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Direct Inoculation of Food as the Cause of an Outbreak of Group A Streptococcal Pharyngitis

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An investigation was conducted of a food-related outbreak of group A streptococcal pharyngitis following an elementary school banquet. Of 166 surveyed banquet attendees, 71 (43%) reported outbreak-associated pharyngitis, and 21 (88%) of 24 tested attendees had evidence of group A streptococcus (GAS) in the throat. Attendees who ate macaroni and cheese were three times more likely to develop pharyngitis than those who did not (66/132 [50%] vs. 5/30 [17%], P = .002). None of the food handlers had GAS recovered by throat culture. However, the cook who prepared the macaroni and cheese had a hand wound; a wound culture grew GAS with the same T agglutination pattern and M- and/or opacity factor type as that of all available GAS strains from ill attendees. Under laboratory conditions, macaroni and cheese supported rapid growth of the outbreak-associated strain of GAS. To the authors' knowledge, this is the first documented foodborne outbreak of GAS pharyngitis in which the only apparent source of contamination was a food handler's skin lesion.

Pharyngeal infection due to group A streptococcus (GAS) is spread primarily through person-to-person contact. However, GAS can also be transmitted through contaminated food. Foodborne outbreaks of GAS pharyngitis caused by contaminated milk were relatively frequent before the routine use of pasteurization [1] but are now rare [2]. Reports of foodborne outbreaks not related to milk have generally implicated as the vehicle either prepared salads (e.g., tuna, potato, seafood) or foods containing eggs [3–10]. The most likely mechanism of food contamination in these previously reported outbreaks was believed to be from the respiratory secretions of food handlers. We report a food-related outbreak of GAS pharyngitis with apparently a different source of contamination.

Methods

Background and epidemiologic investigation. On 11 May 1991, a private elementary school held a banquet at a local country club to honor children in grades 5–8 who had participated in the sports program. The school had an enrollment of ∼355 boys and girls in kindergarten through grade 8. About 200 persons, including students, teachers, and family members, attended the banquet. The catered meal consisted of a green salad, fried chicken, baked chicken, macaroni and cheese, green beans, rolls, peach cobbler, and beverages served at a buffet table. The banquet lasted 3 h and was held in a single room.

On 16 May, the Louisiana Department of Health and Hospitals (DHH) was notified that several students and family members who had attended the banquet developed sore throat, swelling of cervical lymph nodes, or both in the 3 days after the banquet. Later, 4 persons reported having positive throat cultures or rapid antigen detection tests for GAS.

On 21 May, a survey questionnaire was mailed to the families of all children in grades 5–8, whether or not they attended the banquet. The questionnaire gathered information on symptoms compatible with pharyngitis, date and time of illness onset, physician visits and test results, banquet attendance, and food items eaten by those who attended the banquet. Information concerning the seating location of students and their family members at the banquet was sought as well. A second questionnaire was sent to families who had not returned the initial questionnaire by 29 May. Parents who did not return either the first or second questionnaire were contacted by telephone.

For the purposes of analysis, a case of pharyngitis was defined as an illness with onset between 12 and 14 May consisting of sore throat and at least one of the following: swollen cervical lymph nodes, subjective fever, or positive throat culture or rapid antigen test for GAS.

Laboratory investigation. No food items served at the banquet were available for laboratory testing. On 21 and 24 May, all 6 food handlers who prepared the banquet meal and 5 food servers were interviewed and throat cultures were taken. A culture was also taken from a hand lesion of 1 food handler.

Results of streptococcal laboratory tests were obtained from physicians for persons who reported medical visits for pharyngitis; none of the strains of GAS obtained by these physicians were available for typing. On 22 May, throat cultures were obtained at the school from 39 children in grades 5–7 who had returned permission slips and questionnaires from their parents. All positive cultures obtained by DHH were characterized by T agglutination pattern as well as M- and/or opacity factor (OF) typing [11–12].

After the epidemiologic investigation was complete, we examined in the laboratory the likelihood that the GAS could have multiplied in the macaroni and cheese to reach an infective dose. We prepared two batches of macaroni and cheese: one attempting to recreate as closely as possible the recipe used for the banquet meal (on a smaller scale) and one using the ingredients and instructions from a commercially available retail product. The final products were homogenized in an Omnimixer (Sorvall, Norwalk, CT) and inoculated with a fixed number of the strain of GAS that had been isolated from the food handler's hand. The material was then incubated at selected temperatures and cultured quantitatively for 0, 3, and 24 h. The batch prepared with the banquet recipe was incubated at 4, 20, 30, and 37°C, and the batch prepared with the commercial recipe was incubated at 20, 30, and 37°C.

Statistical analysis. Data were analyzed using EpiInfo software version 5 (Centers for Disease Control and Prevention); 95% confidence intervals (CIs) for relative risks (RRs) were calculated using the formulas of Greenland and Robins [13]. The *P* value used to test the hypothesis that children who attended the banquet were more likely to have positive throat cultures was calculated using a one-tailed Fisher's exact test.

Results

Epidemiologic investigation. Of the 122 households of children attending grades 5–8, 100 (83%), representing 373 persons, returned survey questionnaires. Of these 373 persons, 75 (20%) had illnesses that met the case definition for pharyngitis. Besides a sore throat, other common symptoms were cervical lymph node swelling (87%), fever (80%), and headaches (77%). Of 75 persons with pharyngitis, 24 reported that they were tested by their physicians for pharyngeal infection with GAS, and 21 (88%) reported positive tests. We were able to contact physicians and verify these positive results for 17 of the 21 (2 were by culture and 15 by rapid streptococcal antigen test) but were unable to reach physicians for the other 4. No isolates of GAS from these cases were available for further characterization. None of the

ill persons developed complications, and none were hospitalized.

Persons who attended the sports banquet were much more likely to develop pharyngitis than those who did not (43% [71/166] vs. 2% [4/207]; RR, 22; CI, 8.3–59.4). Among banquet attendees, the attack rate was slightly higher for females than males (47% vs. 40%; RR, 1.2; CI, 0.8–1.7) and slightly higher for children than adults (49% vs. 40%; RR, 1.2; CI, 0.9–1.8). Cases did not cluster in any one seating area but rather were scattered throughout the banquet room. Attendees who reported eating the macaroni and cheese were three times more likely to develop pharyngitis than those who did not (50% vs. 17%; RR, 3.0; CI, 1.3–6.9; table 1). Consumption of rolls or fried chicken was also associated with illness, but the macaroni and cheese dish had the strongest association and was eaten by the greatest number of persons with pharyngitis (66/71 [93%]).

The macaroni and cheese dish was prepared the day before the banquet by a single food handler. The food handler reported preparing the macaroni and cheese by mixing milk and cream that had been warmed on a stove (but not brought to boiling) with cheese, corn starch, and cooked macaroni noodles, then storing the mixture in five large pans overnight in a walk-in refrigerator. On the day of the banquet, the pans were warmed in the oven at 250°F (120°C) for 45 min and then kept under heat lamps for 1–2 h before serving.

Laboratory investigation. Throat cultures were collected by DHH from 39 children in grades 5–7 who were in school on 22 May. Among these children, 5 (21%) of 24 who attended the banquet and none of the 15 who did not attend had positive cultures for GAS (RR, undefined; *P* = .07).

All throat cultures taken from the 6 food handlers and 5

Table 1. Attack rates (AR) for pharyngitis among banquet attendees by food consumed.

Food item	Ate food			Did not eat food			Relative risk	(95% CI)
	No. ill	No. not ill	AR (%)	No. ill	No. not ill	AR (%)		
Macaroni/cheese	66	66	50	5	25	17	3.0	(1.3–6.9)
Rolls	59	60	49	9	30	23	2.2	(1.2–3.9)
Fried chicken	54	47	53	13	37	26	2.1	(1.3–3.4)
Iced tea	57	63	47	14	29	33	1.5	(0.9–2.3)
Salad	58	70	45	13	22	37	1.2	(0.8–2.0)
Cobbler	46	57	44	24	34	41	1.1	(0.7–1.6)
Cream	12	15	44	54	65	45	1.0	(0.6–1.6)
Baked chicken	27	36	43	40	44	48	0.9	(0.6–1.3)
Green beans	39	54	41	30	34	47	0.9	(0.6–1.3)
Coffee	18	26	41	50	55	48	0.9	(0.6–1.3)
Beverages	12	20	37	55	56	49	0.8	(0.5–1.2)

NOTE. Persons indicating they were unsure whether they ate food items were excluded from analysis. CI, confidence interval.

servers involved in the banquet meal were negative for GAS. However, when examined on 24 May, the food handler who had prepared the macaroni and cheese had a 1-cm healing lesion on the dorsum of his left hand. A culture of this lesion grew GAS.

The food handler reported that the hand lesion was the result of a barroom fistfight 2 weeks before the banquet. The following day the lesion was treated with a topical ointment. He reported that it showed swelling for 2 days afterward before improving and that it was covered with a gauze bandage at the time that he was preparing the macaroni and cheese. He received no systemic antibiotics before or after the banquet, but he did develop a sore throat on 22 May, 11 days after the banquet.

Seven isolates of GAS obtained by DHH were further characterized. All of these isolates—5 from schoolchildren attendees, 1 from an ill parent attendee, and the 1 from the food handler's hand lesion—were T agglutination pattern 5/9, and M/OF type 9.

Macaroni and cheese prepared in the laboratory supported rapid growth of the outbreak GAS strain (figure 1). In the banquet recipe batch, the organism had a lag period of at least 3 h, after which it increased from 10^4 to 10^8 cfu/g at 30 and 37°C. At 20°C, a lesser increase occurred, and at 4°C (the approximate temperature of a refrigerator), the organism did not multiply but did remain viable. In the commercial batch of macaroni and cheese, the growth of the outbreak strain of GAS over 24 h was even more rapid and consistent.

Discussion

Three findings of our investigation implicate direct food handler contamination of the macaroni and cheese as the cause of this outbreak. First, there was a strong epidemiologic association between illness and consumption of macaroni and cheese. Second, the only apparent source of GAS was a preexisting lesion on the hand of the only food handler

A

B
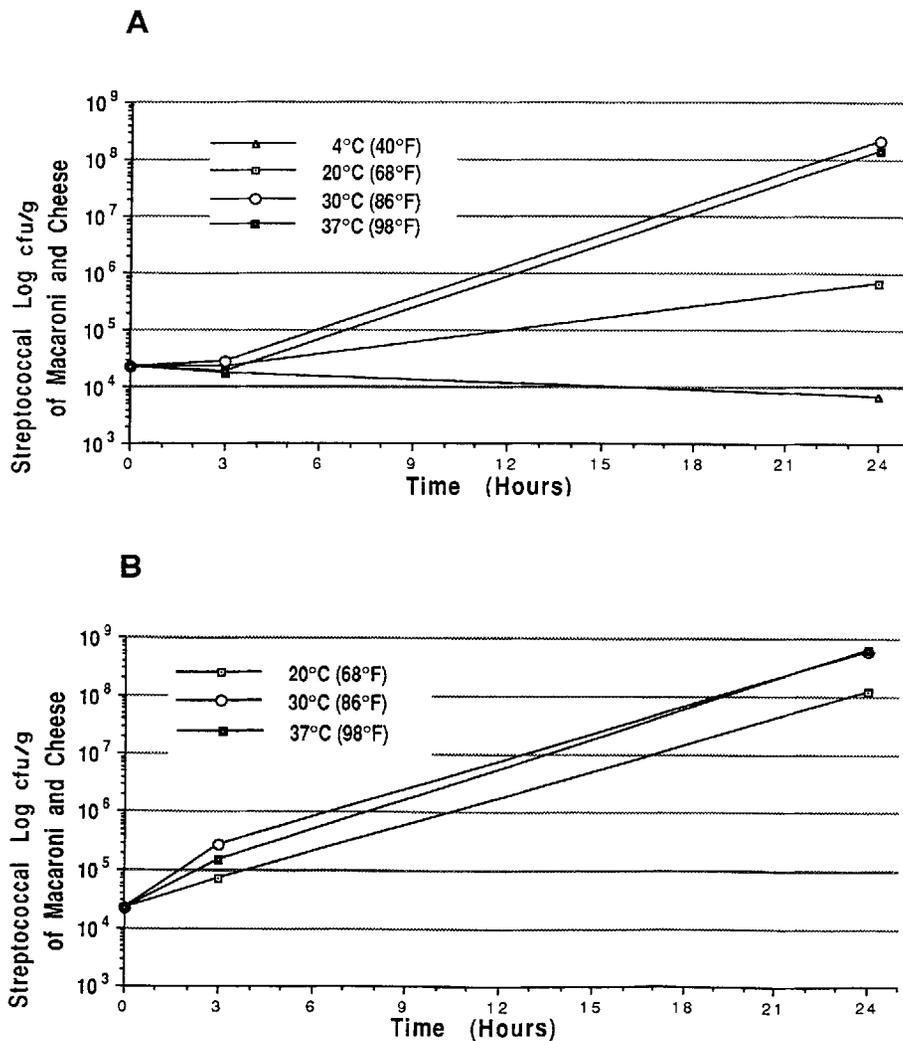
Figure 1. Growth of outbreak strain of GAS in macaroni and cheese at various temperatures prepared (**A**) according to recipe used by banquet cook and (**B**) from commercially available product.

who prepared the macaroni and cheese. Third, the strain of GAS isolated from this lesion matched the T agglutination pattern and M/OF type of all available isolates from ill persons. M9 streptococci are rare among recent clinical isolates from the United States [14].

The food handler's description of the preparation of the macaroni and cheese suggests that deviations from safe food handling practices contributed to the likelihood of occurrence and the magnitude of this outbreak. It is highly probable that his infected hand lesion (covered with a gauze bandage that itself may have been heavily contaminated) came in direct contact with the food during preparation. Although the temperatures attained by the macaroni and cheese during preparation and storage are unknown, it appears that the food was never heated to a temperature sufficiently high to kill ordinary pathogens before serving. Furthermore, it seems that the dish may have been maintained for a prolonged period at a temperature that would allow the organism to multiply—this could have happened on the stove on 10 May, in the refrigerator overnight (if the dish cooled slowly), or in the oven and under the heat lamps on 11 May.

We demonstrated in our laboratory that GAS can grow rapidly in macaroni and cheese at a variety of temperatures and that they survive in this environment even during refrigeration; this finding supports our hypothesis about the mechanism that caused the outbreak. Support for the growth of GAS was found in two different macaroni and cheese preparations, using different ingredients. It seems that this dish may share with milk, eggs, salads containing eggs, and other prepared salads characteristics that support growth of GAS.

Previous food-related outbreaks of GAS pharyngitis have been thought to be caused by contamination of food by respiratory secretions of food handlers; in several such outbreaks, the outbreak-related strain of GAS has been isolated from the throats of food handlers [4, 6, 8, 15]. In one outbreak, the responsible strain was also isolated from the hands of food handlers, and it was considered possible that the food contamination may have occurred through direct inoculation; however, because these food handlers also had positive throat cultures, it was acknowledged that the contamination may have been through respiratory droplets [15]. To our knowledge, ours is the first investigation that has found an infected hand lesion as the only identified source of food contamination. To prevent future such outbreaks, we recommend that food caterers or health departments require food handlers with hand lesions to either wear gloves or refrain from direct food preparation and educate food handlers about maintaining foods at proper temperatures to prevent bacterial growth.

Acknowledgments

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