

***Salmonella* Typhimurium infections associated with peanut products. Cavallaro et al. *New Engl J Med.* 2011;365:601-610.**

**Background**

Early in the large outbreak of *Salmonella* Typhimurium infections during 2008-2009 that was ultimately associated with peanut butter (hereafter referred to as the national outbreak), chicken was a leading hypothesis as the vehicle. This was based largely on a restaurant outbreak of *S.* Typhimurium infections in Ohio associated with chicken consumption. The supplier of the chicken was the same supplier (supplier A) as chicken served in an institution in Michigan that had a case with one of the two primary national outbreak PFGE subtypes of *S.* Typhimurium. Three PFGE patterns, including the two primary subtypes in the national outbreak, were identified in confirmed *S.* Typhimurium cases that had patronized the Ohio outbreak restaurant.

**Ruling out chicken**

Chicken is a common vehicle for *S.* Typhimurium, so evaluation of chicken as a possible vehicle of the national outbreak was certainly warranted. Chicken sources were traced back for the first four Minnesota cases with national outbreak PFGE subtypes. Cases were interviewed by Minnesota Department of Health (MDH) staff with the detailed MDH questionnaire that contains food consumption/purchase locations and details such as brand and variety of product consumed. Chicken exposure information was given by MDH to the Minnesota Department of Agriculture (MDA), which conducted the tracebacks. Chicken consumed by all four cases traced back to different suppliers, none of which was supplier A.

Concurrently, the United States Department of Agriculture was assessing supplier A, and determined that it was very unlikely that distribution of chicken from this supplier could explain the nationwide outbreak that was occurring.

Therefore, traceback and traceforward information provided evidence that chicken was unlikely to be the vehicle for the national outbreak.

Ultimately, cases with the two national outbreak PFGE patterns that had patronized the Ohio outbreak restaurant were temporally distinct from the restaurant outbreak cases with the third PFGE pattern. When peanut butter was implicated as the cause of the national outbreak, the cases with the two national outbreak PFGE patterns were subsequently found to attend institutions that served implicated peanut butter (and had just coincidentally eaten at the restaurant in question after the outbreak that had occurred there).

**Developing the peanut butter hypothesis**

The initial implication of peanut butter stemmed from many different clues provided primarily by conducting traceback investigations.

The first eight national outbreak cases that occurred in Minnesota reported eating peanut butter (no specific product stood out). This raised suspicions, but was not enough evidence to implicate peanut butter as the source of the outbreak. Later in the month a long-term care facility (LTCF A) in northern Minnesota reported an outbreak of salmonellosis that was subsequently

documented to be due to the national outbreak PFGE subtypes of *S. Typhimurium*. Within the next week, national outbreak *S. Typhimurium* cases were identified in another long-term care facility (LTCH B) in northern Minnesota, and in two children who attended the same elementary school in northern Minnesota. Invoices for food served at these institutions during the week before the cases' illness onsets were obtained by MDH. The three institutions had a common food distributor (distributor A) in North Dakota, and the only specific food product common to all three institutions was KingNut brand creamy peanut butter. In addition, a rehabilitation facility in Oregon where a case-patient was exposed also used KingNut creamy peanut butter from another outlet of distributor A.

Investigation of KingNut revealed that it was a brand processed at a Peanut Corporation of America plant in Georgia and distributed as an institutional product. At least six distribution centers across the country distributed KingNut, and these distribution centers aligned in large part to areas of the country with concentrations of cases (although it was clear from the beginning that KingNut institutional exposures could not explain a substantial proportion of cases). In addition, a national outbreak case from Oregon resided in an institution that used KingNut.

Over the next 2 weeks, six more cases with institutional exposures were identified in Minnesota, all six institutions used KingNut creamy peanut butter. All of the nine institutions were in the distribution area of distributor A (northern and western Minnesota). Of note, distributor A had another location in the Minneapolis-St. Paul metropolitan area; this location did not distribute KingNut peanut butter, and no outbreak cases with institutional exposures were identified in the metro area.

With all of the product tracing clues supporting a possible role for KingNut peanut butter, an open tub of KingNut peanut butter that was in use prior to cases' illness onsets was collected from LTCH A for culture by MDA. Both primary outbreak PFGE subtypes of *S. Typhimurium* were cultured from the peanut butter (and subsequently from unopened tubs of product in other states as well as peanut butter crackers).

**Multistate outbreak of *Salmonella* serotype Typhimurium infections associated with consumption of restaurant tomatoes, United States, 2006: Hypothesis-generation through case exposures in multiple restaurant clusters. Barton Behravesh et al. *Epidemiol Infect.* January 12, 2012; epub ahead of print.**

During the last week of September 2006, the Minnesota Department of Health (MDH) Public Health Laboratory (PHL) identified four human-case isolates of *Salmonella* Typhimurium that were indistinguishable by pulsed-field gel electrophoresis (PFGE); the subtype was given the local designation TM376 in Minnesota. Routine interviews of these cases revealed that they had all eaten at the same location of a fast food restaurant chain (Restaurant 1) in the week prior to illness onset. Additionally, on September 27 a complaint was received from an Illinois resident who had traveled to Minnesota and became ill with gastrointestinal symptoms after eating at the Restaurant 1. The complainant reported being diagnosed with *Salmonella* infection. The St. Paul-Ramsey County Department of Public Health, Environmental Health Section (Ramsey County) was contacted, and an investigation of the restaurant was initiated.

On October 4, MDH PHL staff posted a message on the PulseNet web-board about the MDH investigation. During the first 2 weeks of October, the PulseNet national database was queried to find out if other states had *S. Typhimurium* TM376 cases as well. The Centers for Disease Control and Prevention (CDC) was notified of the matches. On October 19, CDC started coordinating a multi-state investigation, including a case-control study including cases in states other than Minnesota. MDH provided information on the Minnesota cases but did not participate in the multi-state case-control study since the Minnesota study was already underway.

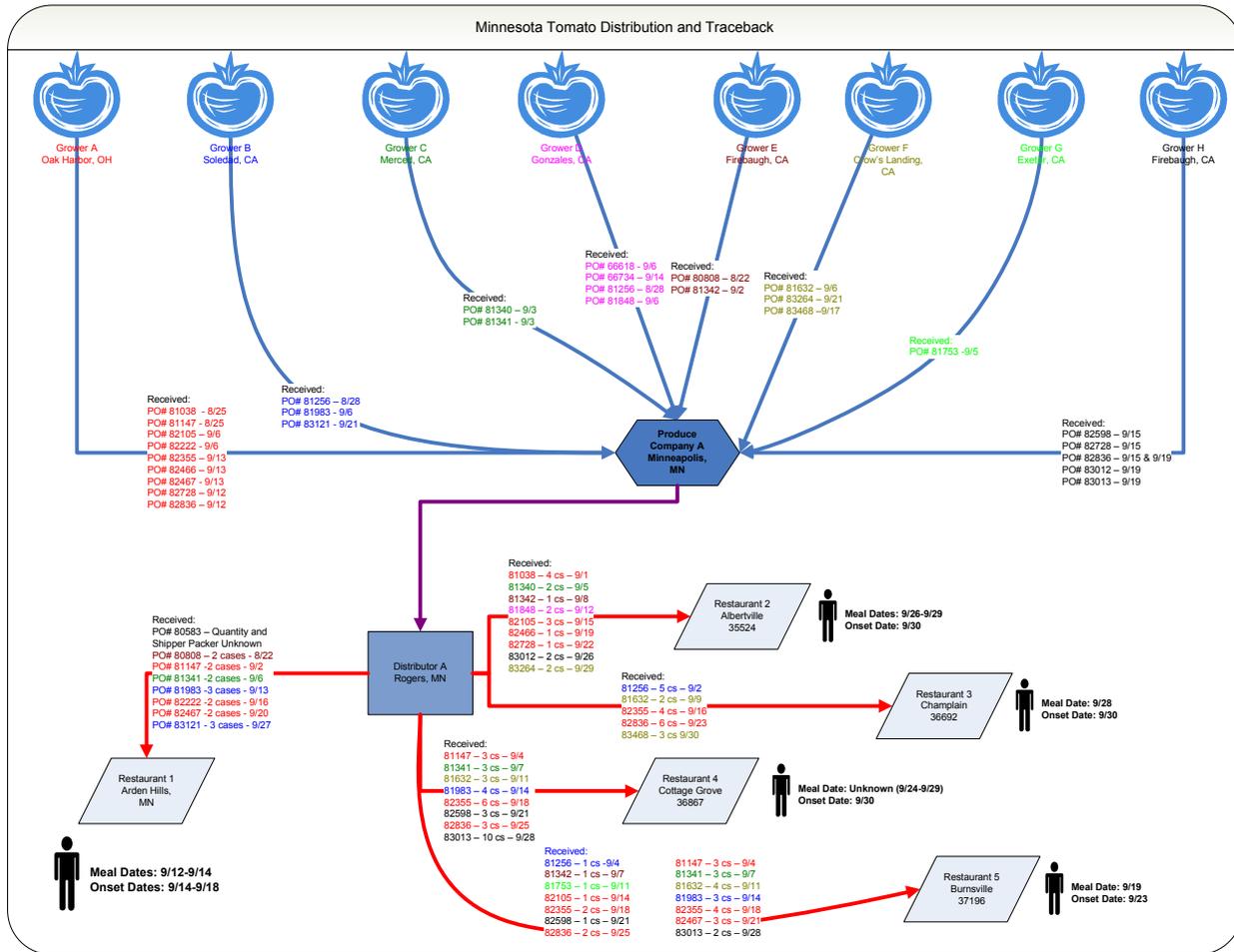
Fourteen *S. Typhimurium* TM376 cases were identified in Minnesota residents, and one in an Illinois resident who ate at Restaurant 1 in Minnesota. Onset dates ranged from September 12 through October 13. Six cases were ultimately identified who ate at Restaurant 1 (meal dates of September 12, 13, 14). All six cases ate hamburgers with lettuce, tomatoes and onions. Eight cases did not eat at Restaurant 1.

All 15 cases and 38 controls were included in a case-control study. Univariate analysis (unmatched) found that eating at tomatoes at a restaurant (11 of 14 cases vs. 13 of 32 controls; odds ratio [OR], 5.4; 95% confidence interval [CI], 1.05 to 30.8;  $p = 0.02$ ), eating lettuce at a restaurant (12 of 15 cases vs. 15 of 33 controls; OR, 4.8; 95% CI, 0.96 to 26.9;  $p = 0.03$ ), eating at any Restaurant 1 location (6 of 15 cases vs. 5 of 35 controls; OR, 4.0; 95% CI, 0.80 to 20.8;  $p = 0.04$ ); and eating at restaurant A (6 of 15 cases vs. 0 of 35 controls; OR, undefined; 95% CI, undefined;  $p < 0.005$ ) were associated with illness. Among cases and controls that did not eat at any Restaurant 1 location, only eating tomatoes at a restaurant (6 of 8 cases vs. 9 of 28 controls; OR, 6.3; 95% CI, 0.85 to 58.4;  $p = 0.05$ ) was associated with illness.

The CDC national investigation identified 183 cases in 21 states (including the Minnesota cases). The CDC multi-state case-control study implicated tomatoes consumed at restaurants as the vehicle.

The Minnesota Department of Agriculture traceback coordinator collected information about tomatoes and invoices from restaurants named by cases in Minnesota. This information was

cross-referenced with data collected from other states. The tomatoes were ultimately traced back to a farm in Ohio (Grower A).



Produce Company A received tomatoes from eight (8) different growers during the investigatory timeframe of interest identified by MDA during their traceback. Interestingly, Produce Company A did minimal repacking for between growers and therefore was able to internally link incoming growers to outgoing shipments with some accuracy. The tomatoes were distributed to the restaurants where case exposures occurred via a food distribution company, Distributor A. Because invoices from the restaurants could link the product from Distributor A back to Produce Company A, investigators were able to identify the source of tomatoes *received* at each restaurant.

An important component of this traceback investigation focused on understanding the tomato handling and use practices in the restaurants where case exposures occurred. The rate of tomato consumption and the regularity of reordering tomatoes helped investigators understand what growers might have been in use at each establishment during the reported meal dates for each case. This case demonstrates the criticality of environmental health investigators working closely with and sharing information with epidemiologists during the course of an investigation.

Investigators constructed a matrix that plotted which tomato grower was received at each restaurant up to 12 days prior to the meal date that most likely resulted in case illness:

Restaurant	Days Prior to Meal Date												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Restaurant 1 - Case 1 Meal Date - 9/12							Grower C 81341 2 cs					Grower A 81147 2 cs	
Restaurant 1 - Case 2 Meal Date - 9/14		Grower B 81983 3 cs							Grower C 81341 2 cs				Grower A 81147 2 cs
Restaurant 1 - Case 3 Meal Date - 9/13	Grower B 81983 3 cs							Grower C 81341 2 cs				Grower A 81147 2 cs	
Restaurant 1 - Case 4 Meal Date - 9/13	Grower B 81983 3 cs							Grower C 81341 2 cs				Grower A 81147 2 cs	
Restaurant 1 - Case 5 Meal Date - Unknown (9/16?) Onset Date - 9/19	Grower A 82222 2 cs			Grower B 81983 3 cs							Grower C 81341 2 cs		
Restaurant 2 - Case 6 Meal Date: 9/26 Onset Date: 9/30	Grower H 83012 2cs				Grower A 82728 1 cs			Grower A 82466 1 cs				Grower A 82105 3 cs	
Restaurant 2 - Case 6 Meal Date: 9/27 Onset Date: 9/30		Grower H 83012 2cs				Grower A 82728 1 cs			Grower A 82466 1 cs				Grower A 82105 3 cs
Restaurant 3 - Case 6 Meal Date - 9/28 Onset Date - 9/30						Grower A 82836 6 cs							Grower A 82355 4 cs
Restaurant 2 - Case 6 Meal Date: 9/29 Onset Date: 9/30	Grower F 83264 2 cs			Grower H 83012 2cs				Grower A 82728 1 cs				Grower A 82466 1 cs	
Restaurant 4 - Case 7 Meal Date: Unknown (9/27?) Onset Date: 9/30			Grower A 82836 3 cs				Grower H 82598 3 cs				Grower A 82355 6 cs		
Restaurant 5 - Case 8 Meal Date: 9/19 Onset: 9/23		Grower A 82355 4 cs				Grower B 81983 3 cs			Grower F 81632 4 cs				Grower C 81341 3 cs

When grower is plotted against the meal date it became evident that only one grower, Grower A, was served in all of the restaurants where there were cases of illness. In some of the restaurants, it had been 10 to 12 days between receipt of implicated tomatoes and the meal date of the ill case. Understanding the use of the product in the store helped to explain how these products could have plausibly been associated with illness.

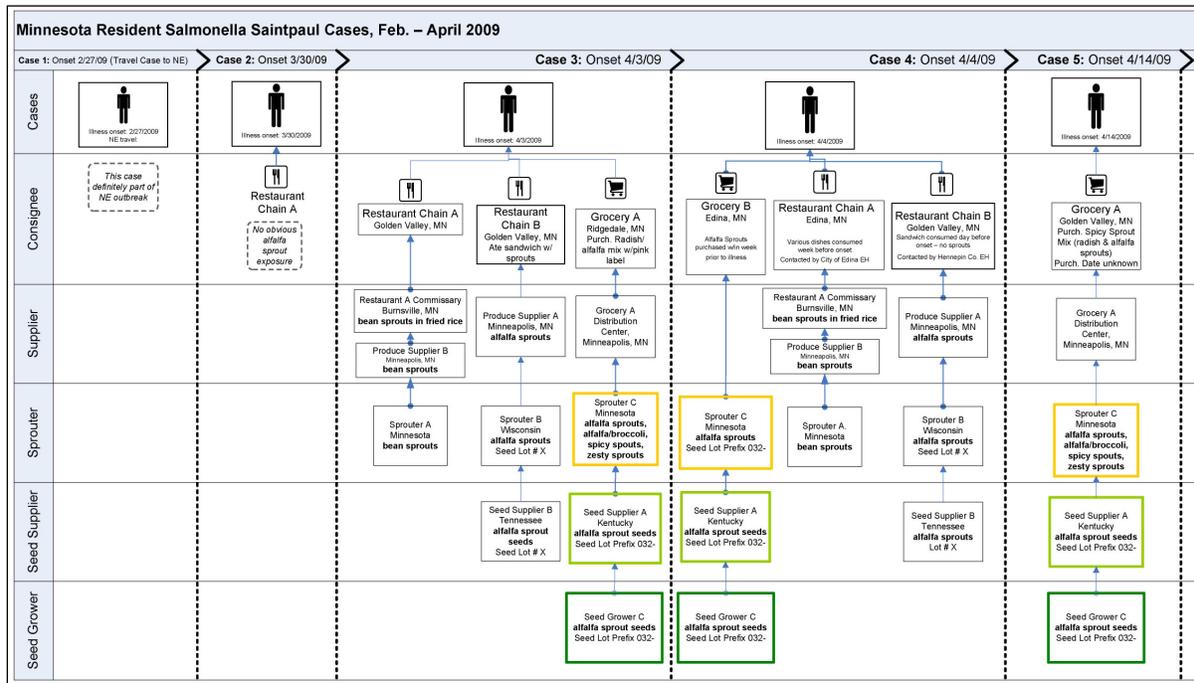
Tracebacks of tomatoes from three implicated restaurants in other states also identified Grower A as the source of tomatoes for this outbreak.

**Salmonella Saintpaul and Alfalfa Sprouts, 2009 (MMWR. 2009;58:500-503).**

During February and early March 2009, the Nebraska Department of Health and collaborators identified an outbreak of *Salmonella* Saintpaul infections associated with alfalfa sprout consumption, particularly at a single restaurant chain. Tracebacks revealed that the sprouts were from seeds from a single seed supplier (Supplier A), and that the seeds had originated from a single seed grower (Grower C).

The Minnesota Department of Health (MDH) identified one *S. Saintpaul* case that was exposed in Nebraska at the implicated restaurant chain (Figure, Case 1). During April, MDH identified 4 additional *S. Saintpaul* cases with the outbreak pulsed-field gel electrophoresis subtype (Figure, Cases 2-5) as part of a second wave of cases in several states. Interviews done by MDH revealed that Case 2 reported no identifiable alfalfa sprout exposure. Cases 3-5 reported various sprout exposures, and at least one including two different alfalfa exposures each. Case 5 reported a single alfalfa exposure.

Because of the prior association with alfalfa sprout consumption in Nebraska and the small number of cases involved, the decision was made not to spend the time to do a case-control study to statistically implicate sprouts. Rather, the Minnesota Department of Agriculture traced back all sprout exposures from cases 3-5. All three cases had consumed alfalfa sprouts from Supplier A. The seeds were traced back to Grower C, indicating that this actually represented a single, ongoing outbreak.



**Concurrent outbreaks of *Shigella sonnei* and enterotoxigenic *Escherichia coli* infections associated with parsley: Implications for surveillance and control of foodborne illness. Naimi et al. 2003. *J Food Prot.* 66:535-541.**

This article describes a number of outbreaks due to *Shigella sonnei* of the same pulsed-field gel electrophoresis (PFGE) subtype that occurred in multiple states and Canadian provinces in July and August of 1998. The vehicle was parsley. However, the initial epidemiologic evidence in most of the individual outbreaks was inconclusive and suggested a local source of contamination, such as a local foodworker. Parsley was initially overlooked because it was used as a garnish accompanying or covering many different food items. PFGE subtyping suggested that these outbreaks had a common source. Reevaluation of the epidemiologic data implicated parsley as the source or indicated that it was a possible source in all of the outbreaks. Tracebacks conducted for six of seven outbreaks indicated that a single farm in Mexico was the likely source of the parsley. Thus, the traceback efforts worked in conjunction with PFGE subtyping and more traditional epidemiologic investigation efforts to show that what seemed like independent outbreaks of shigellosis across the United States and Canada was actually a single widespread outbreak associated with parsley from Mexico.

**Outbreak of *Escherichia coli* O157:H7 infections associated with nonintact blade-tenderized frozen steaks sold by door-to-door vendors. Laine et al., *J Food Prot.* 2005;68:1198-1202.**

This article describes a multistate *E. coli* O157:H7 infections associated with blade tenderized steaks sold by door-to-door vendors. Most of the cases, including all of the cases in Minnesota and Michigan, reported consuming Brand A steaks. A single case reported in Kansas also reported consuming steaks purchased from a door-to-door vendor, but the steaks were of a different brand (Brand B). However, when the product packaging was obtained from the Kansas case, it was revealed that the Brand B product was produced in the same processing plant as the Brand A product, and that the two products were actually the same product that had been packaged under different labels for different vendors. This information prompted a media advisory about the product and a subsequent recall. An analytic study was considered unnecessary, and the intervention preceded the identification of the outbreak strain of *E. coli* O157:H7 in product by several days.

***E. coli* O157:H7 and Steaks, Minnesota, 2007 (unpublished).**

On July 5, 2007, the Minnesota Department of Health Public Health Laboratory identified two *Escherichia coli* O157:H7 (O157) isolates that had indistinguishable pulsed-field gel electrophoresis patterns. The subtype had only been seen once before in Minnesota, in 1998. Therefore, a common source outbreak was suspected. On interview, both cases reported consuming steaks in the 7 days prior to illness onset, and that the steaks had been purchased from the same location of a retail club store (Store A). However, neither case had leftover steaks or packaging materials, and neither case was able to provide additional details on brand or type of steak. In a simple form of epi traceback, Store A identification numbers were obtained from the cases and (with case consent) used by the Minnesota Department of Agriculture to gather data on the steak products. Store A records indicated that the two case households had purchased the same steak product, labeled “beef loin bottom butt sirloin ball tip steak”, at the same Store A location, on June 21, 2007, within about 3 hours of each other (see records for each case household below). The two households had no other beef or other food products in common from the time period of interest.

Club #	Club Name	Transaction Date	Transaction Time	Register #	Category #	Item #	Item Desc 1	Unit Retail	POS Qty
6309	WBL	06/21/2007	4:24:00 PM	12	38	50778	ORANGE JUICE	\$3.62	1
6309	WBL	06/21/2007	4:24:00 PM	12	38	52523	SKIM MILK	\$2.69	1
6309	WBL	06/21/2007	4:24:00 PM	12	40	710854	JUICE BLENDS	\$11.88	1
6309	WBL	06/21/2007	4:24:00 PM	12	41	93818	ANGEL HAIR	\$3.57	1
6309	WBL	06/21/2007	4:24:00 PM	12	41	227712	TOMATO AND BASIL	\$6.87	1
6309	WBL	06/21/2007	4:24:00 PM	12	43	33583	CHICKEN BROTH	\$4.38	1
6309	WBL	06/21/2007	4:24:00 PM	12	48	124498	LEMON BARS	\$7.88	1
6309	WBL	06/21/2007	4:24:00 PM	12	56	867552	CANTALOUPE	\$2.12	2
6309	WBL	06/21/2007	4:24:00 PM	12	76	323506	BEEF LOIN BOTOM BUTT	\$3.97	3

Club #	Club Name	Transaction Date	Transaction Time	Register #	Category #	Item #	Item Desc 1	Unit Retail	POS Qty
6309	WBL	06/21/2007	7:41 PM	7	38	52337	1% MILK	\$2.78	1
6309	WBL	06/21/2007	7:41 PM	7	40	579180	RUBY RED GRAPEFRUIT	\$3.57	1
6309	WBL	06/21/2007	7:41 PM	7	41	428135	CHOCOLATE SYRUP	\$6.12	1
6309	WBL	06/21/2007	7:41 PM	7	42	51887	GRADE AA XL EGGS	\$1.43	1
6309	WBL	06/21/2007	7:41 PM	7	42	100416	RED GRAPEFRUIT	\$7.88	1
6309	WBL	06/21/2007	7:41 PM	7	42	172602	OVEN RSTD TURKEY BRS	\$6.43	1
6309	WBL	06/21/2007	7:41 PM	7	46	752402	ALMOND ACCENTS	\$7.88	1
6309	WBL	06/21/2007	7:41 PM	7	48	59841	MINI SQUARE BAGELS	\$2.58	1
6309	WBL	06/21/2007	7:41 PM	7	48	195923	GRANOLA	\$7.83	1
6309	WBL	06/21/2007	7:41 PM	7	56	362153	BANANAS 3LB	\$1.14	1
6309	WBL	06/21/2007	7:41 PM	7	72	932796	CHICKEN SAUSAGE	\$11.47	1
6309	WBL	06/21/2007	7:41 PM	7	76	323506	BEEF LOIN BOTOM BUTT	\$3.97	3
6309	WBL	06/21/2007	7:41 PM	7	86	727471	FATHERS DAY MIX	\$12.88	1

***E. coli* O157:H7 and Steaks Products at Restaurants, Minnesota, 2009 (unpublished).**

In June 2009 the Minnesota Department of Health (MDH) Public Health Laboratory identified two *E. coli* O157:H7 case isolates with indistinguishable PFGE patterns (XbaI-EXHX01.0405 BlnI-EXHA26.0569). This XbaI pattern had never been seen before in Minnesota. Onsets of illness were June 13 and 14, respectively. On interview, the cases did not report eating at the same restaurant or have any other obvious commonalities. However, it was noted that two of the restaurants named by the cases (one by each case) are owned by the same company (but not part of the same chain) The only beef exposures reported by the cases occurred at these restaurants. The first case reported having the grilled beef tenderloin at one restaurant. The second case reported eating a steak sandwich at the sister restaurant. MDH contacted the two local health departments that licensed these restaurants, and invoices for the beef products used in the dishes consumed by the cases. According to these records, the beef consumed by the cases was the same product, a beef tenderloin which came from a local distributor labeled as (redacted) "Company A Boneless Beef Butt Tender" (invoice below). This is a non-frozen, fresh kyrovac packaged product shipped in a 10 lb. container.

<b>INVOICE</b>									
		Invoice No.		Invoice Date		Page			
				06/09/09		1			
S O L D									S H I P T O
Profile	Stop	Sales ID	Customer ID	Order No.	Order Date	P.O. Number	Terms	Ship Via	
S		01	033600	95948	06/09/09		30 DAYS		
Item ID	Qty. Shipped	Description	Weight	Price	Per	Total			
0192A0C	10.00	TENDERLOIN TAILS CHO (4/5# AVE) 4 1/2 OZ PORTIONS 3.2	3.20	7.69	LB	24.61			
118401C8	10.00	STR CAP NAT CHO 8 (12# AVE) 2.6 2.5	5.10	7.99	LB	40.75			
1190A0C8	15.00	TENDER FILET NAKED CHO 8 (12# AVE) 2.4 5.1	7.50	19.49	LB	146.18			
11910TC	10.00	TENDERLOIN BUTT CRK NT CHO (4/5#) 10.	10.00	9.89	LB	98.90			
BF00N	20.00	FRESH BROUND NATURAL ANGUS 90/20 (10/5#)	20.00	2.34	LB	46.80			
1415017	10.00	PORK TENDERLOIN NAT 7 (10# AVE) 4.3 <i>Proud to be Farmer Owned™</i>	4.30	6.69	LB	28.77			
BR2105	2.00	CHICKEN BRST B/S RANDDM AMISH (2/10# AVE) 20. 20.	40.00	2.99	LB	119.60			

### ***Salmonella* Cubana and Sprouts, Canada and Minnesota, 2009 (unpublished).**

On August 9, 2009, the Canadian Food Inspection Agency issued an alert warning the public to avoid consuming Sprouts Alive and Sun Sprouts brand raw onion sprouts and onion/alfalfa sprout mixes due to potential *Salmonella* contamination. The advisory coincided with a voluntary recall of the product, which reportedly had only been distributed in Canada. Cases in Canada had onsets from April to August 2009. The Minnesota Department of Health (MDH) was made aware of this recall and the associated serotype and pulsed-field gel electrophoresis (PFGE) subtype on August 20. The serotype identified both in sprouts and Canadian residents was Cubana, and the pulsed-field gel electrophoresis pattern subtype was given the PulseNet designation JDGX01.0072. The Minnesota pattern designation for this subtype was CUB4. *Salmonella* Cubana had only been seen in 11 cases in Minnesota since 1995, and this was a novel PFGE subtype. At the time that MDH became aware of this investigation, there were two Minnesota residents since the beginning of 2009 who had confirmed *S. Cubana* CUB4 infection. The onset dates for the two cases were April 27 and August 12. Routine interviews of the cases conducted by MDH revealed that both cases had consumed sprouts in the week prior to illness onset. The Minnesota Department of Agriculture (MDA) was notified and an investigation was initiated.

The two cases reported eating the same brand of sprouts purchased from different grocery store chains in different cities. The case with the earlier onset report consuming alfalfa, onion, and garlic sprouts, and the case with the later onset reported consuming alfalfa, radish, onion, and broccoli sprouts.

Invoices collected by MDA from the two grocery stores revealed that the sprouts had come from the same grower in southern Minnesota. Contact with the grower revealed this establishment had received onion seeds from the same lot that the implicated sprouting facilities in Canada received. This Canadian product had yielded PFGE patterns of *S. Cubana* that were indistinguishable from *S. Cubana* isolates from the two Minnesota cases and the 14 cases in Canada.

Seeds used in the production of the implicated sprouts in Canada were traced back to a distributor in Tennessee. The Minnesota grower which supplied the sprouts purchased by the Minnesota cases had received the recalled lot of onion seeds from this distributor as well.

In summary, the traceback of the sprouts consumed by Minnesota cases revealed the common seed source for those cases and the outbreak cases in Canada.