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A Large Outbreak of *Trichophyton Tonsurans* Among Healthcare Workers in a Pediatric Hospital

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Abstract

Background—*Trichophyton tonsurans* remains a wide spread cause of dermatophytoses among U.S. children, yet nosocomial spread may go unrecognized in a health care setting. We describe a staff outbreak of *T. tonsurans* infection among healthcare workers in a freestanding pediatric hospital.

Methods—Epidemiologic evaluation (retrospective and prospective) was performed in the healthcare providers and ancillary staff assigned to a 27-bed inpatient medical unit where a suspected outbreak occurred.

Results—Twenty-one individuals including staff, a hospital volunteer and a patient developed tinea corporis during a 5 month period. All infections coincided with multiple admissions of a 2 year old suspected index patient who demonstrated persistent infections of the scalp and arm. Fungal isolates obtained from the index patient and affected staff (when available) were subjected to multi-locus strain typing which revealed an identical genetic match between the index case and infected hospital personnel.

Conclusion—*T. tonsurans* can spread widely among staff members caring for children with recalcitrant dermatophyte infections. Timely recognition that work-place transmission may be the etiology of a succession of infections occurring in a single inpatient unit is necessary to limit the number of infected individuals.

Introduction

While the incidence of *Trichophyton tonsurans* dermatophytoses in adults is variable, this organism has emerged as a leading cause of pediatric dermatophytoses in the U.S. As many as 1 in 20 school-aged children develop tinea capitis with *T. tonsurans* and a substantially larger number of children harbor the pathogen in an asymptomatic state.¹⁻³ Consequently, heightened

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transmission and increased rates of infection are observed in environments where individuals are in close contact such as schools, day care centers, households, and sporting clubs.⁴⁻¹⁰

Nosocomial dermatophyte transmission, while less common, has been sporadically reported in both adult and pediatric institutions.¹¹⁻¹⁶ While the nature of contact in these institutional outbreaks strongly implicates a role for nosocomial transmission, the high rate of endemicity observed with this anthropophilic pathogen in the U.S. argues that fungal culture and speciation alone are not wholly adequate for epidemiologic investigations.¹⁷ Rather, strain typing may be necessary to confirm the role of nosocomial transmission when outbreaks of *T. tonsurans* are identified in health care facilities.

In this article, we report an outbreak of *T. tonsurans* that spanned 5 months and involved 21 health care providers, ancillary staff and patients. Fungal cultures, when available, underwent molecular characterization to evaluate the genetic fingerprint of each isolate and confirm their genetic relatedness. Our findings together with reports of previous dermatophyte outbreaks suggest that prompt recognition is necessary to limit the number of infected individuals.

Index patient

The index patient was a 2 year old African American male who was born premature with a history significant for necrotizing enterocolitis requiring ileostomy placement and multiple admissions to the institution for feeding intolerance. The patient had a 28 day hospital admission for failure to thrive and was coincidentally noted to have flaking on the scalp. Scalp cultures were positive for *T. tonsurans* and the patient started on twice weekly applications of ketoconazole shampoo. The patient was readmitted fourteen weeks later for feeding intolerance and weight loss and again noted to have diffuse scaling on the scalp, shoddy posterior cervical lymph nodes and several erythematous, annular, lesions on his upper extremities. He also presented with what appeared to be an id reaction, evidenced by scattered papular eruptions (1 mm in diameter) on his face and forehead. Cultures obtained from both the scalp and glabrous skin grew *T. tonsurans*, and the patient was again started on ketoconazole shampoo with the addition of microsize griseofulvin (20 mg/kg/day). Adverse events prompted the discontinuation of griseofulvin after one week and the patient was switched to fluconazole (3.3 mg/kg/day) on which he remained through discharge. The child was readmitted 9 days post discharge for increased ileostomy output and was continued on his oral fluconazole and topical ketoconazole regimen during that admission. He demonstrated no signs consistent with a dermatophyte infection; however, scalp cultures were obtained and demonstrated the persistence of *T. tonsurans*. The patient was discharged after 11 days in the hospital, and subsequently readmitted two days later for feeding intolerance. Upon readmission, his fluconazole dose was increased (6 mg/kg/day) by the attending dermatologist. The patient was discharged after 21 days in the hospital, and subsequently completed an 8 week course of oral antifungal therapy; however, scalp cultures performed 2 months later during follow-up at an outpatient clinic revealed the persistence of *T. tonsurans*.

Methods

Data Collection

This investigation involved retrospective and prospective evaluation. Inquiries were made of all staff members (n=75) working in the inpatient unit to identify whether they currently and/or recently had lesions consistent with tinea corporis. Staff members that answered yes were further questioned as to the nature of their lesion (e.g. date the lesion was noticed, description of the lesion), management of their infection (e.g. status of visits to occupational health or their primary care provider, whether cultures were obtained, type and duration of treatment) and the

nature of recent contacts (e.g. duties at the hospital, shifts worked, household contacts with ringworm, other known contacts with ringworm).

The same information was collected prospectively from everyone presenting with new lesions until the outbreak ceased after 5 months. The initial three staff members that were infected all responded to having had contact with the same patient (index case) during his first admission. Based on this information, data collection on the index patient was initiated using patient admission history, culture results, patient care notes, consultation notes, and medication order histories.

Six weeks into the outbreak, Infection Control and an attending dermatologist at the hospital elected to culture all staff with active lesions; however, the majority of individuals had commenced treatment prior to the acquisition of cultures. The staff on this inpatient unit were notified that if they developed a lesion they were to notify Infection Control and Occupational Health. When the second outbreak occurred; Infection Control, Dermatology and Occupational Health were able to acquire fungal cultures on individuals with active infections prior to the initiation of treatment. Eight cultures were obtained from staff members, with four positive for *T. tonsurans*. The suspected index case was also cultured and positive for *T. tonsurans*. Cultures from fomites (e.g. telephones, chairs) at each of three nurses' stations on the inpatient unit were also obtained.

Molecular Strain Typing

All *T. tonsurans* cultures underwent molecular characterization to determine their genetic relatedness. Primary cultures were acquired from the microbiology laboratory at the institution and subcultured onto Sabourauds dextrose agar culture medium with chloramphenicol and cycloheximide (Beckton Dickinson, Cockeysville, MD) to provide a sufficient quantity of fungal material for DNA isolation. Isolation of fungal DNA was accomplished using the DNeasy Plant Mini Kit (Qiagen Inc., Valencia, CA). Sequence variations in three gene loci were evaluated; the nontranscribed spacer (NTS) of the ribosomal RNA (rRNA) locus, alkalineprotease-1 (*ALPI*) and leucine aminopeptidase 1 (*LAPI*). In total, 2 length variations, 9 single nucleotide polymorphisms (SNPs), a 10-bp insertion, and a 14-bp deletion were incorporated into the genotyping scheme.

Details on the amplification conditions and enzymes used to determine the sequence variations in the NTS and *ALPI* loci have been previously published.^{18,19} The single sequence variation in *LAPI* (G>T) was determined with primers 5'-ATG AAG TCG CAA CTG TTG AGC and 5'-GAG AAT GTG ATG TAT AGA AAG. A 588 bp fragment was amplified directly from genomic DNA using Taq Gold (Applied Biosystems, Foster City, CA) according to the manufacturer's recommendations. The reaction profile included an initial hold for 10 minutes at 95°C, 40 cycles of 20 seconds at 95°C, 30 seconds at 57°C, 45 seconds at 72°C, and holds for 5 minutes at 72°C and 4°C. Restriction digest of the amplicon with *PvuI* (New England Biolabs, Ipswich, MD) resulted in 2 fragments of 457 bp and 130 bp when the base at the location of the SNP is a G while the enzyme fails to cut the 588 bp PCR product when the base is a T.

Results

Staff Outbreak

In total, 21 individuals presented with tinea corporis over a 5 month period. As depicted in Figure 1, the outbreak appears to segregate into two distinct periods. The initial outbreak occurred approximately 3.5 weeks after the index patient had been discharged. During this time, 11 individuals presented with cutaneous lesions over a period spanning 8 weeks. The

second series of infections were observed in closer temporal relation to re-admission of the index case to the hospital. The first lesions were noted 9 days after the patient was readmitted with 10 new individuals and two previously infected staff members presenting with cutaneous eruptions during the ensuing 6 weeks.

Of the 21 individuals infected, 17 were involved in direct care of the patient (n=12 nurses, n=5 care assistants). The remaining 4 individuals were not involved in patient care, but had contact with the index case. Those with primary/secondary contact included a nurse who was a member of the Vascular Access Team, a hospital volunteer who spent time on the floor entertaining patients, and a 16 year old female patient who was concurrently admitted to the inpatient unit and acknowledged contact with the index patient. Indirect contact occurred between the index patient and a member of the environmental services department responsible for cleaning the index patient's room. In none of these 4 individuals was contact with an infected individual outside of the inpatient unit identified.

Notably, one other child could have played a role in the current outbreak. While data collection was occurring, several staff members noted the readmission of a second patient (#2), who was known to have been infected with *T. tonsurans* a year earlier. During his previous admission, seven staff members concurrently developed tinea corporis infections. However, the child was asymptomatic on admission and no cultures were obtained.

In 18 of the 21 individuals, infection presented as the classical annular lesions comprised of a red raised margin and a zone of central clearing while the description of the lesion in the remaining 3 individuals varied. Infections lasted from 1 to 10 weeks in duration and treatment strategies varied as depicted in Figure 1. Cultures were obtained from eight of the infected individuals, four of which grew *T. tonsurans* and four of which were negative. Fomites were also cultured at the same time and these were negative.

Molecular Strain Typing

The *T. tonsurans* isolates acquired from the index case and the infected members of the health care staff demonstrated an identical strain type by PCR and PCR-RFLP (Figure 2). When compared with isolates acquired from children of the same approximate age, residing in the same city as this hospital,³ the genetic strain type observed on our index patient and staff represents a strain that occurs with a frequency of approximately 25% in the population. Consequently, while highly unlikely, we cannot exclude the possibility of isolate acquisition from other sources, where contact or involvement with a population that demonstrates a high fungal burden, may have occurred.

Discussion

The persistent nature of *T. tonsurans* as a primary pathogen of pediatric dermatophytoses in the U.S. along with the increasing number of *T. tonsurans* epidemics that are reported in non-U.S. countries support the efficiency by which this organism is transmitted between individuals in the community.^{2,13,16} Previously described institutional outbreaks allude to a similar risk for the nosocomial transmission of *T. tonsurans* along with other dermatophytes (Table). Notably, these reports are not restricted to a given facility type or patient population. Both acute and long-term care facilities have been included among the reports with the involvement of patients that span the spectrum of age from newborns through to the ninth decade of life.

Despite knowledge that human-human transmission is the primary route of dissemination for *T. tonsurans*, 2 months elapsed and 11 staff members contracted a dermatophyte infection before the infections were recognized as an outbreak at our institution. Several factors likely contributed to the extensive and protracted nature of this outbreak, among these; the failure of

Occupational Health to initially attribute the staff infections to nosocomial transmission, a delay in the notification and involvement of Infection Control and inadequate medical management of the index case with tinea capitis.

By Occupational Safety and Health Administration (OSHA) definition, work-relatedness is presumed for injuries or illness resulting from events or exposures occurring in the work environment.²¹ While seemingly evident that these infections would be deemed work-related, recognition of, and attention to, this outbreak was slow to occur. Notably, neither the Centers for Disease Control and Prevention (CDC) nor OSHA have written literature recognizing dermatophytoses as an occupational hazard. While it may be difficult to implicate the health care environment in the spread of selected dermatophyte infections, a number of flags should have been raised with this current outbreak. These included 1) the heavy, localized concentration of individuals presenting with infection and 2) the involvement of an atypical population (i.e. Caucasian adults) in a geographic region where the pathogen primarily infects prepubescent African-American children. We propose that the index of suspicion implicating work-place transmission should be heightened, and measures taken at an Occupational Health level to treat those infected immediately, with an outbreak such as described herein,

When the succession of infections was finally recognized as an outbreak, CDC guidelines for Infection Control were implemented to reduce the spread of infection.²² Education related to recognizing tinea infections, principles of disease transmission, and infection control was provided to the staff. Complete data collection was undertaken and cultures were obtained to confirm (by molecular methods) that this was, in fact, an outbreak with a singular strain. Finally, the remaining staff with active lesions were treated by the Occupational Health physician. Once Occupational Health began to treat individuals with active lesions there were no more reported cases of tinea infections.

Apart from the CDC guidelines, no other precautions were universally implemented across the ward. However, several individual staff members implemented personal precautions such as wearing gown and gloves when handling this patient or wearing long sleeves to work. Additionally, discussion between the staff, Infection Control, and Occupational Health occurred regarding the placement of this child in contact isolation. However, this idea was rejected because of a primary concern about social isolation of this child given that his caregivers was seldom present.

The final contributing factor surrounds the adequacy of treatment for the index patient. On initial presentation, the only treatment prescribed was a topical agent despite American Academy of Pediatrics recommendations that oral antifungal agents be used in the management of tinea capitis.²³ Regrettably, this is consistent with trends observed in the management of tinea capitis where reports indicate that slightly over 50% of infected children receive oral antifungals and less than 20% receive the agents for an adequate duration.²⁴ Inadequate treatment of this child could explain why his symptoms did not resolve as evidenced by the persistence of lesions on readmission. Intolerance to griseofulvin, when it was finally prescribed, prompted the switch to fluconazole. Notably, the prescribed dose in this child were nearly half those found to be effective in clinical trials of fluconazole (6 mg/kg/day).^{25,26} This child's dose was eventually increased and the patient completed an eight week course of therapy, but he continued to demonstrate positive scalp cultures. This finding could suggest poor response to medication, non-compliance or reacquisition of the pathogen. However, our recent studies suggest that children of this age can remain persistent carriers despite treatment.

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We would be remiss not to acknowledge the three week period between the time of hospitalization for the index patient and the first reported outbreak. While this likely represents

a protracted incubation period it is possible that the infections could have been transmitted through fomites or an infected staff member.¹⁴ However, the cluster of infections occurring around the time of readmission and the clonal relationship of the fungal isolates strongly supports a link between the infections and the index patient.

As alluded to above, the timing of a second child suspected to have been the cause of an earlier outbreak in the hospital. However, no data collection was performed at that time, no involvement from Occupational Health or Infection Control occurred, and the individuals that were infected were encouraged to seek treatment from their primary care provider. Given the match for strain type with the index case and the infected staff members, the involvement of this second child is unlikely; however, we cannot rule out the fact that he may have been an asymptomatic carrier and consequently a potential alternative source of infection to the staff outbreak.

Based on the current and previously published outbreaks, the threat of dermatophyte transmission in the health care setting needs to be recognized. Mitigating tinea outbreaks relies on prompt recognition and management. Although the CDC currently only recommends standard precautions with tinea infection,²⁷ additional care may be required to reduce the spread of infection (e.g. education of staff and patients, strict adherence to hand washing).

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Figure 1. Timeline of the infections with demographic information, nature of contact and treatment strategies of those infected. Black boxes indicate time frames of admission for the index case. Arrows indicate time frame of infection for staff members. Asterisks indicate individuals in whom fungal cultures were positive and subsequent strain typing was performed.

Figure 2.

Agarose gels showing the PCR-RFLP patterns at each locus evaluated for the index case and affected staff members. MW- molecular weight marker, pos.- positive control, neg.- negative control.

Table
Review of current and previous reports detailing nosocomial dermatophyte outbreaks.

Author and year	Location	Hospital setting	Index patient	Age of infected	Number infected	Type of contact	Organism
Current report	Missouri	inpatient medical unit in a pediatric hospital	2 year old male	16-48 years old	21	direct	<i>T. tonsurans</i>
Drusin, et al., 2000	New York	Neonatal Intensive Care Unit	23 year old female	neonates born 24-28 weeks gestation	5	direct	<i>M. canis</i>
Wood, et al., 1997	New Zealand	Psychiatric ward in a long stay facility	17 year old male	not discussed	13	direct	<i>T. tonsurans</i>
Lewis, et al., 1997	Illinois	Pediatric unit in a Rehabilitation hospital	6 year old male	not discussed	4	direct	<i>T. tonsurans</i>
Amow, et al., 1991	Illinois	Pediatric surgical unit	7 year old female	23-50 years old	10	direct and indirect	<i>T. tonsurans</i>
Kane, et al., 1988	Ottawa, Canada	Nursing Home	80 year old female	26-95 years old	7	direct and indirect	<i>T. tonsurans</i>
Shah, et al., 1988	Ontario Canada	Acute and chronic health care facility	elderly male	28-52 years old	24	direct and indirect	<i>M. canis</i>