

FEATURED ARTICLE

Pediculicide Resistance in Head Lice: A Survey

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Abstract — The head louse is an obligate human parasite. Evidence points to the growing resistance of head lice to nonprescription pesticides (eg, synergized pyrethrins, permethrin). To gather data, recent pharmacy graduates were surveyed about treatment failures and resistant lice. The response rate was 28.4%, with 173 of 609 surveys returned. One hundred and thirty-one pharmacists provided information that they had gathered during counseling sessions or other contacts with patients. Patients who remained infested after using either synergized pyrethrins or permethrin were encountered by 81.7% and 78.6% of pharmacists, respectively; these treatment failures occurred once or twice weekly in 58.1% of pharmacists' practices. Patients treating themselves more frequently or in higher doses with pesticides in an attempt to rid themselves of lice were reported by 62.6% of pharmacists. Patients reported the use of gasoline, kerosene, or other dangerous treatments once weekly or more in the experience of 42% of pharmacists. Resistant head lice had been a problem in their areas for 1 or 2 years for 42.8% of pharmacists. A smaller percentage (5.3%) of pharmacists had received official confirmation that resistant head lice were present in their areas. Pharmacists recommended nontoxic options (eg, combing and vacuuming) 19.8% of the time with positive results. Resistance seems to be a widespread, growing phenomenon and is not entirely related to patients' inability to use pesticides correctly. Pharmacists should consider recommending nontoxic alternatives that do not pose a threat to the patient or environment and do not contribute to resistance.

Key Words — head lice; pediculicides; resistance

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The phenomenon of bacterial resistance to certain antibiotics is well-documented within the medical profession. The ability of bacteria to adapt to specific drugs (eg, penicillins) has limited the effectiveness of these treatments drastically. However, the phenomenon

of resistance to pesticides used to treat insect infestations is less well appreciated.

The head louse (*Pediculus humanus* var. *capitis*) evolved as an obligate human predator millennia ago, filling the sole ecological niche of the human head. Archaeologists have found evidence of these

blood-sucking parasites on ancient Egyptian mummies. The modern advent of pesticides created the hope that humans could finally free themselves of this ancient scourge. Lindane, a chlorinated cyclic hydrocarbon, was first used for head louse eradication in 1946 at Philadelphia General Hospital.¹

However, the optimistic and overenthusiastic use of lindane did not take into account a medical truism: "Under the right circumstances, any insecticide can create a resistant strain."¹ Resistance to lindane was reported in Europe in 1968, presumably due to overuse, although researchers suggested that subtherapeutic lindane doses or failure to treat all household members were the causes.^{1,2} A British pharmacist reported lindane resistance in 1984, explaining that any louse that survives a pesticide application could potentially become resistant.³ He counseled wise use of pesticides to ensure that with each treatment, no lice would survive.

In 1985, a Canadian report of lindane resistance pointed out that some authors preferred to attribute the incidents to patient noncompliance or reinfestation.⁴ In the mid-1980s, reports emanating from Panama, Mexico, and Arizona described a 24% to 67% failure rate from single applications of lindane.⁵ California head lice also exhibited resistance to lindane in 1987.⁵ By 1990, louse investigators had concluded that tolerance or

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Table 1

Location of Survey Respondents (n = 173)	
State	Number
Oklahoma	57
Texas	48
Kansas	10
Missouri	6
Arizona	6
Arkansas	4
California	2
Nevada	2
Florida, Hawaii Iowa, Maryland, Michigan, New Mexico, Oregon, South Carolina, Tennessee, Washington	1 each
No Answer	28

Table 2

Present Practice Venues of Respondents (n = 173)	
Type of Practice	Number (%)
Retail	127 (73.4%)
Hospital	19 (11%)
Indian Health Service	6 (3.5%)
Veteran's Facilities	4 (2.3%)
Mail Order	4 (2.3%)
Nursing Home; Long-Term Care	4 (2.3%)
Home Health Care	3 (1.7%)
Medical Center	1 (0.6%)
Health Source Pharmacy	1 (0.6%)
IV Solutions	1 (0.6%)
No Answer	3 (1.7%)

Table 3

Number of Head Lice Counseling Sessions Weekly (n = 131)	
Number of Sessions	Number (%) of Respondents
1	42 (32.1%)
2	34 (26%)
3	15 (11.5%)
4	10 (7.6%)
5	8 (6.1%)
6	4 (3.1%)
7	5 (3.8%)
8	1 (0.8%)
10	3 (2.3%)
No answer (but survey included other information)	9 (6.9%)

resistance to lindane had been demonstrated through considerable evidence.⁶ In the US in 1990, a hospitalized patient's head lice were resistant to seven daily applications of lindane.⁷ The nurse was forced to shave the patient's head to eradicate the pests. Reports of lindane resistance throughout the world were ignored in the US, where it continued to be a popular pesticide into the 1990s.^{8,9}

In 1990, an Australian physician reported two possible treatment failures to the organophosphate malathion (after 10 years of continuous use) and five to pyrethroid products.¹⁰ A 1991 British paper investigated malathion resistance, explaining that anecdotal reports might have been due to inadequate application.¹¹ However, the author also mentioned that malathion's inability to penetrate nits might be the cause.

In 1994, French researchers reviewed anecdotal reports of head louse and body louse resistance to

malathion, pyrethrins, and synthetic pyrethroids.¹² Resistance to permethrin was reported in Israel, Britain, and the Czech Republic in 1995.¹³⁻¹⁶ A British expert offered the opinion that any efficacy apparently afforded by pesticides might very well result from manufacturer-supplied instructions to comb out dead lice and nits after each treatment.¹⁷ Such combing, properly done, might also remove resistant live lice and viable nits.

In 1997, the Medical Letter reported that treatment failures with lindane and pyrethrins had become common, and that permethrin resistance had recently increased in the US.¹⁸ A British publication offered the opinion that the simultaneous emergence of resistance to malathion and pyrethroids suggested that cross-resistance mechanisms were responsible.¹⁹ In 1999, researchers carried out tests for susceptibility of head lice to permethrin in the US and Borneo.²⁰ Lice in the US,

where exposure to permethrin was common, were less susceptible than lice from Borneo, where the use of permethrin was rare.

British policy for head louse eradication shifted from pesticide use to physical methods such as regular combing and grooming several years ago.²¹ However, in the US, pesticide use is still widespread.

Possible resistance to permethrin and synergized pyrethrins hinges on a central issue: Did the patient use the pesticides as directed, or does noncompliance with labeled directions play a vital role? Those who promote the products favor the latter explanation for obvious reasons, but its validity is not testable. It is impossible to turn back the clock and observe actual use in a patient who reports a treatment failure. Thus, a "blame the victim" mentality persists. The purpose of this study was to survey pharmacists about whether they had noted any instances of treat-

Table 4

Number of Counseling Sessions Weekly With Patients Who Had Used Either Synergized Pyrethrins or Permethrin as Directed, but Remained Lice-Infested* (n = 131)

<i>Number of Occurrences Weekly</i>	<i>Number (%) of Pharmacists Who Counseled With That Frequency</i>	
	Synergized Pyrethrins	Permethrin
1	56 (42.7%)	56 (42.7%)
2	22 (16.8%)	18 (13.7%)
3	2 (1.5%)	3 (2.3%)
4	1 (0.8%)	1 (0.8%)
5	1 (0.8%)	1 (0.8%)
6	2 (1.5%)	2 (1.5%)
7	1 (0.8%)	1 (0.8%)
Does not happen	18 (13.7%)	25 (19.1%)
No number provided	28 (21.4%)	24 (18.3%)

*Only for pharmacists who reported engaging in counseling sessions

ment failures with pesticide use and to explore the issue of possible louse resistance and its ramifications.

MATERIALS AND METHODS

A list of pharmacy graduates from 1994 to 1999 was obtained from Southwestern Oklahoma State University (Weatherford, OK) and permission to conduct a mail survey was granted through the institution's Protection of Human Subject Committee. The survey group consisted of all School of Pharmacy graduates for whom addresses were available.

The preliminary survey instrument was developed and reviewed by the Pharmacy dean and a lawyer actively involved in researching louse resistance. After minor clarifications, the survey and a cover letter describing the study's intent were sent to the target audience in February 2001. This research was not designed to test any hypotheses, so inferential statistical tests were not used.

RESULTS

The total number of pharmacy graduates in the survey group was 658. Addresses were available for 609 of these graduates; 173 returned the survey instrument for a response rate of 28.4%. Given the high mobility of pharmacists, subjects were given the option of providing information obtained at previous practice locations, even if they were not counseling patients in their practices at the time of the survey. Eleven pharmacists took this opportunity. Their modified geographic practice locations are reported in Table 1, and their modified practice venues are listed in Table 2.

Pharmacists were asked how many times per week they counseled patients about head lice. Thirty-six pharmacists reported no weekly counseling sessions and another six pharmacists left this item blank. These surveys were not included in the analysis. Nine additional pharmacists did not answer the question, but their surveys

included other information that was used in the analysis. The responses (see Table 3) reflect the surveys of these 9 individuals plus 122 pharmacists who held report counseling sessions.

Pharmacists were asked if they counseled patients who reported using synergized pyrethrins or permethrin as directed, but remained lice-infested. One hundred seven (81.7%) and 103 (78.6%) pharmacists responded that this had occurred with synergized pyrethrins and with permethrin, respectively. Eighteen denied that it had occurred with synergized pyrethrins (13.7%, with six pharmacists not responding), and 25 denied that it had occurred with permethrin (19.1%, with three pharmacists not responding). Pharmacists were also asked the number of times weekly that such reports had occurred; the results are listed in Table 4 for the 131 pharmacists analyzed.

The survey queried pharmacists about whether they had heard of patients treating head lice more frequently or in higher doses than recommended on the permethrin or pyrethrin label, and how many times weekly this occurred. Eighty-two pharmacists had heard of this practice, three did not respond, and 46 answered in the negative. See Table 5 for the number of times weekly that the pharmacists' patients had used this practice.

The survey asked whether pharmacists had heard of patients resorting to gasoline, kerosene, or other dangerous treatments to deal with resistant head lice. Fifty-five pharmacists had heard of this practice, 74 had not, and two did not respond. The number of times weekly that the 55 pharmacists who answered affirmatively had heard of the practice is provided in Table 6.

Table 5

Number of Times Weekly Respondents Had Heard of Patients Treating Themselves with Pyrethrins or Permethrin More Frequently or in Higher Doses than Recommended (n = 82)

<i>Number Per Week</i>	<i>Number (%) of Respondents</i>
1	41 (50%)
2	13 (15.9%)
3	3 (3.7%)
4	1 (1.2%)
5	1 (1.2%)
6	1 (1.2%)
No Number Given	22 (28.8%)

The survey asked, "If you have seen what may be resistant lice cases, about how many years ago did it begin to be a problem in your area?" The results are shown in Table 7. Although 52 pharmacists either answered this question with a "0" or left it blank, 38 pharmacists in this group had answered previous questions in a manner that would suggest that they had counseled patients for whom the products did not seem to be working.

Pharmacists were asked whether they had received any official confirmation that resistant head lice were present in their area. One hundred and twenty-three of the 131 pharmacists analyzed (93.9%) answered negatively, one (0.8%) left the item blank, and seven pharmacists (5.3%) answered positively. Of those who had received official confirmation, three were from Texas and three were from Missouri. One Oklahoma pharmacist stated that there was no official confirmation, but physicians in the area stated that

Table 6

Number of Times Weekly Respondents Had Heard of Patients Resorting to Gasoline, Kerosene, or Other Dangerous Treatments to Deal with Resistant Lice (n = 55)

<i>Number Per Week</i>	<i>Number (%) of Respondents</i>
1	13 (23.6%)
2	16 (29.1%)
3	8 (14.5%)
4	1 (1.8%)
5	2 (3.6%)
6	2 (3.6%)
No Number Given	10 (18.2%)
Other*	3 (5.5%)

*Answers included: "Few," "?" and "10 to 20 times over the past 5 years"

resistance was present.

Pharmacists were asked if they experienced a higher number of cases of head lice during the start of the 2000/2001 school year than at the start of the 1999/2000 school year. Seventy-two of the 131 pharmacists analyzed (55%) had not, 47 (35.9%) answered positively, and 12 (9.2%) did not respond. Pharmacists were also asked whether they had recommended combing and vacuuming as nontoxic treatment options, and if they had, whether these measures had been successful (see Table 8).

Nondemographic questions solicited pharmacists' comments. A final question asked if the pharmacist would be willing to share a story about patients infested with resistant lice, and many chose to do so. Several outlined cases in which infestations persisted despite multiple uses of pesticides, perhaps even overuse to the extent of 4 to 6 applications with synergized

pyrethrins and/or permethrin in the week they sought professional advice for a treatment failure.

One pharmacist reported counseling two families who were constantly battling head lice. The mother had used prescription and nonprescription products to no avail; she then resorted to reliance on "prayer alone." Another patient had used permethrin four times on her daughter, experiencing repeated treatment failures before she eventually spoke to the pharmacist. Yet another patient had treated herself and her three children — ages 2, 4, and 7 years — more than five times in one month; the patient stated that she had been pregnant during the time of multiple pesticide exposures. In a third case, a mother who had used permethrin unsuccessfully with her two children sought a pharmacist's advice; however, the family was unwilling to follow the pharmacist's advice and chose to shave the children's heads instead.

A few pharmacists offered the opinion that improper use by lay individuals might be responsible for apparent treatment failures. However, professionals themselves applied the product in some cases. One pharmacist mentioned that in two separate episodes, nurses in psychiatric units had treated patients with permethrin and lindane, but experienced treatment failure. In two cases, pharmacists had applied pesticides to their own children with negative results. One pharmacist's daughter caught head lice in day care; the pharmacist used prescription and nonprescription products over a 3-month period with continuing treatment failures, finally resorting to petrolatum. Another pharmacist's daughter contracted head lice; the use of permethrin resulted in treatment failure. This family coped success-

Table 7

Number of Years that Possible Lice Resistance Had Been a Problem in the Respondent's Area (n = 131)

<i>Number of Years</i>	<i>Number (%) of Respondents</i>
0	36 (27.5%)
1	23 (17.6%)
2	33 (25.2%)
3	13 (9.9%)
4	5 (3.8%)
5	3 (2.3%)
6	1 (0.8%)
No Number Given	17 (13%)

fully without pesticides by creating a grid on the head with clips, then painstakingly scanned the entire head and removed nits for 4.5 hours; the process was repeated one week later.

DISCUSSION

This group of pharmacists was most commonly employed in retail pharmacy in the south central US. The majority (58.1%) of the pharmacists counsel patients about head lice either once or twice weekly, a frequency that provides many opportunities to question patients about efficacy or ineffectiveness of currently available pesticides.

Far from "blaming the victim," more than 80% of pharmacists had spoken to patients who asserted that they had followed the directions for both permethrin and synergized pyrethrins and had remained lice-infested. With regard to patient failure vs product failure, it is illuminating that pharmacists and psychiatric nurses had experienced pesticide-related treatment failures in their own families. When trained professionals read

Table 8

If the Respondent Had Recommended Combing and Vacuuming as Nontoxic Options, Were These Measures Effective in Ridding Patients of Head Lice? (n = 131)

<i>Response</i>	<i>Number (%) of Respondents</i>
Yes	26 (19.8%)
No	15 (11.5%)
Sometimes; somewhat	6 (4.6%)
Have never recommended	11 (8.4%)
Unsure; no feedback yet	8 (6.1%)
Only recommend along with other treatments	8 (6.1%)
Patient resists recommendation or regimen	6 (4.6%)
No answer	51 (38.9%)

and interpret instructions, it is unlikely that illiteracy or ignorance will cause treatment failure.

The frequency of pharmacists reporting counseling of patients about possible treatment failures with synergized pyrethrins or permethrin is also alarming. The frequency was once weekly to seven times weekly for 64.9% of pharmacists for synergized pyrethrins and 62.6% for permethrin. As a result of these failures, 65.9% of pharmacists hear of patient misuse once or twice weekly, in the form of too-frequent use or use in excess of the recommended dosages. Nonprescription pesticides are potentially toxic, and excessive use to combat resistant lice increases the risk of adverse effects (eg, irritant or contact dermatitis, breathing difficulties). Over 76% of pharmacists were aware of patients using gasoline, kerosene, or other dangerous treatments in futile and potentially fatal attempts to eradicate resistant lice.

The growing resistance of lice was reflected by responses to questions about the length of time that possible louse resistance had been recognized in the pharmacist's geo-

graphic area (dated February to March 2001, when the majority of surveys were returned). Possible louse resistance was reported only once before 1996, but grew gradually to reach three reports in 1996 and five reports in 1997. The number of pharmacists reporting possibly resistant lice in 1998 jumped to 13, then dramatically increased to 33 in 1999. The number dropped to 23 in 2000. It may not be coincidental that the first FDA-approved comb for the treatment and detection of head lice was approved in 1998; continuing sales of the comb may have been responsible for the drop in resistant lice in 2000. Almost 20% of pharmacists who recommended combing and vacuuming alone as nontoxic options reported favorable results.

The conclusions of this research are limited by the small number of pharmacists who responded and by the regional distribution. Furthermore, only recently graduated pharmacists were chosen as the survey group. Future research with larger groups of pharmacists from other regions of the US is needed to determine

whether head louse resistance is a regional or national phenomenon.

CONCLUSION

There is ample documentation that insects can develop resistance to any pesticide if the population is exposed for a sufficient period of time.²² Permethrin was reported to be virtually useless against head lice in Britain in 1999.²³ Furthermore, multiple resistance to several pesticides has also been reported.²⁴⁻²⁶ Thus there is a compelling need to determine whether nonprescription products sold in the US are efficacious.

This research involving pharmacists working in 18 states suggests that treatment failure among head lice patients using synergized pyrethrins or permethrin is common. The resistance of head lice to pesticides may be the underlying reason for some of these failures. Patients commonly resort to higher doses of pesticides or use them too frequently in attempts to rid themselves and their families of lice. Patients have also used deadly chemicals such as gasoline and kerosene to eradicate the pests. These dangerous practices persist despite the fact that many pharmacists report success in treating lice with thorough vacuuming and combing.

A concerted public health effort should be made to inform patients infested with head lice that pesticides may not be efficacious because of possible resistance. Nontoxic, environmentally safe, and effective options such as combing and vacuuming may be preferable as first-line therapy.

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