Clinical trial

Do head lice spread in swimming pools?

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Abstract

This study investigated the potential for head lice transmission in swimming pools using an *in vitro* experiment and a field trial. In the former study, head lice were submerged for 20 min in aqueous solutions at 25 ± 1 °C: deionized water, sea water, salt solutions (30, 60, 120 and 240 g/l), and chlorinated water (0.2, 2 and 5 mg/l). In all trials, lice located on cut hairs became immobile and did not respond to physical prodding. After entering stasis, no movement was observed until after rescue from submersion and a brief recovery period (0–1 min). Upon recovery, all lice fed and no mortality was observed within the next 4 h. In the field trial, four naturally infected individuals swam in a chlorinated pool for 30 min. No loss of lice or head to head transfer was observed. These results indicated that although head lice survive immersion, head lice transmission is unlikely to occur via the water of swimming pools.

Introduction

Pediculus humanus var *capitis* De-Geer (phthiraptera: pediculidae), known commonly as head lice, are globally prevalent obligate parasites of humans.[1] Survey results from urban and rural primary schools in north Queensland, Australia, show the average prevalence to be 20%.[2,3] From a survey of seven urban primary schools, a mean of 31 lice/head (range: 1–1623) with an average of 130 lice/infested classroom were found. The main route of transmission is believed to be via the active transfer of lice from hairs on one head to hairs on another.[4] Lice require a definite orientation for transfer between head-hair with transfer most likely between hair passing parallel to the host.[5] However, lice will move *in vitro* onto fibers other than hair,[6] but the importance of this for transmission has not been assessed.

Head lice have become adapted to traumatic conditions on the scalp which include immersion in water, washing of hair, mechanical manipulation such as combing and brushing and hair treatments involving use of various chemicals. Head lice, when immersed, become stationary and clasp firmly onto the hair to which they were attached at the time of immersion. This reflex in the closely related body louse (*Pediculus humanus* var *corporis*) was described by Nuttall[7] as "sham death" after immersion in water. Recovery to normal activity occurred rapidly after removal from water. Such a response possibly has a protective effect as "stunned" lice remain clasping the hair on which they were attached prior to exposure.

In north Queensland parents commented that their children had become infected with head lice after swimming in public pools.[8] The parents hypothesized that lice were washed off the head of an infested child and subsequently attached to the hair of a louse-free child. If true, this would be unfortunate since the introduction of swimming pools in rural and remote areas of Australia has reduced the incidence of pyoderma and otitis media.[9]

In this paper we report the survival of head lice in a range of aquatic environments and show that head lice did not become dislodged from infected children using a swimming pool.

Materials and Methods

Lice

All *in vitro* experiments were conducted using freshly caught *P. capitis* within 24 h of them being combed from the heads of primary school children participating in school head lice control programs in Townsville, north Queensland. Head lice were first fed on human blood, by being placed on the back of the hand of volunteers, before being used in the experiment which took place within 4 h.

Experiment 1 – *in vitro* survival

In this study, each head louse was given a hair to grasp and were dunked and prodded until they lost sufficient floatation bubbles to sink beneath the surface of the liquid, and all were kept submerged for 20 min. The aqueous solutions used were: deionized water, sea water (100%), salt solution (30, 60, 120 and 240 g/l), and chlorinated water (0.2, 2 and 5 mg/l). Solution temperatures were maintained at 25 ± 1 °C. In each test one louse was used, and ten replicates

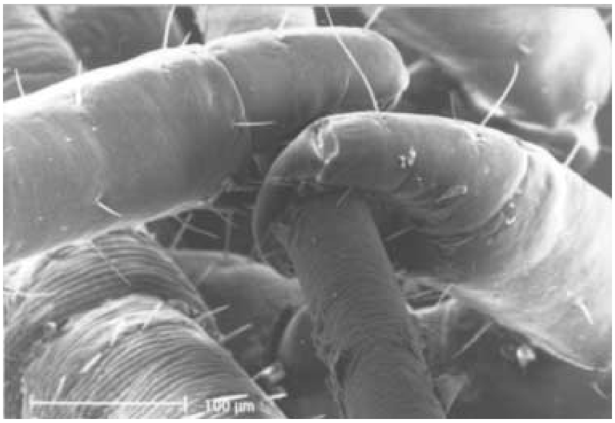

Figure 1 *Pediculus capitis* grasping a hair after immersion in an aqueous solution: a scanning electron micrograph

were carried out for each test solution. Post-test, recovery times to active movement were noted and all lice were offered a blood-meal on the back of a volunteer's hand (DC) to check if they had had recovered enough to feed.

Experiment 2 – pool transmission

This experiment examined if head lice could be dislodged from human heads during swimming. Four naturally infested children aged between 5–19 years, with a known number of head lice, were used. Lice were removed from individuals using the conditioner and comb technique and a total of ten adult and late-stage nymph were placed back onto each head. Individuals then participated, one at a time, in non-contact vigorous swimming for 30 min. They were instructed to vigorously rub their hair under water every few minutes during the 30-min swim. Three replicates were carried out. Experiments took place in a private pool with 1.3 mg/l chlorine. A post-swim assessment using dry combing was conducted to remove all lice and determine if any had left the head. Transfer was not assessed since no negative swimmers were present in the pool during the trials.

The study was carried out under the James Cook University Ethics Review Committee Approval Number H1919.

Results

In all the trials, lice quickly went into stasis while tightly clutching a hair (Fig. 1) and did not respond to prodding with another hair. After entering into this state, no movement was observed until after rescue from submersion and a short recovery period (< 1 min). During stasis all lice continued grasping the hair on which they had been immersed. Upon removal from the solutions and recovery, all lice fed on the back of a hand and no lice died within 4 h.

In the swimming pool trials, all lice placed pre-test on the individuals' heads were recovered from the same heads post-test.

Discussion

Our *in vitro* results from Experiment 1 showed that head lice survived immersion for 20 min in water, sea water, salt solutions and chlorinated water (comparable to that found in swimming pools) and fully recovered after removal. Parasitic lice are clearly adept at surviving in water; body lice survived at least 20 h in both fresh and saline water,[7] and head lice 6 h in deionized water.[10] Head lice as a species, after forming a parasitic relationship with humans, are able to withstand immersion since their human hosts wash their hair with fresh water or immerse their head in fresh or salt water while swimming. The oldest record of head lice on humans is between 6900–6300 BC.[11] Head lice are also able to survive immersion in chlorinated water, a relatively new 20th century altered environment, owing to chlorinated swimming pools. The results from Experiment 2 showed lice did not leave the children's heads during 30 min of vigorous swimming.

Although head lice can survive chlorinated water, two factors make transmission during swimming unlikely. First, immersed head lice will not release their hold on a hair to enable cross-over to another hair. Certain physiological adaptations have made lice quite adept at remaining with a host during times of trauma (e.g. showering and treatment). Lice live on the hair, not on the scalp. They climb rapidly away from movement, hold tightly to hairs with six claws, and are hard to dislodge even in stasis. Lice are equipped with a single tarsal segment and a single claw on each forearm (Fig. 1). When the claw is retracted it makes contact with the tibial spur, leaving the enclosed space the diameter of the host's hair. This enables the louse to maintain itself on an active host. Second, head lice go into stasis upon immersion which precludes any movement whatsoever. There is a risk that stray loose hairs harboring outcasts may lodge on another person's head resulting in transmission, but we suspect that this is a rare occurrence, particularly in children.

Were the parents' observations incorrect? Although our results have shown that transmission seems unlikely during swimming, perhaps there are behaviors associated with swimming that increase the transmission rate between children. These could be before, during or after immersion, but still part of the swimming episode. Possibilities from the literature include head-to-head contact[5] and the sharing of combs or towels.[12]

Before the hypothesis is dismissed, an epidemiological study needs to be performed to evaluate if swimming is a risk factor for pediculosis.

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