to considerable distress, missed days of school, and secondary infections. Pyrethroids are recommended for treatment, but resistance is common. Newer agents, including benzyl alcohol and spinosad, have been developed to address this gap in care.

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**T**he head louse (*Pediculus humanus capitis*) is a blood-sucking arthropod of the suborder Anoplura. Lice are obligate human parasites that have infested humans since antiquity. Pediculosis capitis is an infestation

of the scalp by head lice. It is estimated that 6 to 12 million individuals in the United States are affected with head lice per year.<sup>1</sup> Resistance to topical chemical pediculicides is widespread, and new agents have been developed to address this gap in care.

## Characteristics of Head Lice

The head louse is a tan-gray-colored, wingless insect measuring approximately 2- to 3-mm long with 3 body segments. It has 6 legs with claws used to grasp individual hairs, and it moves by crawling; it does not fly or jump.<sup>2,3</sup> The head louse has an elongated abdomen and a small head with short antennae and anterior piercing mouthparts (Figure 1).<sup>4</sup> Nits are transparent, flask-shaped, 0.5- to 0.8-mm egg cases found firmly cemented to the hair shafts approximately 1 to 4 mm above the level of the scalp (Figure 2).<sup>5</sup> The head louse resides on scalp hair and feeds off the scalp itself. Both lice and nits can be present throughout the scalp but are most commonly found in the postauricular and occipital scalp.<sup>3,4</sup>

Female lice live approximately 30 days and lay 5 to 10 eggs per day. Eggs incubate individually in nits laid close to the scalp for 8 to 10 days before hatching.<sup>1,6</sup> The newly hatched nymphs (also called instars) have multiple exoskeletons that are shed as they grow.<sup>7</sup> Nymphs mature into adults in approximately 2 weeks, and the life cycle begins again.<sup>8</sup> Head lice are obligate human parasites, feeding approximately every 4 to 6 hours on the blood of the host; however, they can survive up to 4 days without a blood meal on fomites if the climate and conditions are favorable.<sup>5,9</sup>

## Epidemiology and Transmission

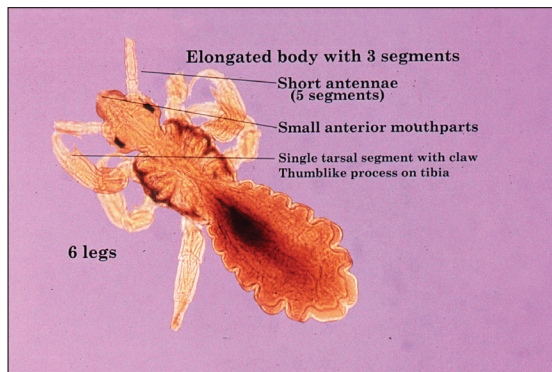
Head lice infestations commonly occur in children aged 3 to 11 years and are more prevalent in girls and women.<sup>1,10</sup> Infestation rates are not reliably recorded, and few population-based studies have been performed; however, it is estimated that 6 to 12 million individuals are infested annually in the United States.<sup>1</sup> Prevalence in some European populations

Dr. Dagrosa is from the Section of Dermatology, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire. Dr. Elston is from the Department of Dermatology and Dermatologic Surgery, Medical University of South Carolina, Charleston.

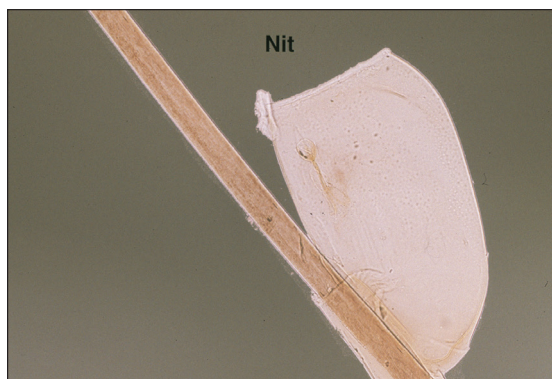
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Correspondence: Alicia T. Dagrosa, MD, Section of Dermatology, Dartmouth-Hitchcock Medical Center, 1 Medical Center Dr, Lebanon, NH 03756 (Alicia.T.Dagrosa@hitchcock.org).



**FIGURE 1.** Identifying characteristics of the head louse.



**FIGURE 2.** Hair shaft with an attached nit.

has been estimated to range from 1% to 20%.<sup>11</sup> A 2008 literature review found that worldwide prevalence varied across populations from 0.7% to 59%.<sup>10</sup>

Transmission occurs most frequently from direct head-to-head contact. One study found that transmission is most likely to occur when hairs are arranged in a parallel alignment and move slowly in relation to one another.<sup>12</sup> Although controversial and probably less notable, transmission also may occur indirectly via fomites or the sharing of hairbrushes, hats, or other headgear.<sup>13,14</sup> Classrooms are a common place for transmission.<sup>1</sup> A 2009 study in Germany found an increase in health department consultations for head lice when schools reopened after vacations. The investigators also found that pediculicide sales peaked from mid-September through October, subsequent to schools reopening after the summer holiday.<sup>15</sup> There is some evidence that overcrowded housing also can lead to increased incidence and transmission.<sup>16,17</sup> There is no consistent correlation of infestation with socioeconomic status.<sup>1,17,18</sup>

### Clinical Manifestations and Diagnosis

Clinically, patients with head lice present with scalp pruritus and sometimes posterior cervical or occipital lymphadenopathy. Pediculosis also can be asymptomatic. With the first exposure, symptoms may not develop for up to 4 to 6 weeks as the immune system develops sensitivity

to the louse saliva.<sup>6</sup> Bite reactions consisting of papules or wheals are related to immune sensitization.<sup>5</sup> Louse feces and excoriations from scratching to relieve itch also may be present on examination. Secondary infection of excoriations also is possible.<sup>1</sup>

Diagnosis of an active infestation is made by identifying living lice. Because lice move quickly and can be difficult to detect, tightly attached nits on the hair shaft within 4 mm of the scalp are at least indicative of a historic infestation and can be suggestive of active infestation.<sup>1,19</sup> Dermoscopy is a helpful tool in differentiating eggs containing nymphs from the empty cases of hatched lice and also from amorphous pseudonits (hair casts)(Figure 3).<sup>19,20</sup> Wet combing improves the accuracy of diagnosing an active infection.<sup>21</sup>

### Treatment

Effective treatment of head lice requires eradication of all living lice as well as louse eggs. Topically applied pyrethroids, including pyrethrin shampoos and mousses and permethrin lotion 1%, are considered the first-line therapy.<sup>8</sup> Pyrethroids are over-the-counter treatments that act by interfering with sodium transport in the louse, causing depolarization of the neuromembranes and respiratory paralysis.<sup>22</sup> Pyrethrins are natural compounds derived from the chrysanthemum plant; permethrin is a synthetic compound. Pyrethrins often are combined with piperonyl butoxide, an insecticide synergist that improves efficacy by inhibiting pyrethrin catabolism.<sup>23</sup> Resistance to pyrethroids has become an increasingly important problem in the United States and worldwide.

Malathion lotion 0.5% is another therapeutic option for head lice. Malathion is a prescription organophosphate cholinesterase inhibitor that also causes respiratory paralysis of the louse and is one of the few treatments that is ovicidal.<sup>22</sup> It was withdrawn from the market in 1995 due to its flammability and a theoretical risk of respiratory depression if ingested; however, it was reintroduced in 1999 and remains an effective treatment option with little resistance in the United States.<sup>24</sup>

Lindane 1% (shampoo and lotion), an organochloride compound that acts by causing neuronal hyperstimulation



**FIGURE 3.** Amorphous keratin forming a pseudonit on the hair shaft.

and eventual paralysis of lice, is no longer recommended due to its serious side effects, including central nervous system toxicity and increased risk of seizure.<sup>8,24</sup>

*New US Food and Drug Administration–Approved Therapies*—Newer topical treatments include benzyl alcohol lotion 5%, spinosad topical suspension 0.9%, ivermectin lotion 0.5%, and dimethicone-based products. Benzyl alcohol was approved by the US Food and Drug Administration (FDA) in 2009 and is available in the United States by prescription.<sup>25</sup> Benzyl alcohol kills lice by asphyxiation. Phase 2 and 3 clinical trials showed significant treatment success 1 day posttreatment (fewer live lice than the vehicle alone;  $P=.004$ ) and 2 weeks posttreatment (absence of live lice compared to the vehicle alone;  $P=.001$ ).<sup>26</sup>

Spinosad was approved by the FDA in 2011 and is available in the United States by prescription.<sup>25</sup> It contains the compounds spinosyn A and spinosyn D, which are naturally derived through fermentation by the soil bacterium *Saccharopolyspora spinosa*. It also contains benzyl alcohol. Spinosad paralyzes lice by disrupting neuronal activity and is at least partially ovicidal.<sup>27</sup> Phase 3 clinical trials published in 2009 showed that spinosad was significantly more effective than permethrin in eradicating head lice ( $P<.001$ ).<sup>28</sup>

Topical ivermectin was approved by the FDA in 2012 for prescription use.<sup>25</sup> It acts on chloride ion channels, causing hyperpolarization of the muscle cells of lice and resulting in paralysis and death. Oral ivermectin (200  $\mu\text{g}/\text{kg}$ ) given once and repeated in 10 days is not FDA approved for the treatment of head lice but has shown some effectiveness and is sometimes used.<sup>8</sup> A comparison study of topical versus oral ivermectin published in 2014 found that eradication was achieved in 88% ( $n=27$ ) of topical ivermectin users after 1 treatment and 100% ( $n=31$ ) after 2 treatments. Oral ivermectin produced cure rates of 45% ( $n=14$ ) after 1 treatment and 97% ( $n=30$ ) after 2 treatments. Both topical and oral ivermectin treatments are well tolerated.<sup>29</sup>

*Physically Acting Preparations*—Products with a physical mode of action are a new attractive option for treatment of pediculosis because the development of resistance is less likely. Studies of silicone-based fluids that physically occlude the respiratory system of the louse, such as dimethicone liquid gel 4%, have shown superiority over treatment with pyrethroids.<sup>30,31</sup> Although the safety of dimethicone has been demonstrated, silicone-based treatments have not yet been widely adopted in the United States and are not currently used as a first-line treatment.<sup>32</sup> However, use of such physically acting pediculicides may in time surpass traditional neurotoxic treatments due to their low susceptibility to resistance and good safety profile.<sup>33,34</sup>

*Alternative Therapies*—Nonchemical treatments for head lice that have shown variable success include wet combing, hot air treatments, and varying occlusive treatments. Physical removal via wet combing requires persistent repeated treatments over several weeks; for example, wet combing may be performed every 3 days for at least 2 weeks or until no

head lice are detected on 4 consecutive occasions.<sup>35</sup> Cure rates range from 38% to 75% with wet combing as a sole treatment of head lice.<sup>36</sup> Because this treatment has minimal risks and no adverse side effects, it can be considered as an alternative treatment for some patients.

Hot air treatments also have been studied. A 2006 study showed that a hot air treatment device had the potential to eradicate head lice, most likely by desiccation. Specifically, 30 minutes of exposure to hot air (at 58.9°F, slightly cooler than a standard hair dryer) using the custom-built device resulted in 98% mortality of eggs and 80% mortality of hatched lice.<sup>37</sup> Large randomized controlled trials of hot air treatments have not been performed.

Other alternative treatments include plant-derived oils. A laboratory study of essential oils found that spearmint, cassia, and clove showed pediculicidal activity similar to malathion with improved ovicidal activity.<sup>38</sup> However, there is a potential for development of contact dermatitis from essential oils.

*Complete Eradication of Head Lice*—Removal of nits is an important component of effective lice eradication. Biochemical analysis has revealed that the nit sheath of the head louse is similar in composition to amyloid, rendering it difficult to design products that will unravel the nit sheath while leaving human hair undamaged.<sup>39</sup> Because pediculicides are not necessarily ovicidal and complete physical nit removal is difficult to achieve, re-treatment in 7 to 10 days often is advisable to ensure that lice in all stages of the life cycle have been killed.<sup>4</sup> Treatment of any secondary bacterial infection also is important. Although transmission of lice via fomites is less likely than from head-to-head contact, the cleaning of hats, hairbrushes, and linens is prudent. Diagnosing and treating infested close contacts also is essential to achieving eradication.<sup>4</sup> Coordinated surveillance, education, and treatment efforts in high-risk communities can help detect asymptomatic cases and control local epidemics in a cost-effective manner.<sup>40</sup> However, “no nit” policies at schools likely cause a net harm, as nit removal is difficult and children with non-viable nits are then excluded from the classroom.<sup>5</sup>

*Treatment Resistance*—Resistance to topical neurotoxic treatments is becoming increasingly common.<sup>41–43</sup> Therefore, it is important to identify local patterns of resistance, if possible, when selecting a therapy for head lice. Improper usage, changes in pediculicide formulations and packaging, decreased product efficacy, and natural selection have all contributed to this rise in resistance.<sup>7</sup> Additionally, due to protection from multiple exoskeletons and the natural molting process as they mature into adults, nymphs may only receive a sublethal dose when exposed to pediculicides, contributing further to resistance.<sup>7</sup> Resistance to synthetic pyrethroids is most predominant, likely due to selection pressure because permethrin historically has been the most widely used insecticide for pediculosis. A 2014 study found that the frequency of sodium-channel insensitivity to pyrethroids, also known as knockdown resistance (or *kdr*), in US head

louse populations collected over a 10-year period was 84.4% and approached 100% in some communities in recent years.<sup>44</sup> This evidence strongly supports the use of alternative therapeutic categories to effectively eradicate head lice infestations.

## Conclusion

Head lice infestation is common in children, and although it is not harmful to the host, it can be an irritating and symptomatic problem and can lead to notable distress, missed days of school, and secondary infections. Identifying active adult lice is the gold standard for diagnosis. Current recommended treatments include pyrethroids as the first-line therapy; however, resistance to these neurotoxic agents is becoming increasingly common. Alternative therapies such as newer neurotoxic agents or pediculicides with physical mechanisms of action (eg, dimethicone-based products) should be considered, particularly in regions where resistance is known to be high. Education about head lice, proper use of treatment, and coordinated diagnosis are necessary for effective management of this problem.

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