



# Clinical Report—Head Lice

## abstract

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Head lice infestation is associated with limited morbidity but causes a high level of anxiety among parents of school-aged children. Since the 2002 clinical report on head lice was published by the American Academy of Pediatrics, patterns of resistance to products available over-the-counter and by prescription have changed, and additional mechanical means of removing head lice have been explored. This revised clinical report clarifies current diagnosis and treatment protocols and provides guidance for the management of children with head lice in the school setting. *Pediatrics* 2010;126:392–403

## INTRODUCTION

Head lice (*pediculosis capitis*) have been companions of the human species since antiquity. In the United States, head lice infestation is common among children 3 to 12 years of age. Before the development of modern insecticides, various botanical treatments, inorganic poisons, and petroleum products were used to treat head lice infestation.<sup>1</sup> Shaving heads was also quite effective. The development of dichlorodiphenyltrichloroethane (DDT) after World War II offered a significant advancement in treatment and continues to be used in some developing countries.<sup>2</sup> Because of environmental concerns regarding DDT, other pharmaceutical agents, including lindane, pyrethrin, permethrin, and malathion, were developed to replace DDT.<sup>3</sup> Resistance to each of these pediculicides has developed. Inadequate treatment can sometimes be mistaken for drug resistance, and careful scrutiny is needed in making that determination.

A 1997 report estimated that approximately 6 to 12 million infestations occur each year in the United States,<sup>4</sup> but this number was based on sales of pediculicides and is most likely an overestimation. Anecdotal reports from the 1990s estimated annual direct and indirect costs totaling \$367 million, including remedies and other consumer costs, lost wages, and school system expenses. More recently, treatment costs have been estimated at \$1 billion.<sup>5</sup> Head lice are not a health hazard or a sign of poor hygiene and, in contrast to body lice, are not responsible for the spread of any disease.

Historically, diagnosis of head lice infestations by parents and other non-health care personnel and the easy availability of safe and effective over-the-counter (OTC) pediculicides for self-treatment essentially removed the physician from the treatment process. However, the potential for misdiagnosis and the resulting improper use of pediculicides raise concerns about unsafe use of these products, specifically when no lice are present or when products are used excessively.<sup>6,7</sup> In addition, the emergence of resistance to available products and the

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### KEY WORDS

head lice, infestation, school, children

### ABBREVIATIONS

DDT—dichlorodiphenyltrichloroethane

OTC—over-the-counter

FDA—Food and Drug Administration

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The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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development of new products, many without proof of efficacy or safety, call for increased physician involvement in the diagnosis and treatment of head lice. Optimal treatments are safe and effective, rapidly pediculicidal, ovicidal, easy to use, and affordable and incorporate a resistance-prevention strategy.<sup>8</sup> Because lice infestation is so benign, treatments must prove safe to ensure that the adverse effects of therapy are not worse than the infestation.

### ETIOLOGIC AGENT

The adult head louse is 2 to 3 mm long (the size of a sesame seed), has 6 legs, and is usually tan to grayish-white in color. The female lives up to 3 to 4 weeks and, once mature, can lay up to 10 eggs per day. These tiny eggs are firmly attached to the base of the hair shaft within approximately 4 mm of the scalp with a glue-like substance produced by the louse. Viable eggs camouflaged with pigment to match the hair color of the infested person often are seen more easily at the posterior hairline. Empty egg casings (nits) are easier to see because they appear white against darker hair. (Note that some experts refer to “eggs” as containing the developing nymph and use “nits” to refer to empty egg casings; others use the term “nits” to refer to both eggs and the empty casings.) The eggs are incubated by body heat and typically hatch in 8 to 9 days, but hatching can vary from 7 to 12 days depending on whether the ambient climate is hot or cold. Once it hatches, a nymph leaves the shell casing and passes through a total of 3 nymph stages (instars) during the next 9 to 12 days and then reaches the adult stage. The female louse can mate and begin to lay viable eggs approximately 1.5 days after becoming an adult. If not treated, this cycle may repeat itself approximately every 3 weeks.<sup>9</sup> The louse feeds by injecting small amounts of saliva with vasodilatory and anticoagulation proper-

ties and sucking tiny amounts of blood from the scalp every few hours. Itching results from sensitization to components of the saliva. With a first case of head lice, itching may not develop for 4 to 6 weeks, because it takes that amount of time for sensitivity to result. Head lice usually survive for less than 1 day away from the scalp at room temperature, and their eggs cannot hatch at an ambient temperature lower than that near the scalp.<sup>2</sup>

### CLINICAL DISEASE

Head lice, unlike body lice, do not transmit any disease agent.<sup>4,10</sup> Itching can develop in a sensitized individual. Rarely, scratching may cause impetigo or other skin infection, which can lead to local adenopathy.

### EPIDEMIOLOGY

In the United States, head lice infestation is most common among preschool- and elementary school-aged children. Caregivers and household members of people infested with head lice can also be at increased risk. All socioeconomic groups are affected, and head lice infestations are common in many parts of the world. In some remote communities in Central and South America, nearly all inhabitants have at least a few head lice.<sup>11</sup> In Australia, the prevalence in schoolchildren is 13%, with a range between schools of 0% to 28%<sup>12</sup>; in Brazil, the prevalence is 43% in a slum and 28% in a fishing village<sup>13</sup>; in China, the prevalence is 14%, with a range of 0% to 52%<sup>14</sup>; and in the United Kingdom, the prevalence is 2%, with an annual incidence of 37%.<sup>15</sup> Head lice infestation is not significantly influenced by hair length or by frequent brushing or shampooing. However, in the United States, where daily brushing is routine for many, infested individuals rarely have more than a dozen live lice, whereas individuals in cultures with

different grooming practices often have a hundred or more live lice.

### TRANSMISSION

Lice cannot hop or fly; they crawl. However, there are reports that combing dry hair can build up enough static electricity to physically eject an adult louse from an infested scalp more than 1 m.<sup>3</sup> Transmission in most cases occurs by direct contact with the head of an infested individual.<sup>16</sup> Indirect spread through contact with personal belongings of an infested individual (combs, brushes, hats) is much less likely but may occur rarely.<sup>17</sup> Lice found on combs are likely to be injured or dead,<sup>18</sup> and a healthy louse is not likely to leave a healthy head unless there is a heavy infestation.<sup>19</sup> This is further illustrated by 2 studies from Australia. In 1 study, examination of carpets on 118 classroom floors found no lice despite more than 14 000 live lice found on the heads of 466 children using these classrooms.<sup>20</sup> In a second study, live lice were found on only 4% of pillowcases used by infested volunteers.<sup>21</sup> Thus, the major focus of control activities should be to reduce the number of lice on the head and to lessen the risks of head-to-head contact.

### DIAGNOSIS

The gold standard for diagnosing head lice is finding a live louse on the head, which can be difficult because lice avoid light and can crawl quickly. Studies have revealed that diagnosis of infestation by using a louse comb is quicker and more efficient.<sup>22</sup> Some experts have suggested using a lubricant (water, oil, or conditioner) to “slow down” the movement of lice and eliminate the possibility of static electricity.<sup>23</sup> The tiny eggs may be easier to spot, especially at the nape of the neck or behind the ears, within 1 cm of the scalp. It is important not to confuse eggs or nits with dandruff, hair casts,

or other hair debris, all of which have been misdiagnosed as nits. Nits are more difficult to remove, because they are firmly attached to the hair shaft. It is also important not to confuse live eggs with dead or empty egg cases (nits). Many presumed “lice” and “nits” submitted by physicians, nurses, teachers, and parents to a laboratory for identification were found to be artifacts such as dandruff, hairspray droplets, scabs, dirt, or other insects (eg, aphids blown by the wind and caught in the hair).<sup>7</sup> In general, eggs found more than 1 cm from the scalp are unlikely to be viable, although some researchers in warmer climates have found viable eggs farther from the scalp.<sup>2</sup> A viable egg will develop an “eye spot” that is evident on microscopic examination several days after being laid.<sup>2</sup>

## PREVENTION

It is probably impossible to prevent all head lice infestations. Young children come into head-to-head contact with each other frequently. It is prudent for children to be taught not to share personal items such as combs, brushes, and hats. However, no one should refuse to wear protective headgear because of fear of head lice. In environments where children are together, adults should be aware of the signs and symptoms of head lice infestation, and infested children should be treated promptly to minimize spread to others.

## TREATMENT

Never initiate treatment unless there is a clear diagnosis of head lice. The ideal treatment for lice would be completely safe, free of harmful chemicals, readily available without a prescription, easy to use, and inexpensive. When recommending a treatment, pediatricians should take into account effectiveness and safety, local patterns of resistance (if known), ease of use,

and cost. Published reviews of available efficacy studies and comparative trials of pediculicides have used different inclusion criteria and reached different conclusions.<sup>1,24</sup> A Cochrane review concerning pediculicides was published in 1999 and updated in 2001<sup>25</sup> but was withdrawn in 2007,<sup>26</sup> and a substantial update is underway. Many of the cited studies were completed before the development of resistance to available pediculicides or were conducted in areas where the lice were naive to pediculicides.

Therapy could be initiated with OTC permethrin 1% or pyrethrins when resistance to these products is not suspected. Malathion 0.5% can be used in people who are 24 months of age or older when resistance to permethrin or pyrethrins is documented or when treatment with these products fails despite their correct use. Other treatments can be considered for people who cannot afford or who wish to avoid pediculicides. The pediatrician (or someone in the community, such as the school nurse) should be skilled in the identification of an active infestation with head lice to avoid treating patients unnecessarily or falsely identifying “resistance” in the community to a certain product. Improper application of the pediculicide should be considered first as a cause of treatment failure.

Finally, it should be noted that these recommendations are intended for use by pediatricians and other practitioners in the United States. Malathion is not available in Canada, and the Canadian Paediatric Society recently updated its position statement on head lice infestation.<sup>27</sup> Pediatricians who work in other countries, especially developing countries in which head lice are naive to pediculicides, should use products or methods that are most economical, effective, and safe. The following products and methods can be effective for treating head lice.

## Pediculicides

### *Permethrin (1%)*

Permethrin has been the most studied pediculicide in the United States and is the least toxic to humans.<sup>1</sup> Introduced in 1986 as a prescription-only treatment, 1% permethrin lotion was approved for OTC use in 1990 and is marketed as a “crème rinse” (Nix [Pfizer Consumer Health Care Group, New York, NY]). One percent permethrin lotion is currently recommended as one of the drugs of choice for head lice.<sup>28</sup> Permethrin is a synthetic pyrethroid with extremely low mammalian toxicity. Reported adverse effects include pruritus, erythema, and edema. Permethrin is less allergenic than pyrethrins and does not cause allergic reactions in individuals with plant allergies. The product is applied to damp hair that is first shampooed with a nonconditioning shampoo and then towel dried. It is left on for 10 minutes and then rinsed off. Permethrin leaves a residue on the hair that is designed to kill nymphs emerging from the 20% to 30% of eggs not killed with the first application.<sup>29</sup> However, conditioners and silicone-based additives present in almost all currently available shampoos impair permethrin adherence to the hair shaft and reduce its residual effect.<sup>8</sup> Therefore, it is suggested that the application be repeated in 7 to 10 days if live lice are seen. Many experts now recommend routine re-treatment, preferably on day 9.<sup>8,30</sup> An alternate treatment schedule on days 0, 7, and 13 to 15 has been proposed for nonovicidal products.<sup>31</sup> Resistance to 1% permethrin has been reported,<sup>8,32–35</sup> but the prevalence of this resistance is not known.

### *Pyrethrins Plus Piperonyl Butoxide*

Manufactured from natural extracts from the chrysanthemum, pyrethrins are formulated with piperonyl butoxide (RID [Bayer, Morristown, NJ], A-200

[Hogil Pharmaceutical Corp, Purchase, NY], R & C [GlaxoSmithKline, Middlesex, United Kingdom], Pronto [Del Laboratories, Uniondale, NY], Clear Lice System [Care Technologies, Darien, CT]). Pyrethrins are neurotoxic to lice but have extremely low mammalian toxicity. Pyrethrins should be avoided in people who are allergic to chrysanthemums. The labels warn against possible allergic reaction in patients who are sensitive to ragweed, but modern extraction techniques minimize the chance of product contamination, and reports of true allergic reactions have been rare.<sup>36</sup> These products are available in shampoo or mousse formulations that are applied to dry hair and left on for 10 minutes before rinsing out. No residual pediculicidal activity remains after rinsing. In addition, none of these natural pyrethrins are totally ovicidal (newly laid eggs do not have a nervous system for several days); 20% to 30% of the eggs remain viable after treatment,<sup>29</sup> which necessitates a second treatment to kill newly emerged nymphs hatched from eggs that survived the first treatment. Previous recommendations have been to re-treat in 7 to 10 days; however, new evidence based on the life cycle of lice suggests that re-treatment at day 9 is optimal. An alternate schedule of 3 treatments with nonovicidal products on days 0, 7, and 13 to 15 has been proposed.<sup>31</sup> Although pyrethrins were extremely effective when introduced in the mid-1980s, recent study results have indicated that efficacy has decreased substantially because of development of resistance.<sup>6</sup> The prevalence of resistance has not been systematically studied but seems to be highly variable from community to community and country to country.

#### *Malathion (0.5%)*

The organophosphate (cholinesterase inhibitor) 0.5% malathion (Ovide [Taro Pharma, Hawthorne, NY]) was reintro-

duced for the treatment of head lice in the United States in 1999 after being taken off the market twice, most recently in 1986, because of problems related to prolonged application time, flammability, and odor. It is available only by prescription as a lotion that is applied to dry hair, left to air dry, then washed off after 8 to 12 hours, although some study results have suggested effectiveness when left on for as short a time as 20 minutes.<sup>37</sup> Head lice in the United Kingdom and elsewhere have shown resistance to malathion preparations, which have been available for decades in those countries.<sup>38,39</sup> The current US formulation of malathion (Ovide lotion, 0.5%) differs from the malathion products available in Europe in that it contains terpineol, dipentene, and pine needle oil, which themselves have pediculicidal properties<sup>25</sup> and may delay development of resistance. Malathion has high ovicidal activity,<sup>29</sup> and a single application is adequate for most patients. However, the product should be reapplied in 7 to 9 days if live lice are still seen. A concern is the high alcohol content of the product (78% isopropyl alcohol), which makes it highly flammable. Patients and their parents, therefore, should be instructed to allow the hair to dry naturally; not to use a hair dryer, curling iron, or flat iron while the hair is wet; and not to smoke near a child receiving treatment. Safety and effectiveness of malathion lotion have not been established in children younger than 6 years, and the product is contraindicated in children younger than 24 months. Because malathion is a cholinesterase inhibitor, there is a theoretical risk of respiratory depression if accidentally ingested, although no such cases have been reported.

#### *Benzyl Alcohol 5%*

Benzyl alcohol 5% (Ulesfia [Sciele Pharma, Atlanta, GA]) was approved by the US Food and Drug Administration

(FDA) in April 2009 for treatment of head lice in children older than 6 months. The product is not neurotoxic and kills head lice by asphyxiation. Two studies demonstrated that more than 75% of the subjects treated were free of lice 14 days after initial treatment. The most common adverse reactions after treatment included pruritus, erythema, pyoderma, and ocular irritation. Benzyl alcohol is available by prescription and is not ovicidal: package instructions state that it is to be applied topically for 10 minutes and repeated in 7 days,<sup>40</sup> although as with other nonovicidal products, consideration should be given to retreatment in 9 days or using 3 treatment cycles (days 0, 7, and 13–15), as mentioned previously.

#### *Lindane (1%)*

On the market since 1951 for the medical treatment of lice and scabies, lindane (Kwell [Reed & Carnick, Jersey City, NJ]) is an organochloride that has central nervous system toxicity in humans; several cases of severe seizures in children using lindane have been reported.<sup>9,41–44</sup> For the treatment of head lice, it is available only by prescription as a 1% lindane shampoo that should be left on for no more than 4 minutes, and a repeat application should be performed in 9 to 10 days. It has low ovicidal activity (30%–50% of eggs are not killed<sup>29</sup>), and resistance has been reported worldwide for many years.<sup>3,45</sup> For these reasons, it should be used cautiously.<sup>30</sup> The FDA has warned that lindane shampoo should only be used for patients who cannot tolerate or whose infestation has failed to respond to first-line treatment with safer medications for the treatment of head lice. The FDA has issued a public health advisory concerning the use of lindane, which emphasized that it is a second-line treatment, is contraindicated for use in neonates, and should be used with extreme caution in chil-



dren and in individuals who weigh less than 50 kg (110 lb) and in those who have HIV infection or take certain medications that can lower the seizure threshold.<sup>46</sup> Lindane is no longer recommended by the American Academy of Pediatrics (*Red Book 2009*<sup>47</sup>) or the *Medical Letter* for use as a pediculicide. The use of lindane has been banned in California.

### Removal of Topical Pediculicides

All topical pediculicides should be rinsed from the hair over a sink rather than in the shower or bath to limit skin exposure and with warm rather than hot water to minimize absorption attributable to vasodilation.<sup>48</sup>

### Topical Reactions

Itching or mild burning of the scalp caused by inflammation of the skin in response to topical pharmaceutical agents can persist for many days after lice are killed and is not a reason for re-treatment. Topical corticosteroids and oral antihistamines may be beneficial for relieving these signs and symptoms.

### Scabicides Used Off-label for Lice

#### *Permethrin (5%)*

Five percent permethrin (Elimite [Allergan, Irvine, CA]) is available by prescription only as a cream, usually applied overnight for scabies for infants as young as 2 months. It has anecdotally been recommended for the treatment of head lice that seem to be recalcitrant to other treatments.<sup>49</sup> No randomized case-control studies have reported efficacy to date. The results of 1 study suggested that lice resistant to 1% permethrin will not succumb to higher concentrations.<sup>34</sup> Permethrin 5% is not currently approved by the FDA for use as a pediculicide.

#### *Crotamiton (10%)*

This product is available by prescription only as a lotion (Eurax [Westwood-

Squibb Pharmaceuticals, Buffalo, NY]), usually used to treat scabies. One study showed it to be effective against head lice when applied to the scalp and left on for 24 hours before rinsing out.<sup>50</sup> Other reports have suggested that 2 consecutive nighttime applications safely eradicate lice from adults.<sup>51</sup> Safety and absorption in children, adults, and pregnant women have not been evaluated. Crotamiton is not currently approved by the FDA for use as a pediculicide.

### Oral Agents Used Off-Label for Lice

#### *Ivermectin*

This product (Stromectol [Merck & Co, West Point, PA]) is an anthelmintic agent structurally similar to macrolide antibiotic agents but without antibacterial activity. A single oral dose of 200  $\mu\text{g}/\text{kg}$ , repeated in 10 days, has been shown to be effective against head lice.<sup>52,53</sup> Most recently, a single oral dose of 400  $\mu\text{g}/\text{kg}$  repeated in 7 days has been shown to be more effective than 0.5% malathion lotion.<sup>54</sup> Ivermectin may cross the blood/brain barrier and block essential neural transmission; young children may be at higher risk of this adverse drug reaction. Therefore, ivermectin should not be used for children who weigh less than 15 kg.<sup>55,56</sup> Ivermectin is also available as a 1% topical preparation that is applied for 10 minutes and has shown promising results that warrant further testing.<sup>6</sup> However, neither form of ivermectin is currently approved by the FDA as a pediculicide.

#### *Sulfamethoxazole-Trimethoprim*

The oral antibiotic agent sulfamethoxazole-trimethoprim (Septra [GlaxoSmith-Kline], Bactrim [Roche Laboratories, Nutley, NJ], and generic cotrimoxazole) has been cited as effective against head lice.<sup>57</sup> It is postulated that this antibiotic agent kills the symbiotic bacteria in the gut of the louse or

perhaps has a direct toxic effect on the louse. The results of 1 study indicated increased effectiveness when sulfamethoxazole-trimethoprim was given in combination with permethrin 1% when compared with permethrin 1% or sulfamethoxazole-trimethoprim alone; however, the treatment groups were small.<sup>58</sup> Rare severe allergic reactions (Stevens-Johnson syndrome) to this medication make it a potentially undesirable therapy if alternative treatments exist.<sup>9</sup> It is not currently approved by the FDA for use as a pediculicide.

### “Natural” Products

Essential oils have been widely used in traditional medicine for the eradication of head lice, but because of the variability of their constitution, the effects may not be reproducible.<sup>59</sup> Several products are marketed for treatment of head lice and are in wide use. As natural products, they are not required to meet FDA efficacy and safety standards for pharmaceuticals. Hair-Clean 1-2-3 (Quantum Health, Eugene, OR) [anise, ylang-ylang, coconut oils, and isopropyl alcohol] was found to be at least as effective as the permethrin product Nix by 1 investigator.<sup>2</sup> Although many plants naturally produce insecticides for their own protection that may be synthesized for use by humans, such as pyrethroids, some of these insecticidal chemicals produce toxic effects as well. The safety and efficacy of herbal products are currently not regulated by the FDA the same as medications.

### Occlusive Agents

Occlusive agents applied to suffocate the lice are widely used but have not been evaluated for effectiveness in randomized, controlled trials. A “petrolatum shampoo” consisting of 30 to 40 g of standard petroleum jelly massaged on the entire surface of the hair and scalp and left on overnight with a

shower cap has been suggested. Diligent shampooing is usually necessary for at least the next 7 to 10 days to remove the residue. It is thought that the viscous substance obstructs the respiratory spiracles of the adult louse as well as the holes in the operculum of the eggs and blocks efficient air exchange.<sup>60</sup> Another interpretation is that the intense, daily attention to hair grooming results in removal of all the lice and nits. Hair pomades are easier to remove but may not kill eggs, and treatment should be repeated weekly for 4 weeks.<sup>61</sup> Other occlusive substances have been suggested (mayonnaise, tub margarine, herbal oils, olive oil), but to date, only anecdotal information is available concerning effectiveness. One study that examined several “home remedies” (vinegar, isopropyl alcohol, olive oil, mayonnaise, melted butter, and petroleum jelly) revealed that the use of petroleum jelly caused the greatest egg mortality, allowing only 6% to hatch.<sup>62</sup>

A 2004 study reported a 96% “cure” rate with a suffocation-based pediculicide lotion applied to the hair, dried on with a hand-held hair dryer, left on overnight, and washed out the next morning. The process must be repeated once per week for 3 weeks. The product contained no neurotoxins and did not require nit removal or extensive house cleaning.<sup>63</sup> The study was criticized for being uncontrolled, with no blinding, randomization, or comparison group.<sup>64</sup> The lotion used in the study was later identified as Cetaphil cleanser [Galderma Laboratories, Fort Worth, TX],<sup>65</sup> and instructions for its use are available on the Internet.<sup>66</sup> It has not been approved by the FDA for use as a pediculicide.

Dimethicone lotion (4% long-chain linear silicone in a volatile silicone base) in two 8-hour treatments 1 week apart eradicated head lice in 69% of participants in the United Kingdom.<sup>67</sup> In

the United States, the OTC product LiceMD (Combe Inc, White Plains, NY) contains dimethicone. Isopropyl myristate 50% (Resultz [Nycomed Canada Inc, Oakville, Ontario, Canada]), a hair rinse that dissolves the waxy exoskeleton of the louse, which leads to dehydration and death of the louse, has recently become available in Canada.<sup>68,69</sup>

### Desiccation

The LouseBuster is a custom-built machine (available commercially in late 2009) that uses one 30-minute application of hot air in an attempt to desiccate the lice. One study showed that subjects had nearly 100% mortality of eggs and 80% mortality of hatched lice.<sup>70</sup> The machine is expensive, and the operator requires special training in its use. A regular blow-dryer should not be used in an attempt to accomplish this result, because investigators have shown that wind and blow-dryers can cause live lice to become airborne and, thus, potentially spread to others in the vicinity.

### Other Agents

Flammable or toxic substances such as gasoline or kerosene should never be used. Products intended for animal use should not be used to treat head lice in humans.

### Manual Removal

Removal of nits immediately after treatment with a pediculicide is not necessary to prevent spread, because only live lice cause an infestation. Individuals may want to remove nits for aesthetic reasons or to decrease diagnostic confusion. Because none of the pediculicides are 100% ovicidal, manual removal of nits (especially the ones within 1 cm of the scalp) after treatment with any product is recommended by some. Nit removal can be difficult and tedious.<sup>71</sup> Fine-toothed “nit combs” are available to make the process easier.<sup>72,73</sup> Studies have sug-

gested that lice removed by combing and brushing are damaged and rarely survive.<sup>16</sup> In the United Kingdom, community campaigns have been launched using “bug-buster” combs and ordinary shampoo,<sup>74,75</sup> with everyone being instructed to shampoo hair twice per week for 2 weeks and to vigorously comb out wet hair each time. The wet hair seems to slow down the lice. Combing dry hair does not seem to have the same effect; a study conducted in Australia in which children combed their hair daily at school with an ordinary comb determined that it was not effective.<sup>76</sup> Some have postulated that vigorous dry combing or brushing in close quarters may even spread lice by making them airborne via static electricity. One study showed that manual removal is not as effective as pediculicides and does not improve results, even when used as an adjunct to pediculicide treatment.<sup>77</sup>

There are battery-powered “electronic” louse combs with oscillating teeth (Quantum MagiComb) that claim to remove live lice and nits as well as combs that resemble small “bug zappers” (LiceGuard Robi-Comb [ARR Health Technologies, Needham, MA]) that claim to kill live lice.<sup>78</sup> No randomized, case-controlled studies have been performed with either type of comb. Their instructions warn not to use on people with a seizure disorder or a pacemaker.

Some products are available that claim to loosen the “glue” that attaches nits to the hair shaft, thus making the process of “nit-picking” easier. Vinegar or vinegar-based products (Clear Lice Egg Remover Gel [Care Technologies]) are intended to be applied to the hair for 3 minutes before combing out the nits. No clinical benefit has been demonstrated.<sup>9,61</sup> This product has not been tested with and is not recommended for use with permethrin, because it may interfere with

permethrin's residual activity. A variety of other products, from acetone and bleach to vodka and WD-40 (WD-40 Company, San Diego, CA), have proved to be ineffective in loosening nits from the hair shaft<sup>61</sup> and present an unacceptable risk to the patient. It seems that nature has protected the louse by making the nit sheath similar in composition to the hair, so that agents designed to unravel the nit sheath can also damage human hair.<sup>79</sup>

Although effective for removing lice and eggs, shaving the head generally is not recommended, because it can be distressing to a child or parent.

### New Products

As new products are introduced, it is important to consider effectiveness, safety, expense, availability, patient preference, and ease of application. Assessment of the severity of the infestation, the number of recurrences, the local levels of resistance to available pediculicides, and the potential for transmission are also critical when recommending newer products.<sup>35</sup>

### Pediculicide Resistance

No currently available pediculicide is 100% ovicidal, and resistance to lindane, pyrethrins, permethrin, and the UK formulation of malathion has been reported.<sup>38,39,41,80–83</sup> This resistance is not unanticipated, because insects develop resistance to products over time. The actual prevalence of resistance to particular products is not known and can be regional. It is important that health care professionals recommend safe and effective products. When faced with a persistent case of head lice after using a pharmaceutical pediculicide, health care professionals must consider several possible explanations, including:

- misdiagnosis (no active infestation or misidentification);
- lack of adherence (patient unable

or unwilling to follow treatment protocol);

- inadequate treatment (not using sufficient product to saturate hair);
- reinfestation (lice reacquired after treatment);
- lack of ovicidal or residual killing properties of the product (eggs not killed can hatch and cause self-reinfestation); and/or
- resistance of lice to the pediculicide.

If resistance is proven, and an active infestation is documented, benzyl alcohol 5% can be prescribed if the patient is older than 6 months, or malathion 0.5% can be prescribed if the patient is older than 24 months if safe use can be reasonably ensured. For younger patients, or if the parent cannot afford or does not wish to use a pediculicide, manual removal via wet combing or an occlusive method may be recommended, with emphasis on careful technique and the use of 2 to 4 properly timed treatment cycles.

### ENVIRONMENTAL INTERVENTIONS

If a person is identified with head lice, all household members should be checked for head lice, and those with live lice or nits within 1 cm of the scalp should be treated. In addition, it is prudent to treat family members who share a bed with the person with infestation, even if no live lice are found. Fomite transmission is less likely than transmission by head-to-head contact<sup>9</sup>; however, it is prudent to clean hair care items and bedding used by the individual with infestation. One study revealed that head lice can transfer to pillowcases at night, but the incidence is low (4%). Changing just the pillowcase could minimize this risk of head lice transmission.<sup>21</sup> Only items that have been in contact with the head of the person with infestation in the 24 to 48 hours before treatment

should be considered for cleaning, given the fact that louse survival off the scalp beyond 48 hours is extremely unlikely. Such items may include clothing, headgear, furniture, carpeting, and rugs. Washing, soaking, or drying items at temperatures greater than 130°F will kill stray lice or nits. Furniture, carpeting, car seats, and other fabrics or fabric-covered items can be vacuumed. Although head lice are able to survive for prolonged periods in chlorinated water, it is unlikely that there is a significant risk of transmission in swimming pools. One study revealed that submerged head lice became immobile and remained in place on 4 people infested with head lice after 30 minutes of swimming.<sup>84</sup> Pediculicide spray is not necessary and should not be used. Viable nits are unlikely to incubate and hatch at room temperatures; if they did, the nymphs would need to find a source of blood for feeding within hours of hatching. Although it is rarely necessary, items that cannot be washed can be bagged in plastic for 2 weeks, a time when any nits that may have survived would have hatched and nymphs would die without a source for feeding. Herculean cleaning measures are not beneficial.

### CONTROL MEASURES IN SCHOOLS

#### Screening

Screening for nits alone is not an accurate way of predicting which children are or will become infested, and screening for live lice has not been proven to have a significant effect on the incidence of head lice in a school community over time.<sup>2,12,24</sup> In addition, such screening has not been shown to be cost-effective. In a prospective study of 1729 schoolchildren screened for head lice, only 31% of the 91 children with nits had concomitant live lice. Only 18% of those with nits alone converted to having an active infestation during 14 days of observation.<sup>85</sup>

Although children with at least 5 nits within 1 cm of the scalp were significantly more likely to develop an infestation than were those with fewer nits (32% vs 7%), only one-third of the children at higher risk converted to having an active infestation. School exclusion of children with nits alone would have resulted in many of these children missing school unnecessarily. In addition, head lice infestations have been shown to have low contagion in classrooms.<sup>86</sup> Using anecdotal information that described the implementation of a “zero-tolerance” program at an elementary school, 1 source reported an average of 20 missed days per student dismissed for infestation.<sup>5</sup> Another study evaluated how often schoolchildren were inappropriately diagnosed and treated. Children without infestation received applications of pyrethroid-based OTC products almost as often as children with active infestations (62% vs 70%). Noninfested children were excluded from school because of presumed lice infestation more frequently than were children who were infested.<sup>7</sup> The results of several descriptive studies have suggested that education of parents in diagnosing and managing head lice may be helpful.<sup>86–89</sup> Because of the lack of evidence of efficacy, routine classroom or school-wide screening should be discouraged.

It may be useful to provide information periodically about the diagnosis, treatment, and prevention of head lice to the families of all children. Parents should be encouraged to check their children’s heads for lice regularly and if the child is symptomatic. School screenings do not take the place of these more careful parental checks.<sup>18,89–91</sup> It may be helpful for the school nurse or other trained person to check a student’s head if he or she is demonstrating symptoms.

### Management on the Day of Diagnosis

Because a child with an active head lice infestation likely has had the infestation for 1 month or more by the time it is discovered and poses little risk to others from the infestation, he or she should remain in class but be discouraged from close direct head contact with others. If a child is diagnosed with head lice, confidentiality must be maintained. The child’s parent or guardian should be notified that day by telephone or by having a note sent home with the child at the end of the school day stating that prompt, proper treatment of this condition is in the best interest of the child and his or her classmates. Common sense should prevail when deciding how “contagious” an individual child may be (a child with hundreds versus a child with 2 live lice). It may be prudent to check other children who were most likely to have had direct head-to-head contact with the infested child. In an elementary school, 1 way to deal with the problem is to notify the parents or guardians of children in an infested child’s classroom, encouraging all children to be checked at home and treated, if appropriate, before returning to school the next day. Some experts argue that because of the relatively high prevalence of head lice in young school-aged children, it may make more sense to alert parents only if a high percentage of children in a classroom are infested. Other experts feel strongly that these “alert letters” cause unnecessary public alarm and reinforce the notion that a head lice infestation indicates a failure on the school’s part rather than a community problem.<sup>92</sup> However, studies examining the efficacy of alert letters are not available; consequently, some schools choose to design guidelines that they believe best meet the needs of their student population, understanding that although

a head lice infestation may not pose a public health risk, it may create a public relations dilemma for a school.

### Criteria for Return to School

A child should not be restricted from school attendance because of lice, because head lice have low contagion within classrooms.<sup>86</sup> Some schools have had “no-nit” policies under which a child was not allowed to return to school until all nits were removed. However, most researchers agree that no-nit policies should be abandoned.<sup>93</sup> International guidelines established in 2007 for the effective control of head lice infestations stated that no-nit policies are unjust and should be discontinued, because they are based on misinformation rather than objective science.<sup>94</sup> The American Academy of Pediatrics and the National Association of School Nurses<sup>95</sup> discourage no-nit policies. However, nit removal may be considered for the following reasons:

- nit removal can decrease diagnostic confusion;
- nit removal can decrease the possibility of unnecessary re-treatment; and
- some experts recommend removal of nits within 1 cm of the scalp to decrease the small risk of self-reinfestation.

A knowledgeable school nurse, if present, can perform a valuable service by rechecking a child’s head if requested to do so by a parent. In addition, the school nurse can offer extra help to families of children who are repeatedly or chronically infested. In rare instances, it may be helpful to make home visits or involve public health nurses to ensure that treatment is being conducted effectively. No child should be allowed to miss valuable school time because of head lice. Numerous anecdotal reports exist of children missing weeks of school and even being forced to repeat a grade because of head lice.<sup>2,7,9,91</sup>



## Reassurance of Parents, Teachers, and Classmates

The school can be most helpful by making available accurate information about the diagnosis, treatment, and prevention of head lice in an understandable form to the entire school community. Information sheets in different languages and visual aids for families with limited literacy skills should be made available by schools and/or local health departments. If pediatricians and schools take the lead and react calmly, parents will be able to focus on appropriate treatment without becoming unduly upset.

## Child Care and “Sleepover” Camps

Little information is available on the incidence and control of head lice outside of the school-aged population and outside of school. Because head lice are most readily transmitted by direct head-to-head contact, child care centers and camps where children share sleeping quarters may allow for easier spread. Reminding parents of the importance of carefully checking a child’s head before and after a sleepover experience may be helpful.

## SUMMARY OF KEY POINTS

1. No healthy child should be excluded from or allowed to miss school time because of head lice. No-nit policies for return to school should be abandoned.
2. Pediatricians should be knowledgeable about head lice infestations and treatments; they should take an active role as information resources for families, schools, and other community agencies.
3. Unless resistance to these products has been proven in the community, 1% permethrin or pyrethrins can be used for treatment of active infestations.
4. Instructions on the proper use of products should be carefully com-

municated. Because current products are not completely ovicidal, applying the product at least twice, at proper intervals, is recommended if permethrin or pyrethrin products are used or if live lice are seen after malathion therapy. Manual removal of nits immediately after treatment with a pediculicide is not necessary to prevent spread. In the school setting, nit removal may be considered to decrease diagnostic confusion.

5. If resistance to available OTC products has been proven in the community, if the patient is too young, or if parents do not wish to use a pediculicide, consider recommending “wet-combing” or an occlusive method (such as petroleum jelly or Cetaphil), with emphasis on careful technique, and repeating for at least 2 weekly cycles.
6. Benzyl alcohol 5% can be used for children older than 6 months, or malathion 0.5% can be used for children 2 years old or older, in areas where resistance to permethrin or pyrethrins has been demonstrated or for a patient with a documented infestation that has failed to respond to appropriately administered therapy with permethrin or pyrethrins.
7. New products should be evaluated for safety and effectiveness.
8. School personnel involved in detection of head lice infestation should be appropriately trained. The importance and difficulty of correctly diagnosing an active head lice infestation should be emphasized. Schools should examine any lice-related policies they have with this in mind.
9. Head lice screening programs have not been proven to have a significant effect over time on the incidence of head lice in the school setting and are not cost-

effective. Parent education programs may be helpful in the management of head lice in the school setting.

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