Research Note

Thermotolerance of human body louse,

Pediculus humanus corporis

II. Preliminary evaluation of hot air for killing adults and eggs

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Abstract: We evaluate the effectiveness of a stream of hot air from a hair dryer for killing eggs and adults of human body lice, *Pediculus humanus corporis*. All adult lice treated with hot air at 50°C for 5 min did not survive, although all adult lice treated with cool air at 27–28°C for 5 min survived normally. In the exposure of hot air at 55°C for 1 min or more all adults died. The stream of hot air at 60°C also killed all adults even when exposure was brief (for 30 sec). Louse eggs treated with hot air at 55°C for more than 90 sec never hatched. The escape behaviour of adult lice treated with hot air at 50°C was observed and the average speed travelled by a female adult was 6.9 mm/sec and by a male adult 7.3 mm/sec.

Introduction

The incidence of human pediculosis, particularly the head louse, recently increased in Japan (Yamada, 1992), but it is unclear

whether this is linked to the level of insecticide susceptibility or not. The statistical data of the Ministry of Health and Welfare in Japan showed that more than 80% of reported cases of head lice occurred in kindergartens, nursery schools and elementary schools. Tongu (1994) reported similar results in Okayama City in Japan. Therapy of the infested children has been carried out by the application of dusting powder supplemented with an insecticide for about 12 years since 1982. The statistical data in Japan showed that the total number of infested children drastically decreased during 1985 to 1990. After this period the number of infested children rapidly increased for unknown reasons.

Recently, Hiraoka *et al.* (1995) reported that eggs and adults of human body lice could be killed by exposure to hot water at 55°C for 5 min. These data are very valuable for treating a large volume of bed linens, clothing, towels and so on in the houses with infested children. In future children who are at risk to be infested from household member or classmate in kindergarten and elementary school should be treated. However, any future countermeasure must consider many problems, *i.e.*, there is no adequate and simple methods for diagnosis and therapy of louse infestation. In the present paper we evaluated the effectiveness of a stream of hot air from a hair dryer for killing eggs and adults of human body lice.

Materials and methods

In the present experiments human body lice, *Pediculus humanus corporis* reared in our department were used for evaluation of effectiveness of a stream of hot air, because human head lice (*P. h. humanus*) have not been colonized in any laboratories in the world. The lice were collected at Sapporo City, Japan in 1953 and colonized in our insectarium. The larval and adult lice were allowed to feed to fully satiety on our arms daily except on Saturday and Sunday. Engorged lice were maintained in a box desiccated with silica gel at 30°C to prevent clumping by the insects because of viscous

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Table 1 Effect of hot air on the mortality of adult human body lice.*

	Control	0.5 min	1.0 min	1.5 min	2.0 min	5.0 min
50°C	0/20** (0.0%)	0/30 (0.0%)	1/30 (3.3%)	1/30 (3.3%)	0/30 (0.0%)	30/30 (100%)
55°C	0/20 (0.0%)	6/30 (20%)	30/30 (100%)	30/30 (100%)	30/30 (100%)	30/30 (100%)
60°C	0/20 (0.0%)	30/30 (100%)	30/30 (100%)	30/30 (100%)	30/30 (100%)	30/30 (100%)

* The mortality was calculated by the data of duplicated experiments. ** Lice of control experiment were treated with air of room temperature (27–28°C) for 5 min.

Fig. 1 Hatch rate of human body louse eggs treated with a stream of hot air at 55°C for various duration (30 sec–5 min).

Numbers on each column indicate the number of eggs tested.

feces. Adult lice confined by a glass ring on a metal mesh were treated with the stream of hot air (50, 55, 60°C) from a hair dryer (Hitachi Inc., 100 V, 600 W) for 0.5 to 10 min. After treatment, the lice were maintained in the same incubator at 30°C and mortality was checked 24 hr after treatment. Adult lice enveloped in nylon mesh were also treated with a stream of hot air at 76–78°C for a short time to mimic the usual conditions of hair styling by a hair dryer. Louse eggs (100–200 per nylon mesh) deposited 4 days before were treated in the same manner as adults except the experiment at 60°C. The treated eggs were maintained in the same incubator at 30°C and the hatching rate was checked 8 to 10 days after treatment. To investigate the escape behaviour of adult lice treated with hot air, the movement of treated individual lice was recorded by tracing the track with a pencil for 20 sec. After

Table 2 Effect of hot air at 76–78°C on the mortality of adult human body lice treated for a short time.

Exposure time (sec)	No. of lice tested	No. of dead lice	Mortality (%)
5	20	20	100
8	20	20	100
10*	40	40	100
5 periods of 2 sec each*	40	40	100

* These experiments were duplicated.

tracing of seven female and male adults, the movement of each louse was measured by digital curvimeter (Uchida Inc.). Temperature of the stream of hot air was checked by digital thermometer (Sato Keiryoki, Inc.) through all experiments.

Results

The effect of a stream of hot air on the mortality of adult lice is shown in Table 1. Almost all adult lice treated with hot air at 50°C for 0.5–2 min survived at least for 24 hr. On the other hand, all adult lice treated with hot air at 50°C for 5 min did not survive. All adult lice treated with cool air at 27–28°C for 5 min survived normally. In the treatment with hot air at 55°C only for 30 sec, 20% mortality was observed and in the exposure of hot air for 1 min or more all adults died. The stream of hot air at 60°C also killed all adults even when exposure was brief (for 30 sec). Louse eggs were also treated with stream of hot air at 55°C and subsequent hatch rate was ob-

Fig. 2 Escape behaviour of adult human body lice treated with a stream of hot air at 50°C for 20 sec on filter paper. Scale bars indicate 50 mm.

Closed circles indicate the starting points of escaped adult lice.

served (Fig. 1). Louse eggs treated with cool air at 27–28°C for 5 min hatched well (75.5%). While the hatch rate of eggs treated at 55°C for 30 sec was 54.5% and the treatment for 1 min drastically reduced egg survival (16.9%). Eggs treated for more than 1.5 min never hatched. When adult lice enveloped in nylon mesh were treated with hot air of high temperature at 76–78°C for short time, almost all lice showed a rapid knocking down by heat shock and never recovered (Table 2). In the treatment of lice only for 10 sec all adults were killed even when they were exposed 5 times for 2 sec. The escape behaviour of adult lice treated with hot air at 50°C for 20 sec on filter paper (30×30 cm) was observed (Fig. 2). Average speed travelled by a female adult was 6.9 ± 1.2 mm/sec and by a male adult 7.3 ± 1.1 mm/sec. This means that adult lice could escape quickly from the heat from a hair dryer. The lice treated with cool air at 27–28°C moved slowly *i.e.* 2.3 ± 1.6 mm/sec in female adults and 2.2 ± 1.4 mm/sec in male adults.

Discussion

There are previous reports describing

thermotolerance of human lice (Hopkins, 1949; Lesson, 1941). Our recent study clearly showed that eggs and adults of human body lice could be killed by hot water (55°C) for 5 min (Hiraoka *et al.*, 1995). In the present paper we tried to evaluate a new method of treatment of human lice by a stream of hot air produced by a commercial hair dryer. Our preliminary results showed that adult lice could be killed by hot air at 55°C for more than 1 min. Eggs of human lice were slightly resistant to a stream of hot air, however, all eggs could be killed by hot air at 55°C for more than 1.5 min. The present experiment also showed that a stream of hot air at 76–78°C killed adult lice in a second. We have to evaluate properly whether stream of hot air with high temperature may be applied to infested children, who are usually below 10 years old. When a hair dryer is used to treat infested children, escape behaviour of adult lice should be borne in mind, because lice are able to move more than 13 cm for 20 sec on filter paper. To prevent the escape behaviour of adult lice, it will be necessary to develop an apparatus which generates a stream of hot air to cover the whole head of infested children.

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摘 要

コロモジラミの熱耐性

II. 成虫および卵の熱風による殺滅に関する予備的評価

コロモジラミ (*Pediculus humanus corporis*) の卵および成虫に対する熱風の影響を市販のヘアードライヤーを用いて調べた。対照として 27~28°C の冷風を5分間処理した成虫は全く死亡しなかったが、50°C の熱風を5分間処理した成虫はすべて死亡した。55°C の熱風では1分間以上の処理ですべての個体が死亡し、60°C の熱風では30秒間以上ですべての個体が死亡した。一方、卵に関しては55°C の熱風を90秒間以上処理された場合孵化が全く認められなかった。熱風を処理されたシラミ成虫には平均秒速約 7 mm 以上の素早い逃避行動が認められた。