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Review

International recommendations for an effective control of head louse infestations

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Abstract

Head louse infestations continue to be a concern of public health in most countries, including the most developed ones. The present recommendations are intended to inform and stress the role and impact of the different authorities, institutions, industry, and the public in the control of head lice in order to reduce the prevalence of this parasite. We encourage health authorities to pursue more effective methods to correctly identify such infestations, and evaluate existing and new pediculicides, medical devices, louse repellents, and louse- and nit-removal remedies. Pediculicides and medical devices must have verifiable claims in the instructions for use and should be tested periodically to document current levels of resistance by lice to the active ingredients and to the formulated products. Where the prevalence of lice is claimed to be epidemic, children should be periodically evaluated objectively to document the actual level of prevalence. Continuing education for health providers and the general population promises to correct misinformation regarding the biology, prevention, and management of lice. Parents should regularly inspect their children for head lice and treat as necessary. Health authorities are encouraged to eliminate policies and practices that rely upon school exclusion as a means to reduce incidence and prevalence, e.g., the 'no-nit' policy which lacks scientific justification, and are counterproductive to the health and welfare of children.

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Introduction

The head louse *Pediculus humanus capitis* De Geer, 1767 (Anoplura: Pediculidae) is an obligate ectoparasitic insect on the scalp of human beings, where it feeds exclusively on blood.[1-3]

Infestations by head lice (pediculosis) occur mainly among children worldwide. Generally, those who are infested do not manifest serious symptoms. Some portion of infested individuals, however, presents with measurable health burdens that directly result from reactions to louse feeding. Itching of the scalp, the main and often sole (but not an obligate) symptom of head louse infestation, can result in loss of sleep or concentration at work or school, and excessive scratching occasionally poses risk of secondary skin infections and lymphadenopathies.[4] For many persons, head lice – or the fear of exposure to these diminutive pests – manifests as more of an emotional and psychological problem rather than a clinical one.

Head lice become a public health concern when their prevalence increases and when perspectives, policies, and practices to prevent and abate these pests pose even greater risks to people than the infestation itself.[5]

Claims of heightened or increasing prevalence of head lice infestations worldwide since the mid-1960s were reviewed by the World Health Organization,[6] with some extrapolating of the annual occurrence of hundreds of millions of cases.[7] The U.S. Centers for Disease Control and Prevention has long suggested a yearly prevalence of 6–12 million cases in the USA[8] (repeating data from a previous review).[6] Because head louse infestations are not a reportable condition in many countries (including the USA), the aforementioned estimates are decidedly questionable at best.

Increased prevalence of head louse infestation has been reported from Israel, Denmark, Sweden, UK, France, USA, Iran, and Australia.[9-15] These epidemiological studies were conducted during different seasons, among vastly different populations (including ages and gender), using different examination methods (visual vs. louse comb), and relied on differing measures to define the basis of an infestation (e.g., nits vs. live lice). The lack of standardization used in such studies confuses efforts to draw conclusions as to the current prevalence at those time points as well as effects of any anti-louse strategy.

Head lice normally move to a new host when an infested person's hair is in direct contact with that of another person. Social and familial contact between children, as well as between parents and children, are more likely routes of infestation than via fomites (shared combs, brushes, towels, clothing, linens, etc.). Risk factors for acquiring head lice are thought to be affected by the number of children per family, the frequency with which they share beds, the local customs and kinds of social contacts, the lack of community-based healthcare system (e.g., school health services), and the socioeconomic status of the family. Head lice are most prevalent among children attending childcare and elementary schools, with elevated prevalence noted among their household members, especially siblings and mothers of children who have lice. Girls are diagnosed as infested 2–10 times more often than boys, and children between 4 and 13 years are most frequently affected.[16-18]

Louse specialists attending the Sixth International Conference on Phthiraptera (held in Brno, Czech Republic, June 23–29, 2018) proposed updating the international guidelines for the control of head louse infestations[19] in the hope of encouraging all stakeholders including those with powers to influence policies toward lowering the prevalence of head lice worldwide and to reduce the emergence and spread of the evolution of resistance to a particular treatment. Consequently, a diverse team of louse and public health specialists debated and agreed to an array of goals and recommendations that form the basis for this document.

Recommendations for the health authorities

A new pediculicide to the local market

Only evidence-based effective products that are not harmful to children or the environment should come to market.[20] Introducing a new pediculicide into the market can only be based on a thorough evaluation of the formulation's safety and efficacy. Pediculicide with an active ingredient that is already well-established for use in the marketplace, but offered for registration in different concentrations, combined with different chemicals, or proposed in different dosages, may provide markedly different results.[21-22] Therefore, each formulation should be tested separately in well-designed studies. In the historical body of evidence for the treatment of head lice, the majority of studies carry a high risk of bias.[23]

All new products whether they rely upon new chemistries, active ingredients currently approved but in products that differ markedly in their formulation or use, or on alternative modes of action (e.g., growth regulation, suffocation, chitin inhibition, microbial action, etc.), should first be tested in the laboratory on colonies of body lice or on ex vivo lice samples; however, it should be noted that even ex vivo tests are only an indicator of possible efficacy and should not be relied upon as a guide to effectiveness in clinical use.

All candidate products should be tested to the minimum standard of an assessor blinded, randomized, and controlled trial at least once,[24] and preferably be compared with an effective pediculicide or other head louse treatment modality used in the same country. The candidate product should be tested on at least 50 head louse infested individuals with a substantial number of living lice that meet state-of-the-art inclusion and exclusion criteria, as well as an effective method to detect living lice at the end of the study and thus enable reliable study results.

A product must not only be better than another less effective one but should also have a high efficacy, to be able to reduce prevalence of head lice in communities and not just sustain the endemic. We believe that an 85% efficacy should be the minimal effect level to be able to control epidemics. Severe

sideeffects should be (nearly) absent, while minor sideeffects should have a frequency of less than 5%.

New products should be tested with standard toxicology data relative to human inhalation, skin absorption, and oral ingestion. If the formulation is flammable, then standard flashpoint and burn test data should also be provided.

Laboratory colonies of body lice (*Pediculus humanus humanus*) may serve as convenient test subjects for initial *in vitro* evaluations.[25] Body lice that survive a test formulation are predictive of such failure of that same product to eliminate head lice in a clinical treatment. Success in the laboratory with these model organisms, however, is not predictive of the same result in the field or when used against head lice.

In all cases, e*x vivo* efficacy studies should be conducted regionally (within the country of proposed use whenever possible). Such a test should strive to evaluate at least 100 adult or third instar head lice to test one condition (e.g., one exposure time) for the test formulation and another 50 as a nontreated comparison group, which should be the minimum sample size to have a reasonably narrow confidence interval around the observed cure rate.

A pediculicide clinically tested in another country

Pediculicides that are effective in one region may not be as effective in another because of the differing regional prevalence of resistant strains of head lice. *Ex vivo* and/or clinical efficacy studies are necessary in the area where it is proposed to market the pediculicide. For example, the practice of carrying out clinical studies in developing countries where head lice are more commonly encountered than in countries with more developed economies should be eliminated. Products should only be approved after clinical evaluation in a country economically similar to the one where it is intended to be marketed.

Testing of existing pediculicides

Pediculicides should be produced in compliance with good manufacturing practice, in order to avoid quality variations in their manufacture and storage.

Because of the emergence and spread of lice that are insensitive (resistant) to the active ingredient and/or formulation, existing pediculicides should be re-evaluated every 5 years in *ex vivo* tests or clinical trials to document the actual level of efficacy they elicit.[26]

Lice have developed varying and fairly widespread levels of resistance to pyrethrins and pyrethroids insecticides as well as organophosphates such as malathion and also to carbamate insecticides.[27-35] For persistent infestations with multiresistant lice, ivermectin could be considered.[36]

However, in most territories neurotoxic chemicals such as these are now extensively superseded by use of alternative materials or methods that exhibit some form of physical activity against lice that is not affected by the metabolic pathways inhibiting the activity of neurotoxic insecticides.

Natural remedies and medical devices

Plant extract remedies and anti-louse devices (such as those relying upon heated air, suction, or electronic teeth) must similarly be evaluated prior to their introduction to the market. Because it is less likely that lice will develop resistance to mechanical methods, nonchemical products might not need periodic evaluation.

Advertising for any product should prominently display whether it is licensed, either as a medicine (pharmaceutical product) or as a medical device. Where a product is designed to be used as a combing aid (i.e., has no intrinsic activity to kill lice or their eggs), it should be made clear that this is the case. Terms such as “hair hygiene” or even obscure references to “lice-cleaner”, “nit-loosener”, or “treats unpleasant scalp conditions” may contravene the spirit, if not the letter, of the regulations governing advertising of pediculicide products in most countries. Regulatory authorities should be encouraged to enforce their own rules to prevent such misleading terminology and advertising.

Louse repellents

As with pediculicides, a randomized, double-blind, clinical study should ideally be conducted with a putative louse repellent prior to its introduction to the market. At least 100 noninfested individuals should participate in such a clinical trial, which might involve more than one member of the same family. The assessment should be performed by an investigator experienced in the design and conduct of such studies.[37]

Nit-removal remedies

Nit-removal remedies should be first tested on nit-bearing hairs ex vivo, using mechanical traction methods, and later in clinical trials on the hair of at least 50 individuals with nits or eggs. For this purpose, 10 cm^2 sections of hair with approximately equivalent abundance of nits or eggs could be selected as test and comparison sites. One section of hair should be treated with the nit-removal remedy, while the comparison site should be treated with water, shampoo, or conditioner. At the end of the trial, the number of nits in the two sites of the hair should be compared. If a comb is being used for this purpose, the same comb should be an integral part of the future product. The cement that lice use to affix eggs to individual hair shafts is a biological entity produced by female lice, and as such any product acting upon it could be used in any other country without retesting in each.

Louse combs and other detection methods

The use of a fine comb for removing lice and eggs/nits from the scalp hair is a relevant tool for diagnosis as well as for mitigating an infestation. The effectiveness of a fine comb depends, in part, on the comb’s design and the skill of the person using the comb. Combing may be considered as the sole means, or as a supplementary activity, to eliminate head lice. A louse comb

(with teeth spaced 0.20–0.30 mm apart) is particularly effective to aid in the initial diagnosis of a louse infestation and for verification that treatment with a pediculicide was successful. A nit comb (with teeth spaced 0.09–0.19 mm apart) exerts the traction necessary for the removal of eggs and nits. Preparation of wet hair with liberal conditioner prior to fine combing makes combing the hair and removal of lice easier than dry combing. The method may be more effective on short and medium hair. If applied systematically, it can serve as a valid alternative to pediculicides for motivated parents provided with the correct combs and instructions.[30,38]

Results of comparative studies of two or more combs confirmed significant differences between combs as detection as well as removal devices.[39-41] Accordingly, *in vivo* testing tests should also be conducted with louse combs, in order to validate claims regarding their efficacy.

"Instruction for Use"

The instructions for use on each packaging and on the information leaflet – whether for pediculicides, other formulations, or for physical devices – should conform to the requirements of each country where the product is marketed and be understandable to residents, regardless of their native language and socioeconomic status. Pictograms demonstrating proper use may help consumers, regardless of their language abilities. Commonly imprecise dosage instructions are given, and sometimes product package sizes are too small to meet the requirement stated in the instructions.[25]

The instructions should make verifiable claims on the packaging; e.g., stressing the limited effect on eggs and therefore the necessity to repeat a treatment to kill recently hatched lice. It is not sufficient to state that a treatment should be repeated only if the first treatment was not effective. It should be clearly stated how the product should be applied, how long it should remain on the scalp, how it should be removed, when the treatment(s) should be repeated, and how the consumer should determine that the product was effective and how long and how often a louse comb should be used as a supplemental tool during or after the treatment. Contraindications, sideeffects, hazards (e.g., flammability), and how to obtain further information should be listed on each product.

Regulations for medical agencies

In case the National Competent Authorities delegate testing of *in vivo* and *in vitro* efficacy of a product to private and academic institutions, adequate guidance and regulation should be assured.

Regular examination of children with the help of school nurses

In kindergartens and schools where there is evidence of a high number of complaints related to lice infestations, health authorities are encouraged to arrange screenings with the help of school nurses and experienced volunteers, and provide appropriate advice to parents. This might relieve strain on the community. Such screenings should be performed solely when nurses are provided with appropriate education regarding louse biology, their proper diagnosis, and appropriate means of management. Furthermore, such nurses should be provided with appropriate magnification devices and screening tools, trained in their use, and then assessed for their competency using blinded/coded samples of lice, eggs, and common kinds of hair-associated debris.

National committee on pediculosis

The formation of national advisory committees is encouraged to guide policies and practices relating to evidenced-based louse management throughout the country. Such a committee might be composed of pediatricians, dermatologists, epidemiologists, medical entomologists, public health specialists, parents, nurses, social workers, and representatives of the pharmaceutical industry. The committee might focus attention on evaluating prevention and control strategies, coordinate the activities of academic and clinical institutions, disseminate information, and conduct or serve as a clearinghouse for reports pertaining to incidence, prevalence, and resistance.

Providing pediculicides

When appropriate, a governmental health agency might facilitate the distribution of effective and subsidized pediculicides.

Education

Governmental health agencies and the national committee would be encouraged to facilitate the distribution of relevant information in manners accessible to their population. Efforts might include: continuing education for health providers and school authorities, as well as basic information for the general public. Informational resources (printed, Internet based, or provided as public service announcements on radio or television) should be made available in languages and degree of comprehension appropriate for the target audiences.

Health providers

The main aim of health providers should be to equip childcare personnel as well as parents to manage head louse infestations. Health providers such as physicians, nurses, and pharmacists should be well-informed about effective anti-louse strategies and products and updated on new developments. School nurses should address the head louse problem proactively by making information available to parents and investigating institutions with a high level of complaints. In addition, the school nurse can support families who find it difficult to manage treatment. Pharmacists should only promote pediculicides which the national committee and health authorities deem to be effective.

Universities and other research institutions

Academic institutions could receive funding to prepare resources and provide training to healthcare workers, conduct base-line susceptibility studies, as well as studies on the efficacy of pediculicides and the evolution of resistance in regional/local head louse populations, and the effectiveness of public community health programs.

Parents

Parents should be routinely informed on how to best inspect their children for head louse infestation as part of normal hair care, or at weekly or biweekly intervals. Feedback from parents to health authorities and/or providers in their area about louse infestations, treatment failures, and sideeffects of products would help improve product surveillance and local head lice control. Under professional supervision, trained parents could also examine children at daycare centers, schools, or other community programs, provided consent is given by the parents or guardians of children attending those institutions.

Pharmaceutical industries

The pharmaceutical industry should have effective products with low toxicological and ecotoxicological risk on the market with instructions based on verifiable claims. Manufacturers should aim to introduce pediculicides based on new chemical compounds, especially physically acting, which are less prone to resistance. In addition, products based on plant extracts are commonly more acceptable to the public, who are sometimes reluctant to use synthetic chemical compounds. Companies should develop nonflammable lotion or gel formulations, which are more effective than shampoo formulations because they are not highly diluted with water during treatment as many shampoo treatments are. Propelled spray formulations should be avoided as they may be inhaled by the treating and treated person and are therefore less safe. Companies should also explore the development of effective and safe repellents and louse combs, as well as effective nit-removal remedies. Manufacturers should publish supporting data on both the efficacy and safety of their products.

General recommendations

Diagnosis of a head louse infestation

The diagnosis of a head louse infestation should be based on the finding of a living louse on a person's scalp hair.[5] A fine-toothed detection comb enhances the efficiency of sampling for head lice.[42-44] Wet combing has been proven to be a more effective diagnostic procedure than inspection or dry combing.[45]

The term 'nit' should refer to the empty eggshell.[46] An embryo within a nonhatched egg might be alive and still developing, nonviable because the egg was not fertilized, or dead as a result of injury, genetic anomaly, or from treatment. Unless a sufficient means of magnification and appropriate expertise is available, it is impractical and unwise to assume the viability of any egg or even to conclude that the object represents a louse egg.

In the absence of a living louse, the finding of presumed louse eggs (nits) is not a sufficient basis to conclude that the person hosts an *active* head louse infestation. Examination of over 15,000 children in Israel using a louse comb revealed that 11–19% of the children were infested with living lice and eggs, while another 22–30% had nits only.[10] Approximately 80% of the children with signs of previous infestations had nits that were 2–5 cm away from the scalp, which was evidence of successfully treated infestations during the last 2–5 months.[16] Accordingly, when the diagnosis of head louse infestation is based solely on the presence of nits, 1–2 of 3 children were mischaracterized as being infested and could be sent home for treatment without justification.

Treating dead eggs and empty eggshells with pediculicides is superfluous, and a pediculicidal treatment will not remove nits from the hair. Accordingly, the continued presence of nits must neither be interpreted as treatment failure nor should it be the basis for continued treatment.

Traditionally, many health professionals and parents would argue to err on the side of 'safety' and base their continued treatments merely on the presence of a nit. This kind of rationale often leads to repeated treatments and to conclusions (in error) that the treatments were ineffective.

In a study conducted in the USA, 1.6% of schoolchildren examined had lice, whereas 3.6% had nits/eggs without lice. When those children who initially presented solely with nits and eggs (but without live lice) were re-examined 14 days later, just 21% were found with live lice.[47] Whereas the finding of nits may indicate a former infestation, it is, however, not predictive of a current or future louse infestation.

In the absence of living lice, the child should not be considered as infested, and accordingly this individual should not be treated or restricted from any activity. A child who presents solely with eggs should, nonetheless, be re-examined during the subsequent days and weeks. If a live louse is then found, it may have derived from a viable egg on that child's scalp hair, or it may have been acquired from close contact with another individual with an active case of lice.

Detection methods for lice

Head lice may be discovered by direct visual examination of the hair. Hair may be parted with a hand, comb, and other implements. Because of their small size, and the tendency for infestations to be composed of just a few lice, reliance on direct visual examination (without combing) commonly underestimates active infestation. Of infested children in Israel, 78% had fewer than 10 lice on their scalp, 18.7% had 11–20 lice, and only 3.3% had more

than 20 lice.[16] Most of the lice on the scalp at any time are nymphs,[48] 1–2 mm in length, and this presents further difficulties in visualizing them without the aid of magnification. In addition, direct visual examination reveals a higher percentage of children with nits only than the examination with a comb, as the examining person spends more time looking at the hair rather than at the comb. Therefore, the chances of diagnosing a false-positive infestation are greater when examining by hand and even more so if the examiner is experienced in finding nits.

A louse comb or a nit comb dramatically enhances the diagnostic process by effectively 'filtering' lice and their eggs from the hair. A louse comb used on dry hair was reportedly 4–5 times more effective and twice as fast than examination by hand.[43-44] Ten to 20 passes with a louse comb was deemed sufficiently effective in detecting lice.[49,50]

Dry combing, however, is neither a practical nor an effective tool for all children. Combs become snarled in hair that is long, curly, frizzy, or braided. This impedes the use of the comb, and may cause discomfort to the child. Wetting the hair, applying conditioner, and then using a regular comb or brush can be used to open the knots, to straighten and smoothen the hair.[45,51] As the detection of lice in long and curly/frizzy hair is more difficult, the examination should last longer.

Measures to be taken after the diagnosis at school

Children with lice should be sent home at the end of the day with a letter to their parents suggesting that the child be examined and if necessary treated promptly, i.e., the same day. Excluding children from school because of the presence of lice or nits is discouraged because the infestation is likely to have been present for several days or even weeks. Parents should be given a pamphlet offering an informed choice of treatment methods and notification of whom to ask if there are questions about which pediculicides or other treatment method(s) would give the best results. Parents could be requested to fill in a questionnaire about when the first treatment session was carried out, when consecutive sessions will be done if necessary, and which product was used. Children should be allowed to return to school the next day. Ideally, the school nurse could check for lice upon return and again on the 10th day after the letter was sent, and do follow-up inspections until the treatment is successful.

Treatment

Treatment with pediculicides

Only anti-louse products, which have been specifically approved by the health authorities, should be used. It is necessary to carefully read and follow the instructions for use. It is particularly important to note the starting time and to treat the hair for the exact period specified in the instructions.

In cases where a member of the family is found to be infested, all other family members should be thoroughly examined, but only those infested should be treated. These treatments should take place concurrently on the same day if possible. For products with a single application, treated individuals should be re-examined at Day 1 and Day 10. For products with two applications, treated individuals should be re-examined one day after the last treatment (usually occurring at Day 7 to Day 10),

If no living lice are found, the treatment could be considered as successful even if nits are still visible on the scalp. To validate the result and knowing that a few surviving lice can be hard to find in the scalp, additional re-examinations after 10 days are recommended. If living lice are still present, the treatment should be continued, but an anti-louse remedy with a different active ingredient or killing mechanism should be used.[22,27] Lice rarely survive for as much as one day away from the host (Mumcuoglu, personal observation). Therefore, clothes, towels, bedding, combs, and brushes which came in contact with the infested individual can be deloused either by leaving them unused for at least two days or by washing or drying them at least at 50 °C for 30 minutes.[52]

Treatment with a louse comb

Systematic use of a louse comb over the 10-day period during which the louse embryo in the egg completes its development can remedy an infestation. Wet combing, or bug busting, requires training for correct execution, whether for diagnostic or therapeutic intent. It entails combing on days 0, 4, 8, and 12; using specific hair washing instructions with shampoo and conditioner; specific combs; and specific combing procedures.[30]

Treatment with heated air

Nonchemical treatments may provide efficacious treatments of head lice infestations. In one *in vivo* study with a heated-air device, 80.1% of hatched lice and 98.0% of eggs were dead after treatment.[49] Such a device can be used efficaciously by trained operators and by novice users who are provided with appropriate training materials.[53] The device evaluated incorporated safety features to prevent scalding the scalp or singeing the hair, safeguards lacking in standard hair dryers and curling and straightening irons.

Nits/eggs and removal remedies

The female louse usually deposits her eggs close to the scalp, attaching them to the hair with quick-hardening cement. Hatchlings emerge about a week (6–10 days) later, leaving the eggshell behind. Any egg more than 12 days old has hatched (and is, therefore, a nit) or contains a dead embryo. In both cases, these are mere relics. They confirm a former infestation but do not provide any evidence of a current infestation.

Dead eggs and eggshells (nits) may remain firmly attached to the hair for at least 8 months. Human hair grows from the base about 1 cm per month. The affixed nit is thereby carried away from the scalp as the hair grows. Nits become more noticeable as they are moved away from the scalp. The contrast afforded by dark hair accentuates the likelihood of their detection. The

discovery of "eggs" several months after the last treatment can lead to a mistaken conclusion or 'false-positive diagnosis' of infestation. Generally, louse eggs found more than 1 cm from the scalp are unlikely to be viable, although some researchers have found viable eggs further away from the scalp.

Because dead eggs and empty eggshells cannot give rise to more lice or perpetuate an infestation, there is no need to remove them for therapeutic reasons. The presence of dead and hatched eggs may, nonetheless, cause some confusion among persons who do not appreciate their insignificance, and these relics may be viewed as esthetically displeasing by others. Some school authorities continue to adhere overly restrictive policies that shun or otherwise create a stigma upon a child who presents with such debris on the hair.

Mechanically removing eggs and nits can be time consuming and difficult. Wetting the hair, whether with water, shampoo, or conditioner, tends to lubricate the hair and comb and thereby eases the combing process. Although several formulated products are claimed by their manufacturers to dissolve eggs or the glue that affixes the eggs to the hair, data to support such claims are lacking.

In some communities, a child's scalp hair may be cut short or the scalp shaved as means to eliminate head lice (and their eggs) and to prevent their establishment. Whereas these methods can be effective in the short term, and possibly only for as little as a few days, it may result in yet further unnecessary and unhelpful embarrassment and stigmatization.

Treatments

Any formulated product used to treat a person for head lice should be one that is regulated and approved by the national health authority for this specific use, and it should be applied in a manner consistent with the product label. No other insecticide, pesticide, or chemical should be applied to a person. Because of their toxic and flammable nature, petrochemical fuels (such as gasoline, kerosene, paraffin oil, and diesel) should never be used to treat for lice.

Anti-louse treatments are justified solely when live lice are present. Their use for prophylactic, preventative, or presumptive treatments is unjustified and should be avoided due to possible adverse effects when used repeatedly and could lead to a rapid selection of pediculicide resistance. Because head lice almost invariably die naturally within about one day when separated from a person's scalp, there is no justification to treat inanimate objects with pesticides (e.g., clothes, furniture, carpets, or the interior of the car or the home). Antibiotics are not labeled or approved for prevention or control of head lice and should not be used for this purpose.

Prophylaxis

Regular examinations

Periodic examinations of the child's scalp hair, with or without a louse comb, can reveal the presence of head lice before they and their eggs become far more numerous. Promptly and effectively managing the lice may thereby reduce the chance of exposing other persons.

Repellents

Essential oils such as rosemary, citronella, and piperonal have been tested for repellency to laboratory colonies of body lice.[54] A placebo-controlled clinical trial demonstrated the efficacy of a citronella formulation as a louse repellent when applied topically on the head of children.[37]

Other preventive measures

Direct head-to-head contact is by far the most likely route whereby head lice transfer from an infested to a noninfested person. Classroom floors, brushes, and hats do not have epidemiological importance as vehicles for the transfer or sharing of head lice. The chance is exceptionally remote that a live head louse or egg, displaced onto an inanimate object, would succeed in infesting another person.[54-56]

The "no-nit" policy

The "no-nit" policy assumes that any egg, whether alive, dead, or empty (hatched), is a sign of risk to that child or other children. The policy (still common in parts of the USA, Canada, and Australia) requires the dismissal of a child from a school, camp, or childcare setting until all head lice, eggs, and nits have been removed from the hair of an infested individual.

The "no-nit" policy requires parents to remove every nit (or other debris commonly mistaken as louse eggs) from the scalp hair of their children. This may involve long and tedious hours of picking nits, repeated treatments with pediculicides and absence from school for the child, and possibly also the absence from work for at least one parent. This unjustified process can result in unnecessary discomfort to the child and may foster discord between child and parent. The nit-removal process is far from certain in reaching the goal. Even when all visible nits are removed from the scalp, a few may remain hidden from view. As the abundance of lice and eggs is reduced, those remaining are more difficult and time consuming to locate (the 'needle in the haystack' conundrum). The expulsion of children from a camp, kindergarten, or school is without medical or public health merit, may harm the child's self-esteem, and imposes unnecessary burdens on their parents.[57]

The efficacy of the no-nit policy was questioned by different groups of scientists[5,47,58,59] and by several agencies, including the Center for Disease Control, the American Academy of Pediatrics, and the National Association of School Nurses. In Australia, the National Health and Medical Research Council's Guidelines for Infectious Diseases warranting school exclusion were amended to exclude head lice.[5] Furthermore, there are no convincing data which show that enforced exclusion policies are effective in reducing the transmission of lice. Therefore, the "no-

nit" policy is unjust, and it is based on misinformation rather than on objective science and should be discontinued.

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