Control of Human Lice (Anoplura: Pediculidae) Infestations: Past and Present

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ABSTRACT Removing lice by hand or with a lice comb, and shaving the scalp and body, were some of the oldest methods of controlling human lice. Date flour was used in the 16th century B.C. for this purpose. Later, quicksilver, cresol, naphthalene, sulphur, mercury, and kerosene, alone or in combination with oil and vinegar, also were applied. Today, insecticides used for the treatment of head and body lice include organochlorines (DDT, lindane), organophosphates (malathion), carbamates (carbaryl), pyrethrins (pyrethrum), and pyrethroïds (permethrin, fenothrin, and bioallethrin). Despite the introduction of these effective insecticides, the number of cases of lice infestation has increased worldwide since the mid-1960s, reaching hundreds of millions yearly. This is because most of the products in the market are either ineffective formulations, or they have lost their efficacy because of the development of resistant strains of lice. Cross-resistance of lice to different pyrethroids has been reported in Israel and several European countries. Mosaic treatment, rotation of the pediculicides, and combination of 2 insecticides within the same formulation, should be implemented to slow the development of resistance. Future efforts should be directed toward the development of pediculicides based on new chemicals. Biological control of lice in humans may be of scientific interest only. Education on the biology and control of head lice is important.

—Then the Lord said to Moses, 'Say to Aaron: Hold out your rod and strike the dust of the earth, and it shall turn to lice throughout the land of Egypt.' (Exod. 8:15–17)

Lice are mentioned in the Bible as the 3rd plague visited on the Egyptians when Pharaoh denied the request by Moses to let the Israelites go. In the 16th century B.C., an Egyptian text, known as the Papyrus Ebers, described a remedy for lice prepared from date flour. Desiccated head lice, Pediculus humanus capitis De Geer, and lice eggs were found on the hair of Egyptian mummies and in mummified pre-Columbian Indians from Peru (Ewing 1924). Lice eggs recovered recently from the hair of an individual who lived 9,000 yr ago in Nahal Hemar Cave near the Dead Sea are the oldest known lice remains (Zias and Mumcuoglu 1991). Head lice and their eggs have been found on combs dated from the 1st century B.C. to the 8th century A.D. from archaeological digs in the Judean and Negev Deserts of Israel (Figs. 1 and 2), and from 1,300 to 1,900 yr ago from excavations in the Dead Sea area (Mumcuoglu and Zias 1988, 1989). Lice combs similar to those used today have been known for at least 3,500 yr and were effective tools for the control of head lice (Mumcuoglu and Zias 1989).

In a reference connected with Homer (900 B.C.) it is said: “...all what we saw and caught, we left behind, we did not see and failed to catch, we bring with us...” they were referring to head lice. The Greek historian Herodotus in the fifth century B.C. wrote that Egyptian priests and scribes solved the problem of lice by shaving their bodies to prevent infestation. Celsus (30 A.D.) proposed sandlerah (a gum obtained from an African tree), soda scum, and bryony (a climbing plant in the yam family) with oil and vinegar for lice control. Pliny (23–79 A.D.) recommended that vaper broth be applied to all parts of the body. Galen (121–201 A.D.) used herbal remedies such as stavesacre seeds and Delphinium sp., which contain alkaloids and have some insecticial action. Avicenna (980–1037 A.D.) treated his patients with a combination of quicksilver and oil of roses. Bartholomew de Glauville, writing 1240, stated that “...against the grieving of lice, washing, combing and medicinal cleansing of the head, help...” (Busvime 1976).

Other remedies for lice have included carbolic acid solution, cresol powder, naphthalene, sulphur, mercury powder, and kerosene, used alone or in combination with oil and vinegar (Alexander 1984). From the beginning of the twentieth century, some of the herbal remedies used for head lice have included larkspur, quassia chips, sebadiila, and tobacco leaves (Lindsay 1993). The insecticidal properties of the plant Chrysanthemum cinerariaefolium (Trevirana) were already known in Persia. This plant was introduced into Europe in the 19th century, and, later, the active ingredients (i.e., the pyrethrins) were extracted. The synthetic insecticide DDT, first developed in 1939, was introduced during World War II to control lice and house-borne typhus, thus enabling the allied armies to enter and liberate Europe from German occupation. For discovering DDT, the Swiss scientist P. H. Müller was awarded the 1948 Nobel Prize.

Today, insecticides used for the treatment of head and body lice, P. humanus humanus L., include organochlorines (DDT, lindane), organophosphates (malathion), carbamates (carbaryl), pyrethrins (pyrethrum), and pyrethroïds (permethrin, fenothrin, and bioallethrin). Despite the introduction of these effective insecticides, the number of cases of lice infestation has increased worldwide since the mid-1960s (Gratz 1977), reaching hundreds of millions yearly (Taplin and Meinking 1987). Although most infested people live in poor hygienic conditions, head lice infestations are very common among children in developed countries. About 6–12 million people.

Fig. 1. Wooden comb found at Ein Rachel (Negev Desert) (100 B.C.–200 A.D.); it contained 10 head lice and 5 nits.
mainly children, are affected annually with lice in the United States (Anonymous 1976, Atkinson et al. 1986).

In Israel, in the past 20–25 yr, 15–20% of all children between 4 and 13 yr old have been infested annually with head lice despite preventive efforts of the Ministry of Health, municipalities, and parents (Tamir et al. 1984, Sarov et al. 1988, Mumcuoglu et al. 1990a).

Head lice infestation is more prevalent among children than all other childhood communicable diseases combined (Figs. 3–5) (Anonymous 1986).

In developed countries, the high prevalence of head lice may be the result of the large number of ineffective over-the-counter pediculicides on the market. For example, several clinical trials conducted in the United States found that many pediculicides were not effective (Brandenburg et al. 1986, Taplin et al. 1986, DiNapoli et al. 1988). In Israel, only 5 of 14 pediculicides available in Israel, tested in vitro in 1990, have been found fully effective. Of these, 3 are spray formulations that should be used only in well-ventilated rooms to prevent the spray from being inhaled. Their strong odor makes them unpleasant to use; therefore, they may be used in insufficient quantities (Mumcuoglu and Miller 1991), which may account for the formulations being less effective under field conditions (e.g., when tested on the hair of children) (Armoni et al. 1988). In a study of 12 pediculicides available on the market in France, 2 were effective, 3 were partially effective, and 7 were ineffective (Anonymous 1994).

Lindane, one of the early pediculicides, is absorbed percutaneously when used as a lotion for the treatment of scabies (Ginsburg et al. 1977). A review of the literature revealed that most cases of acute lindane toxicity resulting from topical application have occurred in the pediatric and geriatric populations and are manifested by toxicity of the central nervous system such as grand mal seizures (Pramanik and Hansen 1979, Fischer 1994).

Recently, the British Medicines Control Agency proposed to add carbaryl-based pediculicides to the list of drugs to be sold by prescription. This decision was based on reports that carbaryl was found to be a potential carcinogen (Anonymous 1995a).

Examination of numerous pyrethrin-based shampoo formulations from Israel, France, and the United States showed that none succeeded in killing all lice and eggs, even after 2 treatments. To improve the efficacy of a pyrethrin-based shampoo in Israel, >40 formulations were tested in the laboratory. The greatest mortality achieved was 80% for adults and nymphs and 30% for eggs (unpublished data).

A systematic review of 28 clinical trials on pediculicides showed that only a 1% creme rinse of permethrin was effective in more than 2 studies (Vander Stichele et al. 1995).

Pediculicides may rapidly lose their efficacy because of the development of resistance. Resistance of head lice to organochlorine insecticides such as DDT and Lindane has been reported in many parts of the world including Israel, Canada, Denmark, and Malaysia (Brown and Pal 1971, WHO 1992). Recently, it was reported that head lice in Britain are becoming resistant to malathion (Anonymous 1995b).

Permethrin was used against body lice in 1976 (Nassif and Osman 1977), and large scale clinical trials for the control of head lice infestations were conducted in the United States in the 1980s (Brandenburg et al. 1986, Taplin et al. 1986, Bowerman et al. 1987).

Recently, in Israel, 2 formulations of permethrin-based pediculicides achieved an important reduction in the incidence of head lice 1 yr after introduction, which accounted for 90% of the pediculicide marketed. There was a 60% reduction in pediculicides sold in 1992 as compared with 1991 (Mumcuoglu et al. 1995a). However, it now appears that the lice are becoming resistant to permethrin.

The baseline susceptibility of Israeli head lice populations to permethrin was determined in 1989, just 2 yr before it was made available to the public (Mumcuoglu et al. 1990b). The 1st reports of

Fig. 2. Head louse nymph from a comb of the first century A.D.

Fig. 3. Head louse female.
resistance appeared as early as 1993; a study conducted in 1994 showed a 4-fold reduction of head lice susceptibility. The rapid development of resistance probably was the result of several combined factors: the residual activity of permethrin, which 2 wk after application is still sufficient to kill lice (Taplin and Meinking 1987); the cross-resistance between permethrin and DDT (DDT and bioallethrin were used previously in Israel); the almost exclusive use of permethrin for louse control during a 3-yr period; and the lack of a synergist in any of the permethrin formulations (Mumcuoglu et al. 1995a).

Exposure of permethrin-resistant lice to 0.2% phenothrin impregnated filter paper showed that the lice in Israel also were resistant to this pyrethroid, which had not been used for the treatment of lice in this country (Mumcuoglu et al. 1995b). Resistance of head lice to permethrin and cross-resistance of lice to different pyrethroids also has been observed in France, Great Britain, and the Czech Republic (Coz et al. 1993, Chosidow et al. 1994, Rupes et al. 1994, Anonymous 1995b). In the United States, reports of permethrin treatment failure in head lice are increasing and several outbreaks of head lice which appear to be tolerant to permethrin have been observed (Taplin and Meinking 1995).

Biological control of lice in humans may be of scientific interest, but it appears to have little practical use. Entomopathogenic nematodes such as Steinernema carpocapsae Weiser and S. glaseri Steiner were effective in killing lice under experimental conditions. Exposure of female body lice to infective juveniles of these parasites resulted in 83% mortality within 24 h (Fig. 6) (Weiss et al. 1993).

Body lice were adversely affected when they fed on rabbits that had been immunized with an extract of louse midgut. These lice took smaller amounts of blood, showed higher mortality, and laid fewer eggs; the different developmental stages took longer to develop than lice that fed on control rabbits. All these factors together resulted in a significant decrease in the louse population (Ben-Yakir et al. 1994).

Future efforts should be directed toward the development of pediculicides based on new chemicals such as avermectins, which are also used topically. Ivermectin, a macrocyclic lactone, was effective against human lice when used systemically or topically in vitro as well as in animal models and human volunteers (Mumcuoglu et al. 1990c, Glaziov et al. 1994). Mosaic treatment (use of pediculicides based on different active ingredients to treat a given population), rotation of the pediculicides, and combination of 2 insecticides within the same formulation, should be implemented to slow the development of resistance.

Recently, the Ministry of Health in Israel demanded that companies producing or importing pediculicides prove the efficacy of their
products by conducting clinical trials in this country. In my opinion, such studies should be made in all countries where the percentage of children infested with head lice remains high.

At a time when widespread confusion about lice control exists, even among scientists, education of the general public and particularly of parents on the biology and control of head lice is important. Although today we can no more agree with Konrad von Magen-berg (1309-1374) who said " . . . what animal is most faithful to man? The louse, which once attached to a man stays with him till death . . .", chances are good that lice will continue to be a serious public health problem for decades to come.

References Cited


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