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Head Lice

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Head lice infestation is associated with limited morbidity but causes a high level of anxiety among caregivers of school-aged children and adolescents. Since the 2015 clinical report on head lice was published by the American Academy of Pediatrics, new medications have been approved, and an algorithm for management of affected patients is included. This revised clinical report clarifies current diagnosis and treatment protocols.

INTRODUCTION

Head lice (*Pediculus humanus capitis*) have been companions of the human species since antiquity. Treatment costs in the United States have been estimated at $500 million annually.[1] It is important for medical providers to educate and reassure affected individuals and caregivers that head lice are neither a health hazard nor a sign of poor hygiene and are not responsible for the spread of any disease. Despite this knowledge, there is significant stigma resulting from head lice infestations in high-income countries, resulting in children and adolescents being ostracized from their schools, friends, and other social events.[2,3] Head lice can be psychologically stressful to the affected individual.

Caregivers and other nonhealth care personnel frequently make the diagnosis of head lice, and the easy availability of safe and effective over-the-counter (OTC) pediculicides often remove the medical provider from the treatment process. However, the potential for misidentification resulting in improper use of pediculicides, the emergence of resistance to available OTC products, and the layperson's interest in alternative approaches without proof of efficacy or safety call for increased physician involvement in the diagnosis and treatment.[4,5] Optimal treatments should be safe and age-appropriate, should rapidly rid the individual of live lice and nits, and should be easy to use and affordable. Given that head lice infestation is benign

abstract

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and not associated with adverse medical events, treatment should be reserved for patients in whom diagnosis is highly suspected or proven.

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.[5] Although some experts use "nits" to refer to only empty casings, this report will use nits to encompass both eggs and empty shell casings, with some exceptions to use "eggs" when describing the reproductive cycle of the louse. The female louse 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 ~ 2 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 nits are easier to see, because they appear white against darker hair. These 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 nit and passes through a total of 3 nymph stages (instars) during the next 9 to 12 days before reaching the adult stage. The female louse can mate and begin to lay viable eggs ~ 1.5 days after becoming an adult. If not treated, the cycle repeats itself approximately every 3 weeks.[6,7]

The louse feeds by injecting small amounts of saliva, which has vasodilatory and anticoagulative properties, into the scalp, allowing the louse to suck tiny amounts of blood every few hours. Pruritus results from sensitization to components of the saliva. With a first case of head lice, pruritus may not develop for 4 to 6 weeks, because it takes that amount of time for sensitization to occur.

Head lice usually survive for less than 1 day away from the scalp, and their nits cannot hatch at temperatures lower than those near the scalp.[6,8,9]

EPIDEMIOLOGY

Pediculosis capitis is widespread throughout the world and does not discriminate on socioeconomic grounds. An analysis of 55 studies revealed worldwide prevalence varying by geographic location from zero to 64.1%.[10] The United States survey revealed a prevalence of 1.6% of children with head lice and 3.6% with nits.[10] Published reports have not found that head lice infestation is significantly influenced by hair length or by frequent brushing or shampooing. Public Web sites may suggest that race or ethnicity may influence the rate of infestation, but there are no consistent findings in the medical literature. Pediculosis capitis can infest all types of hair.

TRANSMISSION

Lice do not hop or jump; they can only crawl.[8] In most cases, transmission occurs by direct contact with the hair of an infested individual, the most common situation being head-to-head contact.[8,11] Indirect spread through contact with personal belongings of an infested individual (combs, brushes, hats, sport helmets) is much less likely to occur.[9] Lice found on combs are likely to be injured or dead,[12] and a louse is not likely to leave a healthy head unless there is a heavy infestation.[13] In one study, live lice were found on only 4% of pillowcases used by infested persons.[14] Thus, the major focus of control activities should be to reduce the number of lice on an individual's head and to lessen the risks of head-to-head contact.

Head lice are specific to humans and cannot be transferred between humans and pets.

DIAGNOSIS

Identification of nits, nymphs, or adult lice with the naked eye, which can be assisted by handheld magnification, establishes the diagnosis. Viewing lice on the head can be difficult sometimes because lice avoid light and can crawl quickly, and a typical affected scalp will have fewer than 10 live lice.[15] Studies have revealed that diagnosis of infestation by using a louse comb is quicker and more efficient than a standard comb, because the very fine teeth of the louse comb are able to separate the hair strands to pull off the lice and nits.[16] The ends of the comb teeth should contact the scalp initially before being pulled toward the end of the hair. The ends of the comb teeth may be sharp, so care should be taken to not scrape or abrade the scalp. Some experts have suggested using a lubricant (water, oil, or conditioner) to "slow down" the movement of lice.[17] Tiny nits may be easier to spot at the nape of the neck or behind the ears, within 1 cm of the scalp. It is important not to confuse nits, which are firmly affixed to the hair shaft, with dandruff, hair casts (pseudonits), or other hair debris (including piedra, which is a fungal infection of the hair shaft), which are not. Many presumed lice and nits submitted by physicians, nurses, teachers, and caregivers 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).[5] It is also important not to confuse live nits with dead nits, because the latter do not represent a treatment failure. In general, nits

found more than 1 cm from the scalp are unlikely to be viable.[18]

Images of the head louse and infections can be found on *Red Book* Online in the Pediculosis Capitis (Head Lice) chapter (https://publications.aap.org/redbook/book/347/chapter/5754779/Pediculosis-Capitis130-Head-Lice).

TREATMENT

The medical provider should initiate treatment only if there is a diagnosis of active head lice infestation. The ideal treatment of head lice should be safe, free of toxic chemicals, readily available, simple to apply, effective, and inexpensive.

The treatment guidance in this report is intended for use by medical providers in the United States. For added information, the reader may consult the most recent position statement by the Canadian Pediatric Society on head lice infestation.[15] The following products and methods can be effective for treating head lice and are prioritized as to US Food and Drug Administration (FDA) approval for safety and efficacy, followed by options that are not FDA-approved. Information is also summarized in Table 1, Table 2, and Fig 1. Product instructions should be followed as closely as possible to maximize benefit and reduce risk.

Topical agents that are FDA-approved for head lice treatment should be regarded as safe to use in pregnant or lactating persons. Topical formulations against head lice have little systemic absorption, and risk of harm to the fetus or breastfeeding child from topical head lice treatment is expected to be minimal.

Pediculicides With FDA Approval for Treatment of Head Lice

Permethrin and Pyrethrins

These organic compounds are neurotoxins that modify voltage-gated sodium channels by keeping them open for abnormally long periods, leading to spastic paralysis and death of the lice. Pyrethrum and pyrethrin are compounds extracted from flowers in the chrysanthemum family.[19] Pyrethrum is the total extract of the flower, whereas pyrethrins represent the refined result of the 6 active molecules (esters), which are directly neurotoxic. The extraction process results in compounds that have variability in their activity. The labels warn of possible allergic reaction in patients sensitive to ragweed, but modern extraction techniques minimize the chance of product contamination, and reports of true allergic reactions have been rare.[20,21] Regardless, these extracted compounds are not completely harmless to human health, and caution must be taken given reports of neurologic symptoms, respiratory symptoms, and dermatitis with ingestion, inhalation, and contact exposure, respectively.[21]

In contrast to these extracted compounds, pyrethroids (such as permethrin) are organic compounds that are synthesized to mimic the action of the esters.[19] As a result of the synthetic process, pyrethroids demonstrate a more consistent activity against lice, have longer residual activity, and have increased stability in storage.

Permethrin and pyrethrin products may have a discernible smell, but there is no need for additional ventilation when in use.

Permethrin (1% Lotion)

Permethrin, a pyrethroid, is the most widely used and studied pediculicide in the United States.[22] Permethrin lotion (1%) is marketed as a "creme

TABLE 1 Available Pediculicides With FDA Approval for the Treatment of Head Lice in the United States

Product	Brand Name	Recommended Age Range	Retreatment Interval (if Needed)	Availability	Cost Estimate[a,b]
Permethrin 1% lotion	Multiple products	≥2 mo	9–10 d	OTC	$
Pyrethrins + piperonyl butoxide shampoo	Example: Rid	≥24 mo	9–10 d	OTC	$
Ivermectin 0.5% lotion	Sklice	≥6 mo	Single use	OTC	$$$$[c]
Malathion 0.5% lotion	Ovide	≥6 y (safety not established for ages <6 y)	7–9 d if live lice are seen after initial dose	Prescription	$$$$
Spinosad 0.9% suspension	Natroba	≥6 mo	7 d if live lice are seen after initial dose	Prescription	$$$$
Ivermectin 3-mg tablet	Stromectol	Any age, if weight ≥15 kg	9–10 d	Prescription	$$$$

Adapted from Gunning et al.[29]

[a] $, <$25; $$, $26–$99; $$$, $100–$199; $200–$299.

[b] Cost varies depending on the length of the hair and the number of bottles of medication required (or patient weight if enteral formulation).

[c] Cost estimation may decrease once generic formulations are more widely available.

TABLE 2 Alternative Agents Reported for Head Lice Treatment (Not FDA-Approved or Recommended)

Category	Agents
Botanical agents for killing or repelling lice	Essential oils (Ageratum, Aloysia, Aniba, Annona, Cananga [ylang ylang], Cinnamomum, Cocos, Curcuma, Elletaria, Eucalyptus, Eugenia, Geranium, Heliantus, Juniperus, Lavandula, Lippia, Litsea, Melaleuca, Melia, Mentha, Monarda, Myrcianthes, Origanum, Pimpinella, Rosmarinus, Salvia, Schinus, Tagetes, tea tree, Zingiberaceae)
	Repellent: citronella
Occlusive agents	Home remedies: petrolatum. mayonnaise, melted butter or margarine, olive oil
	Dimethicone
	Cetaphil cleanser
Desiccants	Natrum muriaticum (Vamousse)
	AirAllé device (formerly Lousebuster)
	Isopropyl myristate (Resultz)
Manual removal	Physical nit combing
	Electronic nit combs
	Vinegar-based products to loosen nits
	Shaving the hair off

Modalities are listed here for reference and do not indicate an endorsement of any particular treatment, because the data supporting the use of these agents has been highly variable.

rinse" (Nix and generics). It is approved for use for individuals 2 months and older and is regarded as the drug of choice for treatment of head lice during pregnancy. Conditioners and silicone-based additives present in many shampoos should be avoided on the day of application, because these impair permethrin adherence to the hair shaft and reduce its residual effect. After washing the hair with a nonconditioning shampoo and towel drying, the product is applied to damp hair (saturating the scalp and working outward to the ends of the hair), left on for 10 minutes, and then rinsed off. Hair should not be shampooed for 24 to 48 hours after application. Permethrin leaves a residue on the hair that is designed to kill nymphs emerging from the 20% to 30% of nits not killed with the first application.[23] A repeat application is recommended between day 9 and 10 after initial treatment if live lice are seen in the interim, with evidence based on the life cycle of head lice suggesting that retreatment at day 9 may be ideal.[24] An alternate treatment schedule on days 0, 7, and 13 to 15 has been proposed on the basis of the longest possible life cycle of lice.[25]

Pyrethrin + Piperonyl Butoxide (Shampoo)

Pyrethrin, the refined product after extraction from the chrysanthemum flower, is often synergized with piperonyl butoxide (RID and generics) to enhance activity.

These products are available OTC in shampoo or mousse formulations for

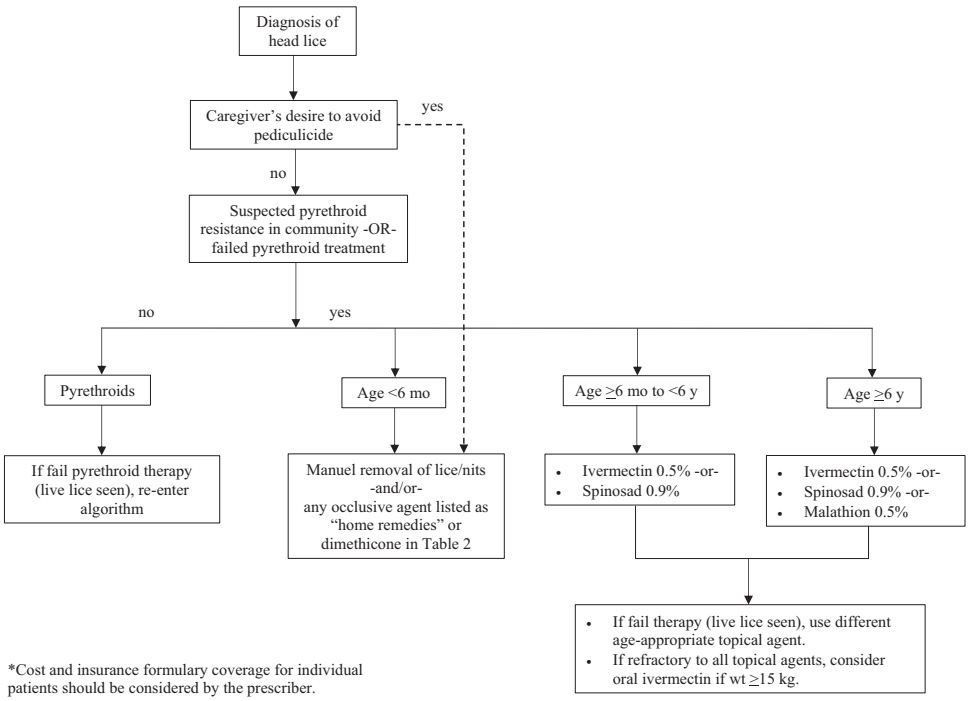

FIGURE 1
Treatment algorithm.*

people 24 months and older. The product is applied to dry hair (saturating the scalp and working outward to the ends of the hair) and left on for 10 minutes before rinsing out. Hair should not be shampooed for 24 to 48 hours after application. Unlike permethrin, no residual pediculicidal activity remains after rinsing. Because 20% to 30% of nits remain viable after treatment,[23] a second treatment is necessary in 9 to 10 days to kill newly emerged nymphs hatched from nits that survived the first treatment. If live lice are still seen, suggested retreatment with these products is similar to permethrin (1%) described previously.[25]

Resistance to Permethrin and Pyrethrins

Several studies have found that, over the past 4 decades, clinical effectiveness of these compounds has declined from near 100% (when first introduced in the 1980s) to as low as 25%. Prevalence of clinical resistance may be highly variable from community to community and country to country.[24,26–28] Genetic alterations and ex vivo studies in head lice that might predict resistance have been described, but these factors do not necessarily predict clinical outcomes (see Box).[22,29]

Resistance of head lice against permethrin and pyrethrins is mostly conferred by the recessive knock-down resistance (*kdr*) gene mutation. Collections of head lice from different geographic areas across the United States and around the world have revealed variable frequencies of the *kdr* mutation, ranging from 0.00 in Ecuador, South Korea, and Thailand, to 0.93 in France, 0.97 in Canada, and 0.97 in the United States.[26] In the decades after broad accessibility of these organic compounds, studies have shown decreased in vitro head lice killing activity.[23,24] Despite those findings, areas with a high prevalence of *kdr* mutant head lice have not conclusively correlated with clinical treatment failure in prospective studies. Particularly, a study in Germany reporting near-universal presence of *kdr* mutant alleles did not correspond with clinical failure of pyrethroids.[30] Further clinical trials are required to document the relevance of the *kdr* genotype as a predictor of clinical outcomes of pyrethroid or pyrethrin treatments.

Ivermectin (0.5% Lotion; Oral Formulation)

Ivermectin, a widely used anthelmintic agent, increases the chloride ion permeability of muscle cells, resulting in hyperpolarization, paralysis, and death of lice.[31] This medication was approved in a lotion form (Sklice) by the FDA in 2012 for people 6 months and older for head lice and was approved for OTC use in late 2020. Topical ivermectin lotion is applied to dry hair (saturating the scalp and working out to the ends of the hair) and rinsed after 10 minutes. Hair should not be shampooed for 24 to 48 hours after application. Only 1 application is required, because when the treated nits hatch, the lice are not able to feed as a result of pharyngeal muscle paralysis and, therefore, are not viable.[32] Two randomized controlled trials in the United States reported the effectiveness of 0.5% ivermectin lotion 14 days after a single application to be 71% and 76%.[31] Adverse effects are rare and include skin or eye irritation and erythema, burning, or dryness.[31]

The oral formulation of ivermectin (Stromectol) is FDA-approved for treatment of head lice in adult patients, although it does not have this indication in pediatrics. However, it is approved for treatment of other infections in pediatric patients, so it can be used for the treatment of head lice in pediatric patients. Oral ivermectin is only available by prescription and should only be used if head lice is resistant to all topical FDA-approved treatments. Treatment with 2 single oral doses of 200 μg/kg, spaced 7 to 10 days apart, has been shown to be effective against head lice.[15,33,34] Comparisons of oral ivermectin versus malathion lotion has demonstrated that oral ivermectin, with a single dose of 400 μg/kg and repeated 7 days later, is comparable or more effective than 0.5% malathion lotion (see below for malathion information).[35] Concerns have previously been raised that ivermectin could cross the blood/brain barrier and block essential neural transmission and that young children may be at higher risk of resulting adverse drug reaction. However, ivermectin acts principally on glutamate-dependent chloride channels in nerve and muscle cells in nonmammals, and these are absent in mammals. Ivermectin might have theoretical effects on central nervous system gamma-aminobutyric acid channels resulting in inhibition of neurotransmission. However, there have been a small number of studies that have begun to document the relative safety and low rate of adverse effects of ivermectin use in infants weighing $<$15 kg treated for scabies.[36,37] Therefore, oral ivermectin should be used with caution for children who weigh $<$15 kg until more data are available.[34,35] Although ivermectin-resistant head lice is not well documented, 2 cases of probable ivermectin resistance have been observed outside the United States.[38]

Oral ivermectin is likely safe during pregnancy, with limited human data showing a small risk of adverse fetal outcomes. Permethrin remains the first-line agent for head lice treatment during pregnancy.

Ivermectin (oral, or in topical form such as a solution or paste) for veterinary use is available through Web sites without a prescription but is not condoned for use in humans. The dose of active ingredients may differ between human and veterinary products. Inactive ingredients may

exist in veterinary formulations that would not be tolerated by humans. Production standards and quality controls are different between human and veterinary products. Although veterinary formulations may be viewed as affordable alternatives for expensive prescriptions, products intended for animal use are never appropriate in treatment of head lice in humans.

Malathion (0.5% Lotion)

The organophosphate (cholinesterase inhibitor) 0.5% malathion (Ovide) has been used for the treatment of head lice in the United States since 1999 for individuals 6 years and older. It is available only by prescription. The lotion is applied to dry hair (saturating the scalp and working outward to the ends of the hair), left to air dry, then washed off after 8 to 12 hours.[39] Hair should not be shampooed for 24 to 48 hours after application. The product has a strong odor, which may dissipate as it dries on the hair. It may be prudent to use this product in a well-ventilated room or outdoors if the odor is not tolerable.

The product should be reapplied in 7 to 9 days of the initial application if live lice are still observed in the interim. However, malathion has high ovicidal activity,[23] and a single application is adequate for most patients. When compared with pyrethrins and permethrin, malathion was the most pediculicidal and ovicidal agent with highest cure rates after 1 application.[23,39]

The high alcohol content of the product (78% isopropyl alcohol) makes it highly flammable; therefore, patients and their caregivers should be instructed to allow the hair to dry naturally after product application; not to use a hair dryer, curling iron, or flat iron while the hair is wet; and not to smoke near a child or adolescent receiving treatment. Safety and effectiveness of malathion lotion have not been established in children younger than 6 years. Because malathion is a cholinesterase inhibitor, respiratory depression may occur if ingested.[40] Malathion-resistant head lice have been documented in many countries[22,41]; however, resistance in the United States is not reported.

Spinosad (0.9% Suspension)

Spinosad (Natroba) has a broad spectrum of activity against insects, including many species of lice. Activity appears to be both ovicidal and pediculicidal by disrupting neuronal activity and lingering long enough to exert its effect on the developing larvae until they form an intact nervous system.[42] Spinosad was approved by the FDA for topical use in people 6 months and older. It is available by prescription only. Spinosad should be applied to dry hair (by saturating the scalp and working outward to the ends of the hair, which may require a whole bottle). Spinosad should be rinsed off 10 minutes after application. Hair should not be shampooed for 24 to 48 hours after application. A second treatment is given at 7 days if live lice are observed after the initial treatment. Superiority of spinosad over permethrin has been demonstrated with treatment success rates of 84% to 87% as compared with 43% to 45%.[27] It is not recommended for children younger than 6 months, because it contains benzyl alcohol, and systemic absorption may lead to benzyl alcohol toxicity.

Abametapir (0.74% Lotion) (Not Available in the United States)

Abametapir (Xeglyze) is a topical pediculicide that inhibits metalloproteinases critical to egg development and survival of lice. It received FDA approval in 2020 for use in head lice in patients 6 months and older but is not yet commercially available. It should be applied to dry hair (saturating the scalp and working outward to the ends of the hair, which may require a whole bottle). Abametapir should be rinsed off 10 minutes after application, and hair can be shampooed any time afterward. A success rate of 81% (subjects not having live lice throughout a 14 day observation period) was described in phase 3 trials.[43] For 2 weeks after abametapir application, the treated individual should avoid taking drugs that are substrates of CYP3A4, CYP2B6, or CYP1A2.

Benzyl Alcohol (5%) – no longer available by manufacturer

Benzyl alcohol lotion (formerly known as Ulesfia) was FDA-approved in 2009 for treatment of head lice in people older than 6 months. Although effective, it was discontinued by its manufacturer because of business decisions and not because of any safety concerns. This medication has not been available for many years, and there has been no indication that it will be brought back in the near future.

Lindane (1%) – not recommended by AAP

Although available and FDA-approved for pediculosis capitis in adults, lindane is not recommended by the American Academy of Pediatrics (AAP), the Centers for Disease Control and Prevention (CDC), or the *Medical Letter*[44] for use as treatment of head lice because of its neurotoxicity.

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 skin absorption attributable to vasodilation. Hair should not be shampooed as part of the initial rinse process, and for most products, the hair should not be washed for 24 to 48 hours after rinsing.

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 head lice are killed and is not a reason for retreatment. Topical corticosteroids or oral antihistamines may be taken to relieve these signs and symptoms if itching or burning is very uncomfortable or persistent.

It is unclear whether application skin reactions would occur more in people with underlying dermatologic or systemic inflammatory conditions compared with the general population. Application instructions and management of subsequent adverse events are unchanged. It is prudent to ensure control of the underlying medical condition, if possible, before head lice treatment.

POOR RESPONSE TO INITIAL PEDICULICIDE TREATMENT

When faced with a persistent case of head lice after using a pharmaceutical pediculicide, health care professionals can 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; failing to follow directions);
- reinfestation (lice reacquired after treatment); and
- resistance of lice to the pediculicide (see Box).

Considering the familiarity and convenience of OTC permethrin- or pyrethrin-based formulations and the lack of clear evidence that *kdr* genetic mutations diminish clinical effectiveness, permethrin, or pyrethrin–piperonyl butoxide are first-line treatments for head lice. If treatment failure (specifically, detection of live lice within 3 weeks of completing therapy) is not attributable to improper use of an OTC pediculicide, then a full course of topical treatment from a different class of medication is recommended. These alternatives (when age-appropriate and not cost-prohibitive) include topical ivermectin lotion, spinosad suspension, and malathion lotion. When head lice are resistant to all topical agents, oral ivermectin may be used in children weighing more than 15 kg. A suggested treatment algorithm is provided in Fig 1.

If the caregiver cannot afford or does not wish to use a pediculicide, manual removal (see "Manual Removal" section below) via wet combing or an occlusive method can be used, with emphasis on careful technique and the duration of at least 3 weeks (1 life cycle of the louse).

ALTERNATIVE APPROACHES

Alternative approaches (listed below and in Table 2) are not FDA-approved or recommended but are included because many families may choose to use them. Close surveillance of patients treated with products and devices not approved by the FDA may improve discovery of treatment failure early, so other evidence-based and FDA-approved treatments might be implemented.

"Natural" Products

Although not condoned for treatment of head lice, a wide variety of essential oils have been used for the eradication of head lice,[45,46] and some studies have identified organic compounds such as anethole, cineole, cinnamaldehyde, cymene, eugenol, linalool, limonene, pulgeone, terpineols, and thymols, which are known to have neurotoxic effects on insects, and these may play a role in the reported antiparasitic effect of some essential oils.[47] The clinical use of essential oils in the treatment of head lice is complicated by a number of factors. Products containing essential oils vary in their composition (even from batch to batch), and responses to them may not, therefore, be consistently reproducible. Many of these oils and their components are known to be sources of contact irritation and contact sensitization, and may cross-react with other agents the patient is using. Although some essential oils (such as eucalyptus, lavandula, melaleuca) may have pleasant scents, others may have unpleasant or offensive odors, limiting their use. Recent publications also raise the possibility that some essential oils such as lavender appear to be associated with premature thelarche and prepubertal gynecomastia because of the estrogenic and antiandrogenic properties of the oils.[48]

A citronella essential oil formulation has been shown to be effective in a single clinical trial in Israel. It was used as a repellent for head lice as a means of reducing the incidence of reinfestations and to minimize lice transmission among children and adolescents.[49]

As natural products, essential oils are not required to meet FDA efficacy and safety standards for pharmaceuticals. Although many plants naturally produce insecticides that may be synthesized for use by humans, some of these insecticidal chemicals produce toxic effects, as well. The safety and efficacy of natural or herbal products are currently not regulated by the FDA,

and until more data are available, their use in infants, children, and adolescents should be avoided.

Occlusive Agents

Occlusive agents, such as "petrolatum shampoo," mayonnaise, melted butter or margarine, herbal oils, and olive oil, applied to suffocate the lice, are widely used. A meta-analysis comparing neurotoxic versus occlusive topical agents suggest the latter being more effective, although significant bias existed.[50] There was no statistical difference in the relative risk of adverse outcomes between occlusive and neurotoxic agents.

Dimethicone is an emollient that has been used for head lice treatment. 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.[51] A single application of 100% dimethicone gel was used in a multisite, open-label study of 58 children between 3 and 12 years of age, with 96% of subjects free of live lice at day 14.[52] In the United States, the OTC product LiceMD contains dimethicone but is not FDA-approved.

An uncontrolled, nonrandomized 2004 study reported a 96% "cure" rate with Cetaphil cleanser applied to the hair, dried on with a hand-held hair dryer, left on overnight, and washed out the next morning and repeated once per week for 3 weeks.[53,54] Instructions for its use are available on the Internet.[55] It has not been approved by the FDA for use as a pediculicide.

Desiccation

Natrum muriaticum is available OTC (brands include Vamousse) and is essentially hypotonic saline solution (table salt in varying concentrations) with the intent to dehydrate lice and nits. No studies are available to assess efficacy.

The AirAllé device (formerly known as the Lousebuster) is a custom-built machine that is cleared by the FDA.[56] This device uses one 30 minute application of hot air in an attempt to desiccate the head lice. Two studies (performed by the same group that designed the device) showed that treatment resulted in nearly 100% mortality of nits and 80% mortality of hatched lice.[56,57] 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.

Isopropyl myristate 50% (Resultz), a hair rinse that dissolves the waxy exoskeleton of the louse, which leads to dehydration and death of the louse, is available in Canada.[58,59] It has received FDA premarket clearance but is not yet available in the United States.

The published studies on desiccation as a head lice treatment note that no adverse outcomes were reported.

Manual Removal

Although there is little peer-reviewed information in the literature about the benefits of the manual removal of live lice and nits, the inherent safety of the manual removal relative to the minor toxicity of the pesticides is real and can be part of the toolbox used by medical providers when determining treatment options. The manual removal process may be beneficial in allowing a caregiver and child or adolescent to have some close, extended time together while safely removing infestations and residual debris. Furthermore, manual removal of nits will help to diminish the social stigma and isolation a child or adolescent can have in the school setting. Individuals may also 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 within 1 cm of the scalp) is reasonable after treatment with any product.

Nit removal can be difficult and tedious.[60] Fine-toothed "nit combs" are available to make the process easier.[61–64] Nit removal combs, such as LiceMeister, Nit-free Terminator, or Lice Logic, are sold commercially. However, it appears that it is less important the type of comb used and rather that combing occur after treatment, which may be most easily accomplished on wet hair. Studies have suggested that head lice removed by combing and brushing are damaged and rarely survive.[11]

There are battery-powered "electronic" louse combs with oscillating teeth (MagiComb) that claim to remove head lice and nits, as well as combs that resemble small electronic "bug zappers" (Robi-Comb) that claim to kill live lice.[65] 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. Other devices under preclinical investigation include nit combs that use ultrasonographic actuation or production of localized ionized gas (plasma) to loosen or kill nits and lice.[66,67]

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 are intended to be applied to the hair for 3 minutes before combing out the nits. There are

Web sites suggesting that these products may be used and rinsed off before applying permethrin, although no clinical benefit has been demonstrated.[6,68] A variety of other products, including acetone, bleach, vodka, and WD-40, have proved to be ineffective in loosening nits from the hair shaft,[68] and present an unacceptable risk to the patient because of chemical skin irritation and possible ingestion.

Although effective for removing head lice and nits, shaving the head generally is not required nor recommended, because it can be traumatizing to a child or adolescent and distressing to the caregiver.

Other Household Products

Highly flammable substances, such as gasoline or kerosene, or products intended for animal use (eg, flea shampoos) are never appropriate in treatment of head lice in humans.

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, exclusion of children or adolescents from school, and the potential for transmission are also important when deciding about the use of newer products.

ENVIRONMENTAL INTERVENTIONS

If a person is identified as having head lice, all household members should be checked for head lice, and those with 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[6]; however, it would be advisable to clean hair care items and bedding used by the individual with the infestation. Only items that have been in contact with the head of the person with infestation within 2 days 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, stuffed toys, headgear, furniture, carpeting, and rugs. Machine washing with hot water and hot air cycles should be used, because lice and nits are killed by exposure for 5 minutes or more to temperatures greater than 130°F. Furniture, carpeting, car seats, and other fabrics or fabric-covered items can be vacuumed to remove an infested person's hairs that might have viable nits attached. Pediculicide spray is not necessary and should not be used. Items that cannot be washed can be bagged in plastic for 2 weeks, a duration when any nits that may have survived would have hatched and nymphs would die without a source for feeding. Dry cleaning is another option for clothing and similar items. Several public health Web sites, as well as the CDC, state that exposing infested items to below-freezing temperatures (in home freezer or outdoors) may kill head lice and nits, although duration varies. Exhaustive cleaning measures are not beneficial.

PREVENTION

It is unlikely that all head lice infestations can be prevented, because children and adolescents come into head-to-head contact with each other frequently. It is prudent to teach children and adolescents not to share personal items such as combs, brushes, hats, and pillows, but individuals should not refuse to wear protective headgear because of fear of head lice. In environments where persons congregate, infested individuals should be treated promptly to minimize spread to others (see "Control Measures in Congregate Settings" section below). Regular surveillance by caregivers is one way (perhaps on a monthly cadence) to detect and treat early infestations, thereby preventing the spread to others.

CONTROL MEASURES IN CONGREGATE SETTINGS

Close quarters shared by persons in congregate settings such as group homes, shelters, long-term care facilities, and immigration centers have the potential for direct head-to-head contact or fomite transmission with persons not otherwise related to the infested individual. If an outbreak occurs in a congregate setting, priorities of outbreak control are to reduce the number of persons affected and educate unaffected individuals to not engage in activities that may result in transmission of head lice.

After diagnosis, the first-line treatment of 1% permethrin should be used, because this agent would encompass the widest group of individuals potentially affected (young age, pregnant individuals). Close contacts (usually family members) should be examined and treated if active lice or nits are seen. Individuals who shared beds with an infested person should also be treated. After treatment, close follow-up of individuals in the next 3 weeks (the life cycle of the organism) is prudent to detect any live lice which survived hatching from nits not killed by the treatment.

Items which have been in contact with persons undergoing treatment within the 2 days preceding the treatment should be cleaned

(see "Environmental Interventions" section above).

CONTROL MEASURES IN SCHOOLS

Screening

Screening for nits alone is not an accurate way of predicting which children or adolescents are or will become infested, and screening for head lice has not been proven to have a significant effect on the incidence of head lice in a school community over time.[69,70] In addition, such screening has not been shown to be cost effective. In a prospective study of 1729 school-aged children 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.[71] Because of the lack of evidence of efficacy, routine classroom or schoolwide screening should be discouraged.

Although children and adolescents 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 or adolescents at higher risk converted to having an active infestation.[72] School exclusion of children or adolescents with nits alone would have resulted in many of these children or adolescents missing school unnecessarily. In addition, head lice infestations have been shown to have low contagion in classrooms.[73] The results of several descriptive studies have suggested that education of caregivers in diagnosing and managing head lice may be helpful.[73–77] Caregivers should be encouraged to check their children's or adolescent's heads for lice regularly if the child or adolescent is symptomatic. School screenings do not take the place of these more careful checks by the caregiver.[12,78–80] It may be helpful for the school nurse or other trained person to check students' heads if they are demonstrating symptoms.

Management on the Day of Diagnosis

A child or adolescent with an active head lice infestation likely had the infestation for 4 to 6 weeks, given that is the amount of time needed for an individual to start itching from an allergic reaction to lice saliva,[15] although those with previous sensitization and recurrent head lice might react more quickly if reinfested. Given this duration of exposure and that the child or adolescent 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 head lice is diagnosed in a child or adolescent, confidentiality is important to minimize social stigma, which may occur if communication inadvertently reveals the affected individual. The child's or adolescent's caregiver should be notified that day by telephone or by having a note sent home with the child or adolescent at the end of the school day stating that prompt, proper treatment of this condition is in the best interest of the child or adolescent and his or her classmates. Common sense and calm should prevail within a school when deciding how "contagious" an individual may be (a child or adolescent with hundreds versus a child or adolescent with 2 live lice). It may be prudent to check other children or adolescents who are symptomatic or who were most likely to have had direct head-to-head contact with the infested child or adolescent. 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 caregivers only if a high percentage of children in a classroom are infested. Other experts feel strongly that these "alert letters" violate privacy laws, 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.[79] 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. Regardless of the extent of the communication on a specific case, schools may wish to provide general education to their constituency that head lice is not a public health hazard.

Criteria for Return to School

A child or adolescent should not be restricted from school attendance because of head lice, given the low contagion within classrooms.[71] "No-nit" policies that exclude children or adolescents until all nits are removed may violate a child's or adolescent's civil liberties and are best addressed with legal counsel for schools. Most health care professionals who care for children or adolescents agree that no-nit policies should be abandoned.[79] International guidelines for the effective control of head lice infestations have stated that no-nit policies are unjust and should be discontinued, because they are based on misinformation rather than objective science.[81] The AAP and the National Association of School Nurses[82] discourage no-nit policies that exclude children or adolescents from school. Additional information that may be used by providers and caregivers to counter

school no-nit policies may be found on the CDC Web site.[83]

A school nurse familiar with head lice infestations, if present, can perform a valuable service by rechecking a child's or adolescent's head if requested to do so by a caregiver; this screening should be performed privately to maintain confidentiality. In addition, the school nurse can offer extra help to families of children or adolescents who are repeatedly or chronically infested.

SUMMARY OF KEY POINTS

1. Medical providers should know about head lice infestations and treatments (pediculicides and alternative therapies) and take an active role as information resources for families, schools, and other community agencies.
2. Unless resistance to these products has been proven in the community, or a child or adolescent has already failed therapy with these agents, pyrethroids are recommended as first-line therapy of active infestations if pediculicide therapy is required.
3. Carefully communicated instructions on the proper use of products are important. Because many products are not completely ovicidal, a second application at the proper interval according to manufacturer's instructions may be required. Manual removal of nits immediately after treatment with a pediculicide is optional but is not necessary to prevent spread. In the school setting, nit removal may be considered to decrease diagnostic confusion and social stigmatization.
4. Topical ivermectin lotion and spinosad (for people 6 months and older) or malathion 0.5% (for people 6 years and older) should be used in areas where resistance to permethrin and pyrethrins has been demonstrated or for a patient with a documented infestation that has failed to respond to appropriately administered therapy with these agents. Cost and insurance formulary coverage for individual patients are important factors to be discussed and considered by both the prescriber and caregiver (Table 1). Products intended for animal use are never appropriate in treatment of head lice in humans.
5. If resistance to FDA-approved treatments has been proven in the community, if the patient is too young for commercially available therapy, or if caregivers do not wish to use a pediculicide, then manual removal of lice/nits or occlusive methods is recommended, with emphasis on careful technique, close surveillance, and repeating for at least 3 weekly cycles, given the life cycle of head lice being 21 days.
6. Products without FDA approval for head lice treatment (Table 2) should be avoided because of lack of evidence of efficacy. If used by caregivers, the latter should be counseled by providers to discuss concerns about treatment failure and the option to use FDA-approved agents.
7. Head lice screening programs in schools have not been proven to have a significant effect over time on the incidence of head lice in the school setting, are not cost-effective, and may stigmatize children suspected of having head lice. Educational programs for families may be helpful in the management of head lice in the school setting.
8. No healthy child or adolescent should be excluded from school or allowed to miss school time because of head lice or nits. Medical providers should educate school communities that no-nit policies for return to school should be abandoned, because such policies would have negative consequences for children's or adolescents' academic progress, may violate their civil rights, and stigmatize head lice as a public health hazard.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
CDC: Centers for Disease Control and Prevention
FDA: US Food and Drug Administration
kdr: knock-down resistance
OTC: over the counter

REFERENCES

1. Gur I, Schneeweiss R. Head lice treatments and school policies in the US in an era of emerging resistance: a cost-effectiveness analysis. *PharmacoEconomics.* 2009;27(9):725–734
2. Hansen RC, O'Haver J. Economic considerations associated with Pediculus humanus capitis infestation. *Clin Pediatr (Phila).* 2004;43(6):523–527
3. Gordon SC. Shared vulnerability: a theory of caring for children with persistent head lice. *J Sch Nurs.* 2007; 23(5):283–292
4. Burkhart CG. Relationship of treatment-resistant head lice to the safety and efficacy of pediculicides. *Mayo Clin Proc.* 2004;79(5):661–666
5. Pollack RJ, Kiszewski AE, Spielman A. Overdiagnosis and consequent mismanagement of head louse infestations in North America. *Pediatr Infect Dis J.* 2000;19(8):689–693, discussion 694
6. Meinking TL, Taplin D. Infestations: pediculosis. *Curr Probl Dermatol.* 1996; 24:157–163
7. Takano-Lee M, Yoon KS, Edman JD, Mullens BA, Clark JM. In vivo and in vitro rearing of Pediculus humanus capitis (Anoplura: Pediculidae). *J Med Entomol.* 2003;40(5):628–635
8. Centers for Disease Control and Prevention. Parasites: lice: head lice. Available at: https://www.cdc.gov/parasites/lice/head/index.html. Accessed June 3, 2021
9. Burkhart CN. Fomite transmission with head lice: a continuing controversy. *Lancet.* 2003;361(9352):99–100
10. Falagas ME, Matthaiou DK, Rafailidis PI, Panos G, Pappas G. Worldwide prevalence of head lice. *Emerg Infect Dis.* 2008;14(9):1493–1494
11. Chunge RN, Scott FE, Underwood JE, Zavarella KJ. A review of the epidemiology, public health importance, treatment and control of head lice. *Can J Public Health.* 1991;82(3): 196–200
12. Chunge RN, Scott FE, Underwood JE, Zavarella KJ. A pilot study to investigate transmission of headlice. *Can J Public Health.* 1991;82(3):207–208
13. Human lice: some basic facts and misconception. *Pan American Health Organization Bulletin.* 1985;19(2): 194–197
14. Speare R, Cahill C, Thomas G. Head lice on pillows, and strategies to make a small risk even less. *Int J Dermatol.* 2003;42(8):626–629
15. Cummings C, Finlay JC, MacDonald NE. Head lice infestations: a clinical update. *Paediatr Child Health.* 2018;23(1):e18–e24
16. Mumcuoglu KY, Friger M, Ioffe-Uspensky I, Ben-Ishai F, Miller J. Louse comb versus direct visual examination for the diagnosis of head louse infestations. *Pediatr Dermatol.* 2001;18(1):9–12

17. Burgess I. Detection combing. *Nurs Times*. 2002;98(46):57

18. Meister L, Ochsendorf F. Head lice. *Dtsch Arztebl Int*. 2016;113(45):763–772

19. MGK. Pyrethrins versus Pyrethroids: what's the difference? Available at: https://www.mgk.com/pyrethrins-vs-pyrethroids-whats-the-difference/. Accessed April 16, 2021

20. Osimitz TG, Franzosa JA, Maciver DR, Maibach HI. Pyrethrum allergic contact dermatitis in humans–real? common? or not documented? An evidence-based approach. *Cutan Ocul Toxicol*. 2006; 25(4):287–308

21. Proudfoot AT. Poisoning due to pyrethrins. *Toxicol Rev*. 2005;24(2):107–113

22. Koch E, Clark JM, Cohen B, et al. Management of head louse infestations in the United States–a literature review. *Pediatr Dermatol*. 2016;33(5):466–472

23. Meinking TL, Entzel P, Villar ME, Vicaria M, Lemard GA, Porcelain SL. Comparative efficacy of treatments for pediculosis capitis infestations: update 2000. *Arch Dermatol*. 2001;137(3):287–292

24. Meinking TL, Serrano L, Hard B, et al. Comparative in vitro pediculicidal efficacy of treatments in a resistant head lice population in the United States. *Arch Dermatol*. 2002;138(2):220–224

25. Lebwohl M, Clark L, Levitt J. Therapy for head lice based on life cycle, resistance, and safety considerations. *Pediatrics*. 2007;119(5):965–974

26. Durand R, Bouvresse S, Berdjane Z, Izri A, Chosidow O, Clark JM. Insecticide resistance in head lice: clinical, parasitological and genetic aspects. *Clin Microbiol Infect*. 2012;18(4):338–344

27. Stough D, Shellabarger S, Quiring J, Gabrielsen AA Jr. Efficacy and safety of spinosad and permethrin creme rinses for pediculosis capitis (head lice). *Pediatrics*. 2009;124(3):e389–e395

28. Downs AM. Managing head lice in an era of increasing resistance to insecticides. *Am J Clin Dermatol*. 2004;5(3): 169–177

29. Gunning K, Kiraly B, Pippitt K. Lice and scabies: treatment update. *Am Fam Physician*. 2019;99(10):635–642

30. Bialek R, Zelck UE, Fölster-Holst R. Permethrin treatment of head lice with knockdown resistance-like gene. *N Engl J Med*. 2011;364(4):386–387

31. Pariser DM, Meinking TL, Bell M, Ryan WG. Topical 0.5% ivermectin lotion for treatment of head lice. *N Engl J Med*. 2012;367(18):1687–1693

32. Deeks LS, Naunton M, Currie MJ, Bowden FJ. Topical ivermectin 0.5% lotion for treatment of head lice. *Ann Pharmacother*. 2013;47(9):1161–1167

33. Nofal A. Oral ivermectin for head lice: a comparison with 0.5 % topical malathion lotion. *J Dtsch Dermatol Ges*. 2010;8(12):985–988

34. Sanchezruiz WL, Nuzum DS, Kouzi SA. Oral ivermectin for the treatment of head lice infestation. *Am J Health Syst Pharm*. 2018;75(13):937–943

35. Chosidow O, Giraudeau B, Cottrell J, et al. Oral ivermectin versus malathion lotion for difficult-to-treat head lice. *N Engl J Med*. 2010;362(10):896–905

36. Levy M, Martin L, Bursztejn AC, et al. Groupe de Recherche de la Société Française de Dermatologie Pédiatrique. Ivermectin safety in infants and children under 15 kg treated for scabies: a multicentric observational study. *Br J Dermatol*. 2020;182(4):1003–1006

37. Ständer S, Kirschstein DJ, Kohl-Sobania M, Zillikens D, Ludwig RJ, Anemüller W. Effectiveness and adverse events of ivermectin treatment for scabies in 30 infant patients: report from a German single centre. *J Eur Acad Dermatol Venereol*. 2020;34(11):e736–e737

38. Diatta G, Abat C, Sokhna C, Tissot-Dupont H, Rolain JM, Raoult D. Head lice probably resistant to ivermectin recovered from two rural girls in Dielmo, a village in Sine-Saloum, Senegal. *Int J Antimicrob Agents*. 2016;47(6):501–502

39. Meinking TL, Vicaria M, Eyerdam DH, Villar ME, Reyna S, Suarez G. Efficacy of a reduced application time of Ovide lotion (0.5% malathion) compared to Nix creme rinse (1% permethrin) for the treatment of head lice. *Pediatr Dermatol*. 2004;21(6):670–674

40. Pannell M, Gilbert JD, Gardiner J, Byard RW. Death due to malathion poisoning. *J Clin Forensic Med*. 2001;8(3):156–159

41. Bouvresse S, Berdjane Z, Durand R, Bouscaillou J, Izri A, Chosidow O. Permethrin and malathion resistance in head lice: results of ex vivo and molecular assays. *J Am Acad Dermatol*. 2012;67(6):1143–1150

42. Villegas SC, Breitzka RL. Head lice and the use of spinosad. *Clin Ther*. 2012; 34(1):14–23

43. Bowles VM, VanLuvanee LJ, Alsop H, et al. Clinical studies evaluating abametapir lotion, 0.74%, for the treatment of head louse infestation. *Pediatr Dermatol*. 2018;35(5):616–621

44. Drugs for head lice. *Med Lett Drugs Ther*. 2016;58(1508):150–152

45. Mac-Mary S, Messikh R, Jeudy A, et al. Assessment of the efficacy and safety of a new treatment for head lice. *ISRN Dermatol*. 2012;2012:460467

46. Barker SC, Altman PM. A randomized, assessor blind, parallel group comparative efficacy trial of three products for the treatment of head lice in children–melaleuca oil and lavender oil, pyrethrins and piperonyl butoxide, and a "suffocation" product. *BMC Dermatol*. 2010;10:6

47. Candy K, Akhoundi M, Andriantsoanirina V, Durand R, Bruel C, Izri A. Essential oils as a potential treatment option for pediculosis. *Planta Med*. 2020;86(9): 619–630

48. Ramsey JT, Li Y, Arao Y, et al. Lavender products associated with premature thelarche and prepubertal gynecomastia: case reports and endocrine-disrupting chemical activities. *J Clin Endocrinol Metab*. 2019;104(11):5393–5405

49. Mumcuoglu KY, Magdassi S, Miller J, et al. Repellency of citronella for head lice: double-blind randomized trial of efficacy and safety. *Isr Med Assoc J*. 2004;6(12):756–759

50. Flores-Genuino RNS, Gnilo CMS, Dofitas BL. Occlusive versus neurotoxic agents for topical treatment of head lice infestation: a systematic review and meta-analysis. *Pediatr Dermatol*. 2020; 37(1):86–92

51. Burgess IF, Brown CM, Lee PN. Treatment of head louse infestation with 4% dimeticone lotion: randomized controlled equivalence trial. *BMJ*. 2005; 330(7505):1423

52. Ihde ES, Boscamp JR, Loh JM, Rosen L. Safety and efficacy of a 100%

dimethicone pediculocide in school-age children. *BMC Pediatr.* 2015;15:70

53. Pearlman DL. A simple treatment for head lice: dry-on, suffocation-based pediculicide. *Pediatrics.* 2004;114(3): e275–e279
54. Pearlman D. Cetaphil cleanser (Nuvo lotion) cures head lice. *Pediatrics.* 2005;116(6):1612
55. Pearlman D. Nuvo method for head lice. Available at: http://nuvoforheadlice.com. Accessed January 16, 2021
56. Bush SE, Rock AN, Jones SL, Malenke JR, Clayton DH. Efficacy of the Louse-Buster, a new medical device for treating head lice (Anoplura:Pediculidae). *J Med Entomol.* 2011;48(1):67–72
57. Goates BM, Atkin JS, Wilding KG, et al. An effective nonchemical treatment for head lice: a lot of hot air. *Pediatrics.* 2006;118(5):1962–1970
58. Burgess IFBC, Lee PN. Randomized, controlled, parallel group clinical trials to evaluate the efficacy of isopropyl myristate/cyclomethicone solution against head lice. [Published online June 23, 2009] *Pharm J.* 2009
59. Kaul N, Palma KG, Silagy SS, Goodman JJ, Toole J. North American efficacy and safety of a novel pediculicide rinse, isopropyl myristate 50% (Resultz). *J Cutan Med Surg.* 2007;11(5):161–167
60. Bartels CL, Peterson KE, Taylor KL. Head lice resistance: itching that just won't stop. *Ann Pharmacother.* 2001;35(1): 109–112
61. Bainbridge CV, Klein GL, Neibart SI, et al. Comparative study of the clinical effectiveness of a pyrethrin-based pediculicide with combing versus a permethrin-based pediculicide with combing. *Clin Pediatr (Phila).* 1998;37(1):17–22
62. Burkhart CN, Arbogast J. Head lice therapy revisited. *Clin Pediatr (Phila).* 1998;37(6):395
63. Speare R, Canyon DV, Cahill C, Thomas G. Comparative efficacy of two nit combs in removing head lice (Pediculus humanus var. capitis) and their eggs. *Int J Dermatol.* 2007;46(12):1275–1278
64. Gallardo A, Toloza A, Vassena C, Picollo MI, Mougabure-Cueto G. Comparative efficacy of commercial combs in removing head lice (Pediculus humanus capitis) (Phthiraptera: Pediculidae). *Parasitol Res.* 2013;112(3):1363–1366
65. O'Brien E. Detection and removal of head lice with an electronic comb: zapping the louse! *J Pediatr Nurs.* 1998; 13(4):265–266
66. Burgess MN, Brunton ER, Burgess IF. A novel nit comb concept using ultrasound actuation: preclinical evaluation. *J Med Entomol.* 2016;53(1):152–156
67. Ten Bosch L, Habedank B, Siebert D, Mrotzek J, Viöl W. Cold atmospheric pressure plasma comb-a physical approach for pediculosis treatment. *Int J Environ Res Public Health.* 2018; 16(1):19
68. Burkhart CN, Burkhart CG, Pchalek I, Arbogast J. The adherent cylindrical nit structure and its chemical denaturation in vitro: an assessment with therapeutic implications for head lice. *Arch Pediatr Adolesc Med.* 1998;152(7):711–712
69. Vander Stichele RH, Dezeure EM, Bogaert MG. Systematic review of clinical efficacy of topical treatments for head lice. *BMJ.* 1995;311(7005):604–608
70. Heukelbach J, Wilcke T, Winter B, Feldmeier H. Epidemiology and morbidity of scabies and pediculosis capitis in resource-poor communities in Brazil. *Br J Dermatol.* 2005;153(1):150–156
71. Hootman J. Quality improvement projects related to pediculosis management. *J Sch Nurs.* 2002;18(2):80–86
72. Williams LK, Reichert A, MacKenzie WR, Hightower AW, Blake PA. Lice, nits, and school policy. *Pediatrics.* 2001;107(5): 1011–1015
73. Mathias RG, Wallace JF. Control of head-lice: using parent volunteers. *Can J Public Health.* 1989;80(6):461–463
74. Clore ER, Longyear LA. Comprehensive pediculosis screening programs for elementary schools. *J Sch Health.* 1990; 60(5):212–214
75. Donnelly E, Lipkin J, Clore ER, Altschuler DZ. Pediculosis prevention and control strategies of community health and school nurses: a descriptive study. *J Community Health Nurs.* 1991;8(2): 85–95
76. Brainerd E. From eradication to resistance: five continuing concerns about pediculosis. *J Sch Health.* 1998;68(4): 146–150
77. Clore ER. Dispelling the common myths about pediculosis. *J Pediatr Health Care.* 1989;3(1):28–33
78. Stafford G; Stafford Group. Head lice: evidence-based guidelines based on the Stafford Report. *J Fam Health Care.* 2002;12(5 Suppl):1–21
79. Mumcuoglu KY, Meinking TA, Burkhart CN, Burkhart CG. Head louse infestations: the "no nit" policy and its consequences. *Int J Dermatol.* 2006;45(8): 891–896
80. Mumcuoglu KY, Barker SC, Burgess IE, et al. International guidelines for effective control of head louse infestations. *J Drugs Dermatol.* 2007;6(4):409–414
81. Mumcuoglu KY, Pollack RJ, Reed DL, et al. International recommendations for an effective control of head louse infestations. *Int J Dermatol.* 2021;60(3): 272–280
82. National Association of School Nurses. Head lice management in schools (position statement). Available at: https://www.nasn.org/advocacy/professional-practice-documents/position-statements/ps-head-lice. Accessed January 16, 2021
83. Centers for Disease Control and Prevention. Head lice information for schools. Available at: https://www.cdc.gov/parasites/lice/head/schools.html. Accessed June 13, 2021