

Outbreak Investigation Case Series

Commercially Distributed Food Vehicles



In-depth, behind-the-scenes analyses of foodborne outbreak investigations

Introduction

This series focuses on investigations of outbreaks caused by commercially distributed food items and detected through pathogen-specific surveillance. The etiologic agents often are *Salmonella*, Shiga toxin-producing *E. coli* (STEC), or *Listeria monocytogenes*, but other pathogens are sometimes responsible. The primary target audience is foodborne disease epidemiologists who investigate (or are training to do so) these types of outbreaks, but others might find this series informative as well.

The primary focus of this series is methods used by epidemiologists (in concert with their co-investigators) to generate, develop, and confirm hypotheses about the outbreak vehicle. Descriptions will generally begin with the detection of a cluster (typically by molecular subtyping of submitted clinical isolates at a public health lab) and end when the food source is identified to a level of certainty/confidence that public health interventions are implemented. While this outbreak occurred when pulsed field gel electrophoresis was the subtyping method used by public health laboratories, the lessons are still applicable now that whole genome sequencing is the subtyping method.

From an epidemiologist's perspective, the overall goal in these types of investigations is to document a sufficiently specific food exposure in a sufficiently high proportion of cases that one can confidently conclude that the food item of interest is the outbreak vehicle. This series will use outbreak examples that detail the exact process and methods that led investigators to that "threshold of confidence" that prompted them to take action. What were the epidemiologists thinking and doing day-by-day, case-by-case, and step-by-step as the investigation progressed, leading up to the attainment of that threshold of confidence? How were leads identified, and how did investigators decide when and how aggressively to follow a particular lead? The nuances, complexities, obstacles, and decision nodes involved in these types of investigations are nearly impossible to fully describe in the limited space of a peer-reviewed manuscript (plus, many excellent investigations are never published). It is our objective to capture all of the important methodological intricacies of selected particularly speedy or effective investigations using a detailed timeline format. We strongly encourage our audience to read the published investigation manuscript (when one exists) before going through our description. We hope that our descriptions will be a useful, educational supplement to the characterization of the investigation.

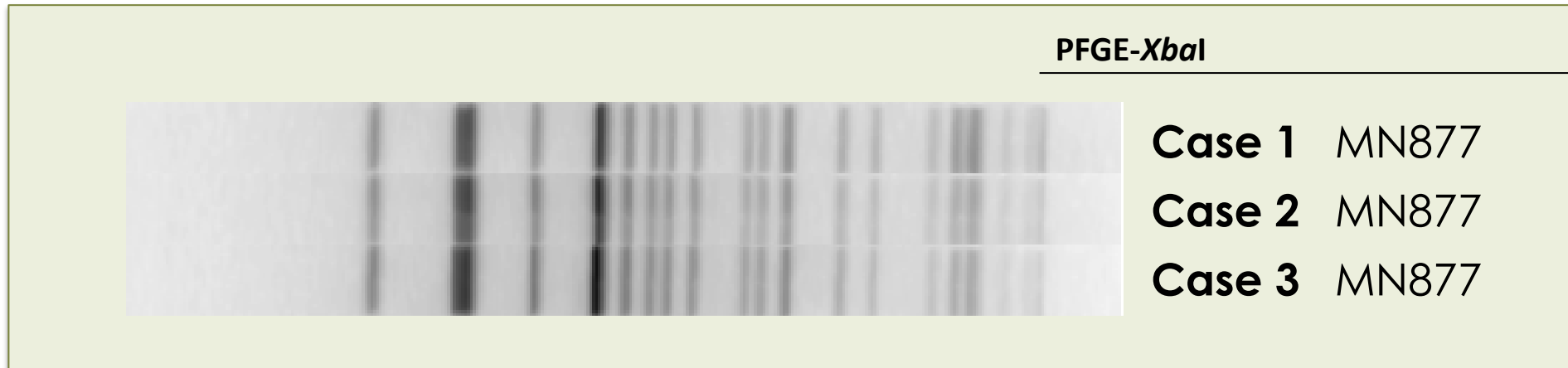
***E. coli* O157:H7 – Dole
Prepackaged Salad, 2005**

SEPTEMBER 27 (DAY 1 OF

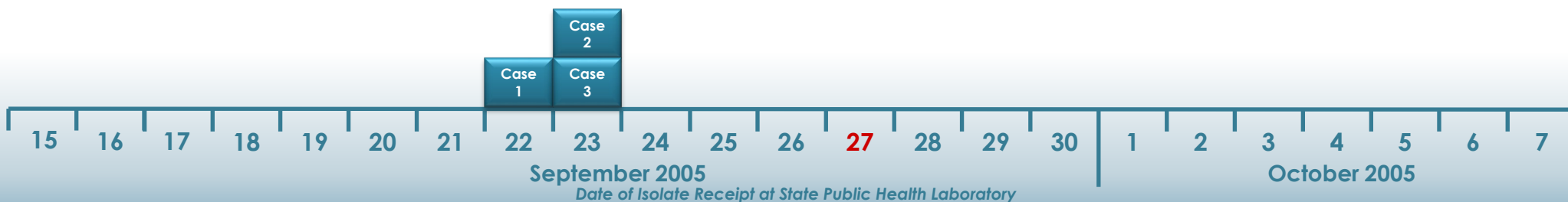
INVESTIGATION)

This story starts with receipt of three clinical *E. coli* O157:H7 (O157) isolates at the Minnesota Department of Health (MDH) Public Health Laboratory (PHL) on September 22 and 23, 2005 (submission of clinical O157 isolates to MDH is mandatory in Minnesota). By September 27, subtyping of the three cases' O157 isolates revealed that they were indistinguishable by pulsed-field gel electrophoresis (PFGE). The isolates were given the Minnesota subtype designation MN877 (national PulseNet subtype designation EXHX01.0238).

The MDH PHL notified MDH foodborne epidemiologists, and a cluster investigation was initiated.



What are the first two questions an epidemiologist should consider once receiving these laboratory results?
Move to the next page to see what the investigators were thinking...

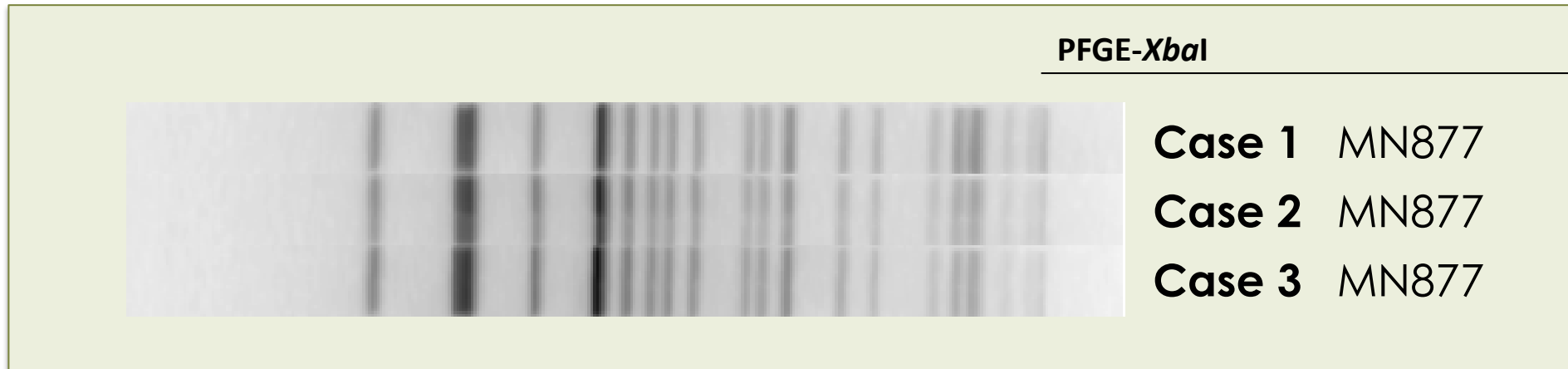


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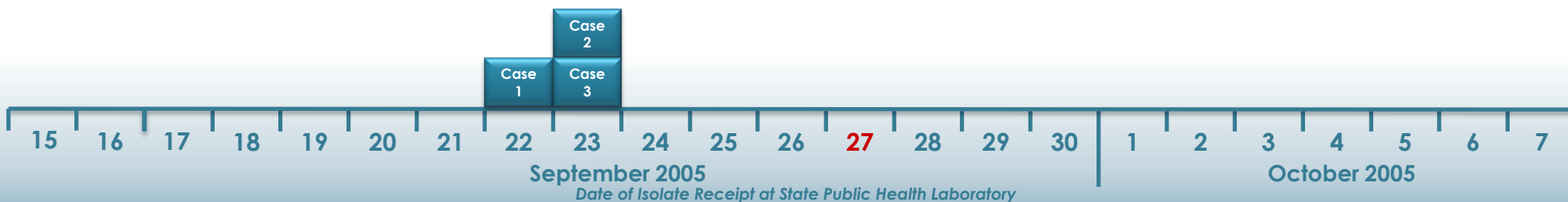


Assessment:

How common is this PFGE pattern?

This PFGE pattern had not previously been seen in Minnesota, and is rare in the U.S. (0.35% of patterns in the PulseNet National Database). Therefore, this cluster almost certainly represents a common source outbreak. Aggressive follow-up is warranted.

Are there other cases with this PFGE pattern in other states? A PulseNet search indicated that there were no cases in other states at this time.



SEPTEMBER 27 (DAY 1 OF INVESTIGATION)

The three cases interviewed with the MDH [Standard Questionnaire for STEC and Salmonella Cases](#) on Day 1 reported exposure to prepackaged salad (one reported household exposure but not eating it), and there were no other common exposures evident.

Item	Ate	Did not eat	May have eaten	How prepared	Variety or brand	Date purchased (mo/da)	Grocery store where purchased	Date eaten (mo/da)	Restaurant where eaten* (include address)	
VEGETABLES										
Prepackaged salad	X				Dole Classic Romaine	/ /	Rainbow	/ /		
VEGETABLES										
Prepackaged salad	X			American blend mostly iceberg w/ carrots + cabbage	Archer farms or Dole or Rainbows - cheap		Target or kind Rainbow	5 times in week prior - (note - she doesn't wash it) - eats every day almost with dinner		
VEGETABLES										
Prepackaged salad		X		Dole - family eats, but she doesn't					/ /	

What would you do now?

Move to the next page to see what the investigators were thinking...



15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7

September 2005

October 2005

Date of Isolate Receipt at State Public Health Laboratory

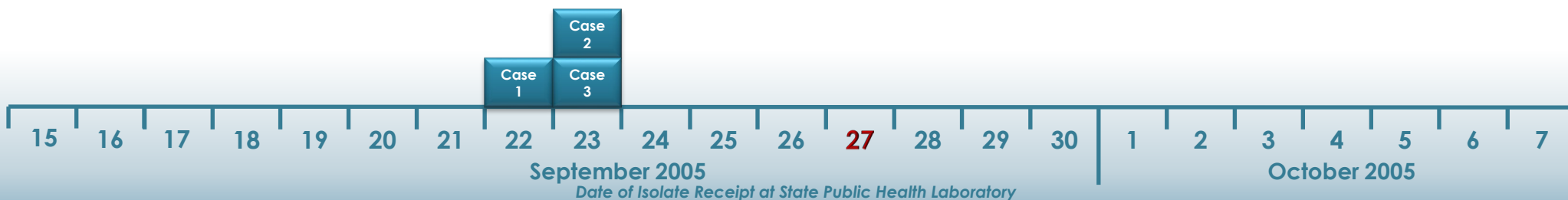
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VEGETABLES										
Prepackaged salad		X		Dole - family eats, but she doesn't					1 / 1	

Assessment:

The prepackaged salad signal is interesting, but this is a commonly eaten food item. Waiting for more data seems most appropriate. Investigators did not have to wait long – read on.



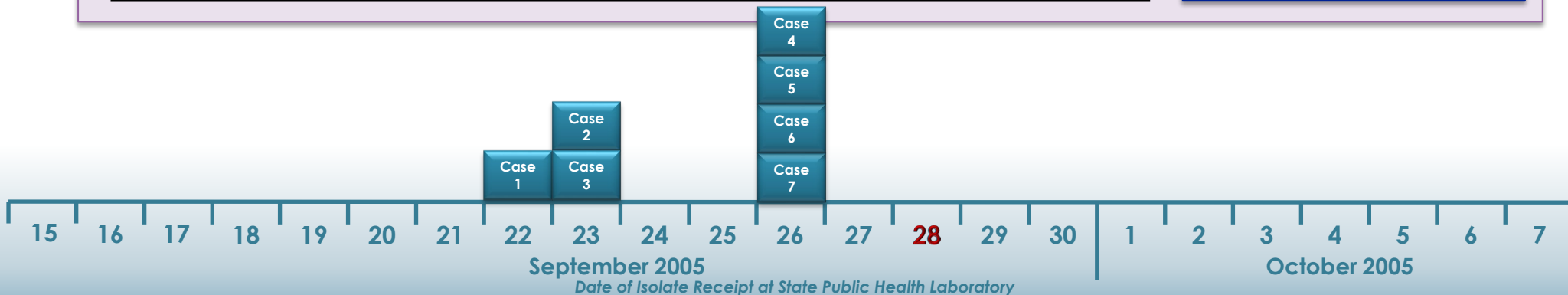
SEPTEMBER 28 (DAY 2 OF INVESTIGATION)

Additional O157 isolates were received by the MDH PHL on September 26. On September 28, PFGE subtyping results indicated that four of the new isolates matched the outbreak subtype, MN877. Demographics of the initial cases in the cluster are given below:

	Age (years)	Gender	Race/Ethnicity
Case 1	10	Female	White/Non-Hispanic
Case 2	3	Female	White/Non-Hispanic
Case 3	52	Female	White/Non-Hispanic
Case 4	13	Female	White/Non-Hispanic
Case 5	68	Female	White/Non-Hispanic
Case 6	26	Female	White/Non-Hispanic
Case 7	49	Male	White/Non-Hispanic

86% Female
Median Age 26 years
All White and Non-Hispanic

What clue does these demographics provide?
Move to the next page to see what the investigators were thinking...



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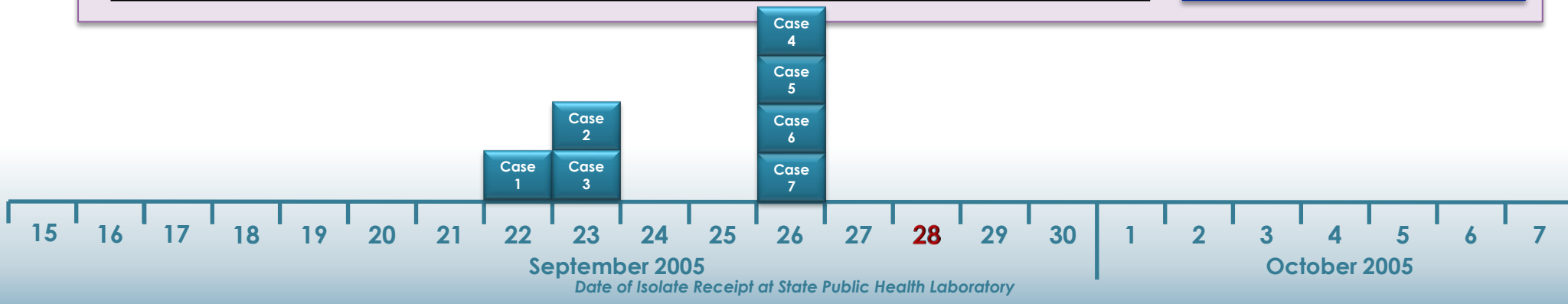
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Median Age 26 years

All White and Non-Hispanic

Assessment:
 The gender and age distributions strongly suggest that the outbreak vehicle is a fresh produce item such as a leafy green or sprouts. The prepackaged salad hypothesis gains steam.



SEPTEMBER 28 (DAY 2 OF INVESTIGATION)

Day 2 was an extremely busy day in the investigation. Several things happened:

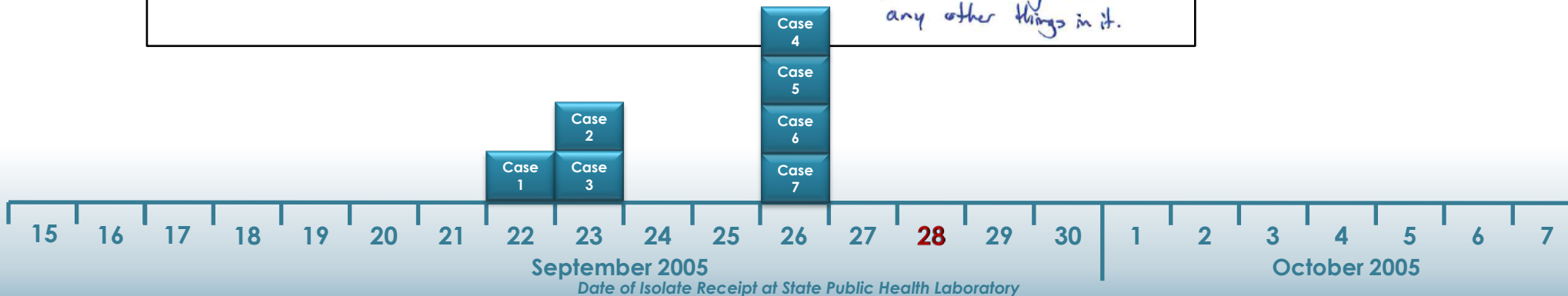
- Interviews of new cases continued and revealed something very interesting in common between two cases, one of whom was interviewed on Day 1 of the investigation and one of whom was interviewed on Day 2.

15. Do you know of anyone else with a diarrheal illness prior to or following your illness? Yes No
if yes, when? same time who? [redacted]
→ he goes to Northwestern College. On 9/13 someone brought in food to share for dinner - chix tacos w/ sour cream, shredded cheese & lettuce (probably). Either [redacted] or [redacted] brought the food. At least 3 were sick & [redacted] tested ⊕ for E.coli also.

19. Did you attend any large gatherings the week before your illness (wedding, receptions, showers, Parties, festivals, fairs, etc.)? Yes No
if yes, when: 9/13/05
what type of event? Class @ Northwestern College
where? _____
foods served? chix in crockpot, bagged lettuce, salsa, sour cream, tortilla.
- Dix brand or style of lettuce → "probably iceberg" w/out any other things in it.

What are you going to do with this information?

Move to the next page to see what the investigators were thinking...



SEPTEMBER 28 (DAY 2 OF INVESTIGATION)

Day 2 was an extremely busy day in the investigation. Several things happened:

- Interviews of new cases with the Standard Questionnaire continued and further strengthened the potential link with prepackaged salad. Also, gathering detailed product information made one brand and variety stand out.

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VEGETABLES									
Prepackaged salad	X				Dole	dk	Rainbow or Bynum's or Kobal's	any day	

What would you do now?

Move to the next page to see what the investigators were thinking...

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Assessment:

In addition to the sub-cluster investigation, investigators decided to concurrently launch a community case-control study using cases that were not part of the sub-cluster, read on.

SEPTEMBER 28 (DAY 2 OF INVESTIGATION)

Day 2 was an extremely busy day in the investigation. Several things happened:

- A supplemental questionnaire was created and a community case-control study initiated. (Note the “dummy” variables included, to avoid bias.)

Case Definition

- Diarrheal illness
- E. coli* O157:H7 of outbreak PFGE subtype isolated from stool
- Illness on or after September 9, 2005

Control Enrollment

- Three controls per case attempted
- Sequential digit dialing anchored on case's phone number
- Matched by age group: 2 to <6 yrs; 6 to <12 yrs; 12 to <18 yrs; 18 to <40 yrs; 40 to <60 yrs; and >60 yrs.
- No diarrhea or vomiting during preceding 2 weeks.

Supplemental Interview Form:

Name: [REDACTED]
 Date became ill: 9/26
 Onset Time: 00:00

Did you eat lettuce before your illness? Y N DK
 When did you eat the lettuce (date)?

Was the lettuce prepackaged? 9/22 Y N DK

Do you recall brand name of prepackaged lettuce? Y N DK
 If yes, list brand name:

ASK about these brands as well:

FRESH EXPRESS BRAND	Y	<input checked="" type="radio"/> N	DK
DOLE	<input checked="" type="radio"/> Y	<input type="radio"/> N	DK
EARTH BOUND FARM	Y	<input checked="" type="radio"/> N	DK
ARCHER FARM	Y	<input checked="" type="radio"/> N	DK

Do you recall the type of lettuce or salad components? Y N DK
 If yes, list type of lettuce: Romaine
 If no, was it romaine lettuce? Y N DK
 was it iceberg lettuce? Y N DK

Do you recall the store purchased from? Y N DK
 If yes, list name: Rainbow - Quarry

Did you purchase the lettuce from any of the following stores?

RAINBOW	<input checked="" type="radio"/> Y	<input type="radio"/> N	DK
CUB	Y	<input checked="" type="radio"/> N	DK
TARGET	Y	<input type="radio"/> N	DK
LUND's	Y	<input type="radio"/> N	DK
BYERLY	Y	<input type="radio"/> N	DK
Kowalskis	Y	<input type="radio"/> N	DK
WalMart	Y	<input type="radio"/> N	DK

other (name):

Location of Store (City/Street):
 The Quarry

DATE PURCHASED LETTUCE OR SALAD: 9/13
 ORIGINAL GROCERY STORE RECEIPT AVAILABLE? Y N DK

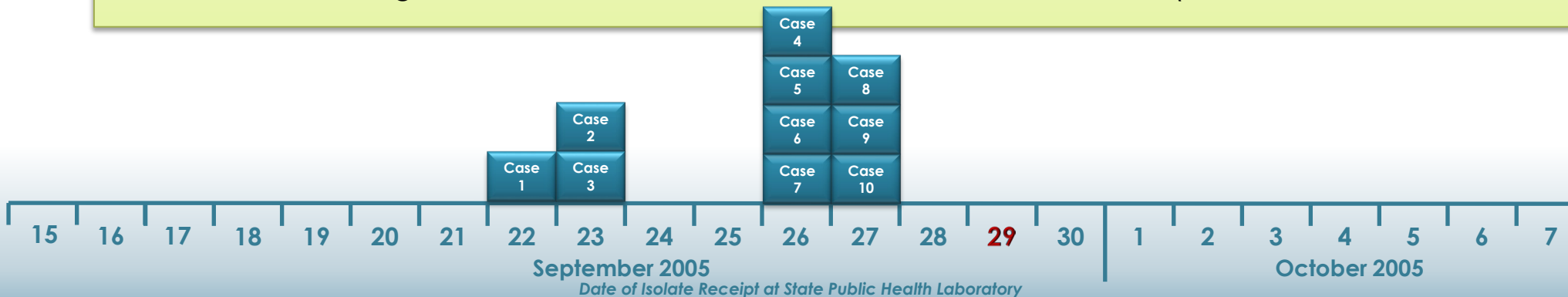
REMAINING LETTUCE FROM PACKAGE AT HOME? Y N DK
 IF YES, expiration date? 9/23
 Lot #: will get when test it.
 May we obtain it for testing?
 Yes

SEPTEMBER 29 (DAY 3 OF INVESTIGATION)

Three additional O157 isolates had PFGE subtyping results available that matched the outbreak subtype, for a total of 10 confirmed cases to this point. These cases were enrolled in the case-control study that had been initiated the prior day.

Additionally, the investigation of the sub-cluster at Northwestern College was completed:

- Food items served at the potluck included chicken, cheese, salsa, sour cream, tortillas, and lettuce.
- Interviews of classmates identified 1 additional probable O157 case, for a total of 3 cases (2 lab-confirmed). The incubations for the 3 cases from the event were 3, 3, and 6 days (very compatible with the event as the source).
- 11 of the 12 class potluck attendees were interviewed as part of a cohort study (since we do have a discrete cohort). 3 of 6 students who consumed lettuce became ill, vs. 0 of 5 students who did not consume lettuce (relative risk, undefined; $p=0.18$).
- The student who brought the lettuce to the class potluck reported purchasing two bags of Dole Classic Romaine prepackaged salad on September 13 from a Rainbow Foods in Minneapolis.
 - A leftover bag of salad was recovered from the home of this student (who had taken it home after the event).



SEPTEMBER 30 (DAY 4 OF INVESTIGATION)

The results of the community case-control study implicated Dole prepackaged salad as the likely outbreak vehicle.



Community Case-Control Study Results

Exposure	Cases	Controls	Matched OR*	95% CI†	P-value
Any lettuce	9/10	17/26	3.5	0.5-25.0	0.17
Prepackaged lettuce salad	9/10	10/26	8.4	1.2-59.6	0.01
Dole prepackaged lettuce salad	9/10	5/23	10.1	1.5-67.3	0.002

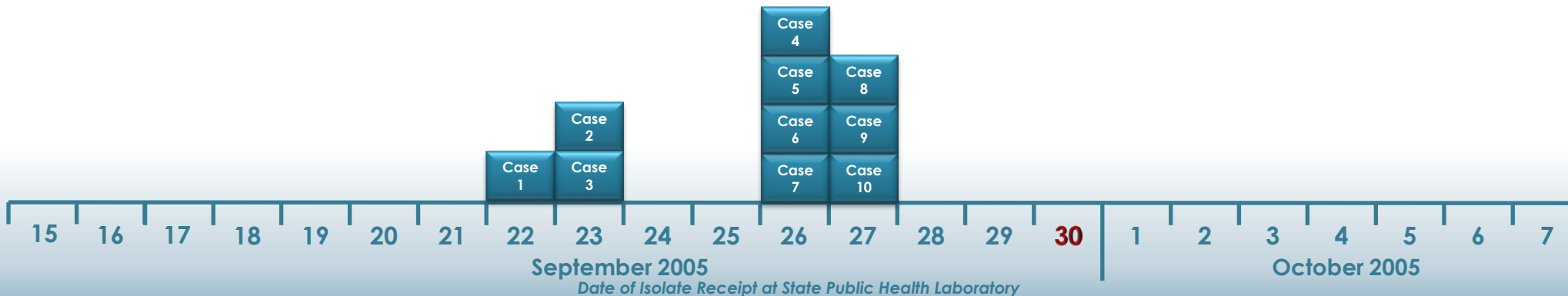
* OR = odds ratio

† CI = confidence interval

What would you do now?

- Is there enough information to issue a press release yet?
- Would you wait until you could confirm the vehicle by testing products that cases had leftover?

Move to the next page to see what the investigators were thinking...



SEPTEMBER 30 (DAY 4 OF INVESTIGATION)

The results of the community case-control study implicated Dole prepackaged salad as the likely outbreak vehicle.

Minnesota Department of Health

News Release

September 30, 2005

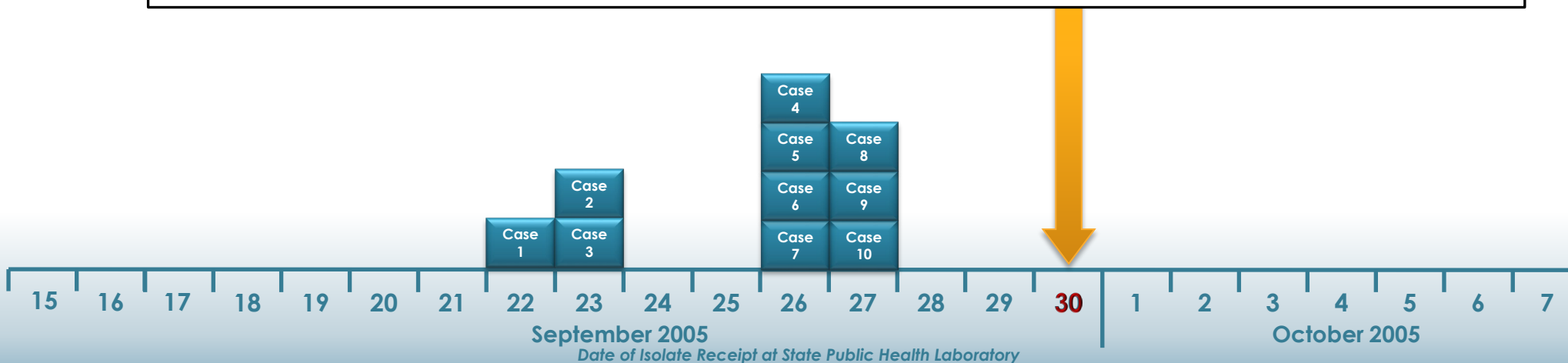
Contact information

Health officials investigate *E. coli* O157:H7 cases related to prepackaged lettuce mixes



Assessment:

A press release and health alert were issued by MDH, and the CDC and FDA were notified. FDA contacted Dole Food Company about the Minnesota findings.


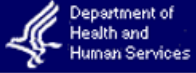


October 2 (DAY 6 OF INVESTIGATION)

As a result of the investigation in Minnesota, FDA issued a nationwide health alert to warn consumers, and Dole Food Company voluntarily recalled 245,000 bags of prepackaged lettuce salad.

This action took place 10 days after the receipt of the first O157 outbreak isolate.



 **U.S. Food and Drug Administration** 

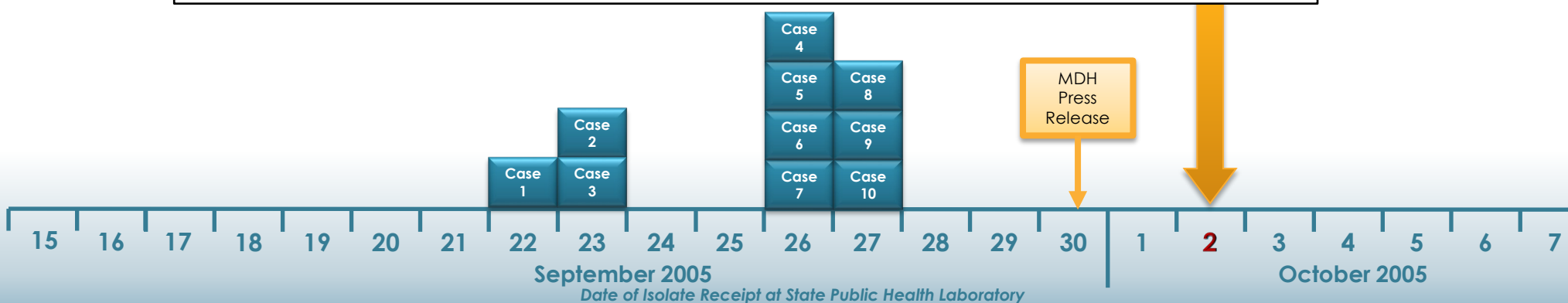
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FDA News

FOR IMMEDIATE RELEASE
P05-67
October 2, 2005

Media Inquiries:
Kimberly Rawlings, 301-827-6242
Consumer Inquiries:
888-INFO-FDA

FDA Issues Nationwide Health Alert on Dole Pre-Packaged Salads





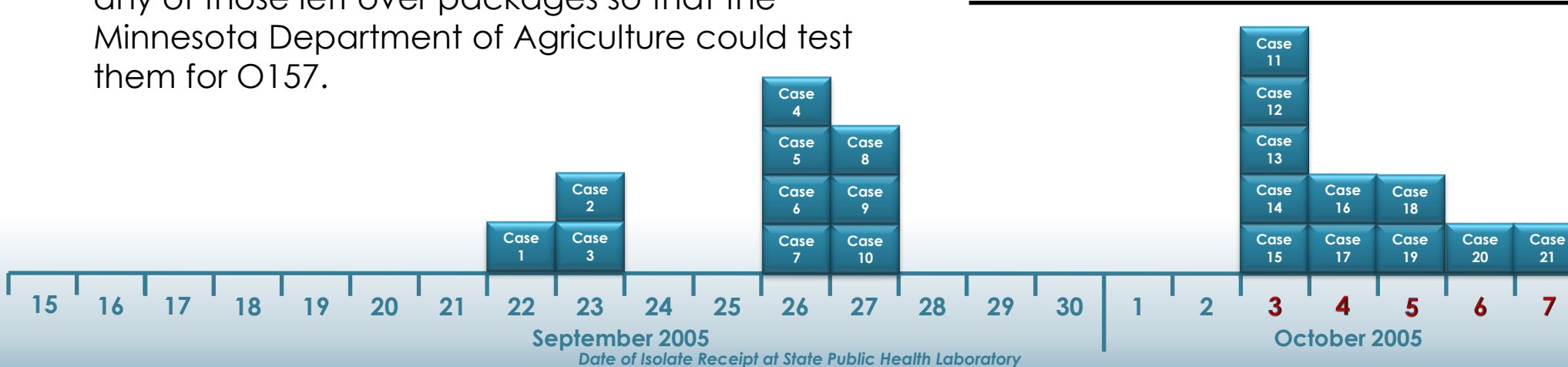
OCTOBER 3-7 (DAYS 7-11 OF INVESTIGATION)

Additional O157 isolates were being received by the MDH PHL, and many matched the outbreak PFGE pattern. These cases were still from exposures prior to the interventions.

Cases reported three varieties of Dole prepackaged salad: Classic Romaine, American Blend, and Greener Selection. All, however, contained romaine lettuce.

During interviews, we asked cases to provide production codes for any salad packages that could have been in use during the week before illness onset. In addition, we arranged to acquire any of those left over packages so that the Minnesota Department of Agriculture could test them for O157.

	No. of Cases	No. with Leftover Product Recovered
	21	11
 Other Varieties	6	1

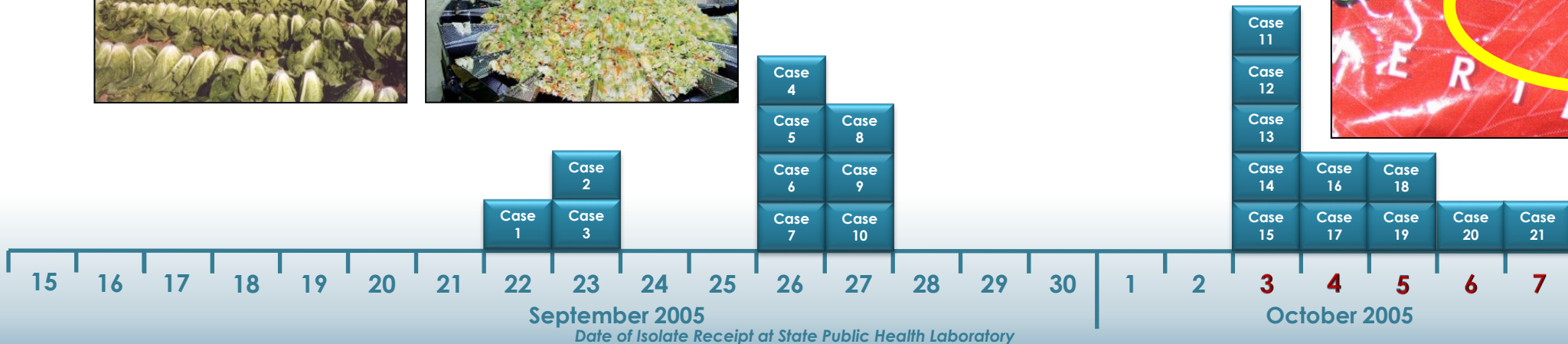
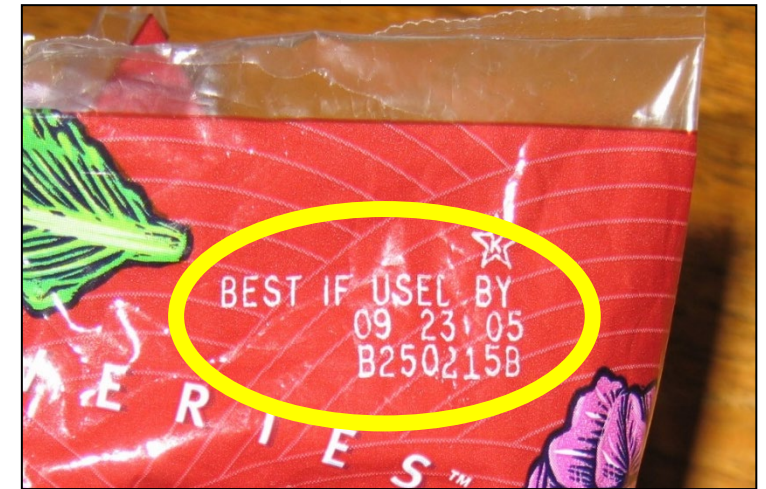


OCTOBER 3-7 (DAYS 7-11 OF INVESTIGATION)

Bags of leftover salad were recovered from 12 case households and submitted to the MDA Laboratory. All 11 bags of Classic Romaine had a best-if-used-by (BIUB) date of 09/23/05 and production codes beginning with "B250." These common production codes indicated the products had originated from a single Dole processing plant in Soledad, California on September 7, 2005 and were harvested from any 1 of 7 fields. The investigation team later determined that approximately 245,000 bags of the implicated varieties of Dole salad were distributed in September.

Within 60 hours of receipt, O157 was isolated from two bags of Classic Romaine salad. The isolate from the lettuce consumed at the Northwestern College class potluck was confirmed as the primary outbreak PFGE subtype. The second positive lettuce sample submitted by a confirmed case also yielded isolates that matched the outbreak strain.

Waiting for final product testing would have resulted in unnecessary additional exposure to the product among the public.



September 2005

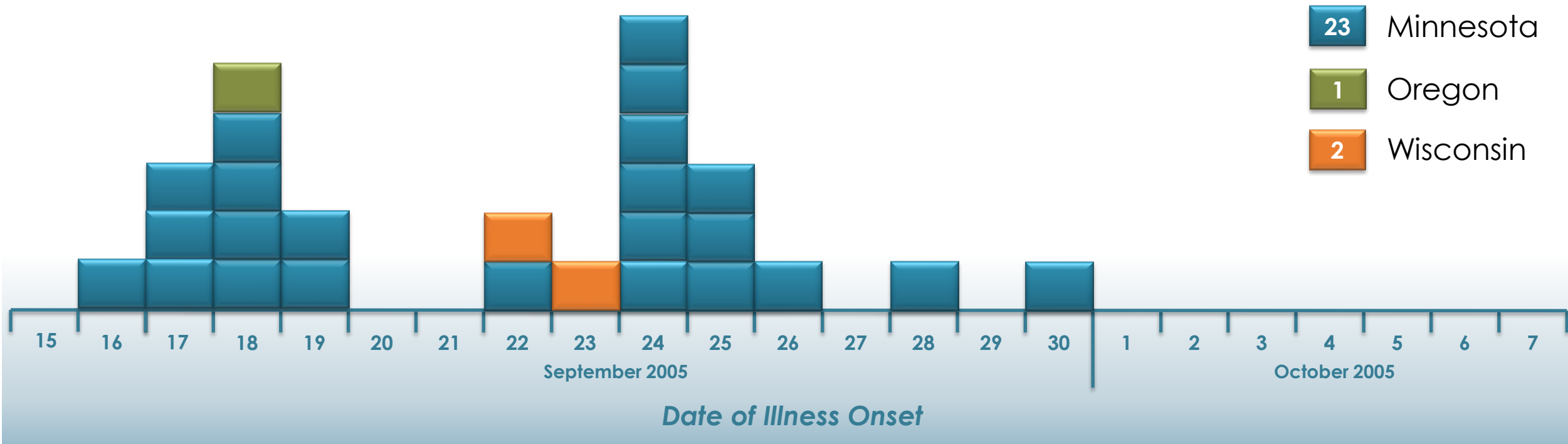
October 2005

Date of Isolate Receipt at State Public Health Laboratory

Final Outbreak Case Count

Overall, there were 26 cases identified in this outbreak: 23 in Minnesota, 2 in Wisconsin, and 1 in Oregon. The 2 cases in Wisconsin were not surprising, as Wisconsin and Minnesota often share the same food distribution networks. The Oregon case is slightly more curious, but illustrates the seemingly random nature of case geographic distribution that can be observed in outbreaks associated with widely distributed food products. The Oregon case did report consuming Dole Classic Romaine prepackaged salad.

Of the 26 outbreak cases, 12 (46%) were hospitalized, and 2 developed hemolytic uremic syndrome. No deaths occurred.



Regulatory Agency Response

On November 4, FDA sent the letter below (only the first few paragraphs shown) to the fresh and fresh-cut lettuce industry. Of note, O157 outbreaks associated with leafy greens had been a regular occurrence from 1995 to 2005. The letter contained such phrases as "...serious concern with continuing outbreaks," "We [FDA] believe that there are actions that can and should be undertaken immediately to address this issue" and "...it is clear that more needs to be done." Alas, even with this emphasis, 3 more prominent O157 leafy outbreaks occurred the very next year (2006), including the fresh spinach outbreak that resulted in over 200 cases, 31 HUS cases, and 3 deaths. Indeed, to this very day, O157 leafy greens outbreaks remain a prominent and intractable food safety challenge.



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CFSAN/Office of Plant and Dairy Foods
November 4, 2005

Letter to California Firms that Grow, Pack, Process, or Ship Fresh and Fresh-cut Lettuce

This letter is intended to make you aware of the Food and Drug Administration's (FDA's) serious concern with the continuing outbreaks of foodborne illness associated with the consumption of fresh and fresh-cut lettuce and other leafy greens. We also outline below what we plan to do and the actions that we expect your industry will take to enhance the safety of these products.

FDA is aware of 18 outbreaks of foodborne illness since 1995 caused by *Escherichia coli* O157:H7 for which fresh or fresh-cut lettuce was implicated as the outbreak vehicle. In one additional case, fresh-cut spinach was implicated. These 19 outbreaks account for approximately 409 reported cases of illness and two deaths. Although tracebacks to growers were not completed in all 19 outbreak investigations, completed traceback investigations of eight of the outbreaks associated with lettuce and spinach, including the most recent lettuce outbreak in Minnesota, were traced back to Salinas, California.

Because these products are commonly consumed in their raw state without processing to reduce or eliminate pathogens, the manner in which they are grown, harvested, packed, processed, and distributed is crucial to ensuring that microbial contamination is minimized, thereby reducing the risk of illness to consumers. In 1998, the FDA issued guidance to industry entitled "[Guide to Minimize Microbial Food Safety Hazards for Fruits and Vegetables](#)." This Guide recommends good agricultural practices (GAPs) and good manufacturing practices (GMPs) that growers, packers, and shippers may undertake to address common risk factors in their operations, and thereby minimize food safety hazards potentially associated with fresh produce.

Epilogue: Community Case-Control Studies: an Obsolete Practice?

In this outbreak, way back in 2005, we conducted a traditional community case-control study. As most of you know, recruiting appropriate age-group controls from the same geographical area as cases can be extremely time and labor intensive, and suffers from the challenge of rapidly declining land-line telephone use. Was it necessary for us to have done this case-control study in this investigation? Would we do the same thing if the outbreak occurred today?

While having the case-control study results did give us additional confidence to act quickly and issue press before we had lab results on the left-over salad packages, it wasn't necessarily the most important factor. Even without the control group data, we knew that all of the initial cases were exposed to Dole prepackaged salad with Romaine lettuce in it (1 case did not report eating it but her family did). We also had the sub-cluster cohort – statistical results were inconclusive but the food exposures were limited, the lettuce was the most likely culprit among them, and the type of lettuce served was Dole Classic Romaine, the same exact brand and variety named by the majority of cases who were not part of the sub-cluster. Finally, production information from left over salad packages, when available, indicated the same production date.

Today, we most likely would **not** have conducted the community case-control study, and that seems to be the trend in the foodborne disease epidemiology community in the United States. If we need more than the case-control study results to implement a public health intervention anyway, why commit all of those personnel and time resources? Whether or not we conduct the traditional case-control study, we still need to confirm our hypothesis using other tools, namely strong sub-cluster investigations and obtaining compelling traceback information (and food testing results in some instances, if we are quick enough to identify and acquire food for testing before it is all gone).

In today's world, using a binomial probability model to tell us whether the frequency of prepackaged salad or Romaine lettuce consumption reported by initial cases is unusual, and thus worth investigating further, would be used in the same way as the community case-control study was back in 2005. Read on to see what that would have looked like in the context of this outbreak.

The Binomial Probability Model

To create our binomial probability model, we first need an estimate of the background consumption rate of the food item of interest. Shown below are some values from sporadic O157 cases in Minnesota, along with Minnesota and national FoodNet population survey data from 2006-2007 (<http://mnfoodsafetycoe.umn.edu/wp-content/uploads/2016/10/Background-Population-Exposure-Estimates-E.-coli-O157.pdf>). We could use prepackaged salad or Romaine. To be conservative, let's take the highest %, which is the national value for Romaine consumption, 47%. Read on to see how this value is used.

VEGETABLES

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Prepackaged salad	770	22%	28%	24%	20%	18%	28%	22%	24%	21%	23%	29%	37%	39%
Iceberg	768	29%	35%	31%	27%	22%	36%	38%	28%	30%	27%	30%	44%	46%
Romaine*	512	21%	28%	25%	18%	14%	28%	39%	18%	20%	25%	23%	39%	47%
Leaf lettuce**	172	12%	17%	11%	12%	12%	12%	8%	0%	9%	11%	40%	N/A†	N/A†
Salad greens**	177	5%	9%	7%	3%	2%	9%	8%	0%	5%	6%	7%	N/A†	N/A†
Other lettuce/leafy greens (red leaf, radicchio, mesclun, endive)*	512	7%	10%	9%	4%	4%	11%	7%	7%	6%	7%	10%	N/A†	N/A†
Spinach	772	12%	16%	13%	10%	8%	16%	13%	13%	9%	13%	23%	20%	24%
Cabbage	771	9%	12%	8%	10%	5%	12%	20%	11%	8%	10%	6%	23%	28%
Tomatoes	771	38%	43%	39%	38%	29%	45%	67%	37%	34%	45%	43%	49%	60%
Cucumbers	768	21%	24%	25%	16%	16%	22%	38%	15%	19%	25%	18%	39%	47%
Peppers (green, yellow, red, jalapeno, serrano)	768	22%	26%	23%	22%	16%	29%	27%	23%	20%	22%	33%	N/A†	N/A†
Asparagus	767	6%	8%	5%	6%	3%	8%	11%	14%	4%	6%	6%	18%	21%
Celery	769	15%	20%	18%	12%	10%	18%	33%	25%	13%	14%	15%	43%	42%
Carrots	770	44%	49%	47%	40%	41%	42%	65%	47%	39%	50%	44%	N/A†	N/A†
Radishes	767	5%	6%	5%	5%	2%	6%	21%	8%	6%	4%	4%	N/A	N/A
Pea pods/snap peas	767	8%	10%	8%	7%	7%	8%	5%	2%	8%	8%	10%	N/A	N/A
Onions (red, white, yellow)	769	43%	48%	44%	42%	32%	54%	61%	49%	41%	44%	51%	67%	71%
Green onions/scallions	760	5%	9%	6%	5%	3%	6%	15%	4%	6%	4%	8%	23%	30%
Broccoli	770	25%	31%	25%	24%	23%	25%	32%	28%	22%	28%	27%	45%	53%
Cauliflower*	511	11%	14%	12%	10%	8%	13%	21%	13%	8%	15%	3%	25%	23%
Sprouts (alfalfa, bean, radish, clover)*	512	2%	3%	2%	2%	2%	3%	0%	5%	2%	1%	3%	N/A†	N/A†



The Binomial Probability Model (continued)

Plug the background consumption rate of 47% into the model. We had 10 cases in our case-control study, so then enter 10 into sample size. Remember that we determined that 9 of those 10 ate Romaine lettuce (as part of their Dole prepackaged salad) – the probability of that happening by chance, given the background consumption rate we have chosen, is 0.0065.

This tells us that this food item is worth investigating further using our other tools. Go to this link if you are interested in reading more about the practical use of this method: <http://mnfoodsafetycoe.umn.edu/wp-content/uploads/2018/12/Key-Points-Binomial-Final.pdf>

	# cases with exposure	% cases with exposure	Cumulative Probability	Cumulative Probability (exponential)	P (exactly that many hits)
	10	100%	0.0005	5.260E-04	0.00053
sample size	9	90%	0.0065	6.457E-03	0.00593
10	8	80%	0.0366	3.656E-02	0.03010
	7	70%	0.1271	1.271E-01	0.09051
	6	60%	0.3057	3.057E-01	0.17861
background rate	5	50%	0.5474	5.474E-01	0.24170
47.0%	4	40%	0.7745	7.745E-01	0.22713
	3	30%	0.9209	9.209E-01	0.14635
	2	20%	0.9827	9.827E-01	0.06189
	1	10%	0.9983	9.983E-01	0.01551
	0	0%	1.0000	1.000E+00	0.00175

How Else Might this Investigation Look Different in 2019?

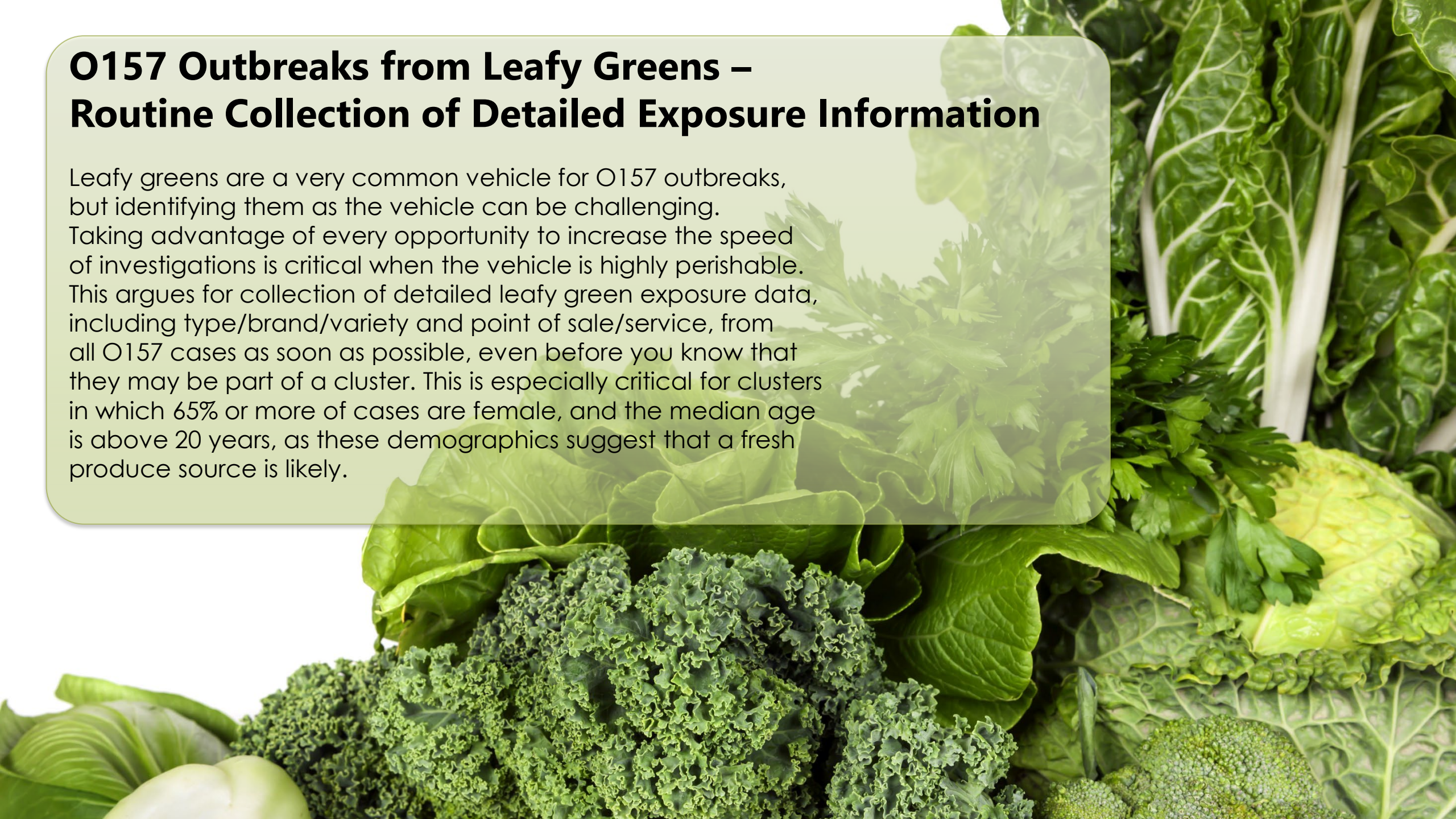
In March 2019, whole genome sequencing (WGS) replaced PFGE as the standard molecular subtyping method for O157. Because this outbreak was caused by a rare PFGE subtype, WGS wouldn't have provided much, if any, additional discrimination or advantage (but it certainly would if the PFGE subtype was more common).

If the outbreak happened today, WGS would actually have resulted in a temporary delay, as it can take around a week longer than PFGE to get results back. Without the WGS results at hand when conducting initial interviews of cases means that investigators will not know whether they are part of a molecular subtype cluster. Therefore, it will be increasingly critical to apply traditional “shoe leather” epidemiologic approaches to detect potential outbreaks before subtyping results are available. For example, investigators should pay particular attention to unusually high case counts, along with temporal and geographic clustering, to determine whether an outbreak might be occurring, and compare interviews accordingly.

Aside from swapping out the community case-control study for the binomial approach, the rest of this investigation likely would have gone down much the same. Getting detailed exposure info quickly identified a sub-cluster, and we still would have done an analytic study for that sub-cluster (read more about sub-cluster investigations: <http://mnfoodsafetycoe.umn.edu/wp-content/uploads/2014/10/Key-Points-Investigating-Restaurant-Subclusters3-FINAL.pdf>). Aggressive collection of production information from left over product packages, along with the product itself for testing, would also still be done.

O157 Outbreaks from Leafy Greens – Routine Collection of Detailed Exposure Information

Leafy greens are a very common vehicle for O157 outbreaks, but identifying them as the vehicle can be challenging. Taking advantage of every opportunity to increase the speed of investigations is critical when the vehicle is highly perishable. This argues for collection of detailed leafy green exposure data, including type/brand/variety and point of sale/service, from all O157 cases as soon as possible, even before you know that they may be part of a cluster. This is especially critical for clusters in which 65% or more of cases are female, and the median age is above 20 years, as these demographics suggest that a fresh produce source is likely.



Summary of Key Investigation Lessons:

- The PFGE subtype of isolates in this cluster was very rare, which indicated that this cluster indeed represented a common source outbreak, thus warranting aggressive follow-up. In 2019, whole genome sequencing will replace PFGE subtyping.
See: [CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 4.2.9.2](#)
- The epidemiologic curve and demographic characteristics of the cases can give clues to the vehicle. In this outbreak, these things suggested a fresh produce vehicle.
See: CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 4.2.4
- Obtaining detailed product information (e.g., brand, variety, purchase/service location) during initial interviews was critical to rapid identification of the vehicle. This is often especially true for commonly eaten food items like lettuce.
See: [CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 4.2.9.3.2](#)
See: [CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 4.2.10.3](#)
- Anytime a sub-cluster is identified in an outbreak, aggressive follow-up is warranted, as it may provide information leading to a swifter conclusion. Analytic studies should be conducted whenever possible.
- In lieu of traditional community case-control studies, analytic approaches like binomial model comparisons using background food consumption rates can be used to quickly assess potential associations between reported foods and illness, and whether further efforts should be expended to confirm a hypothesis (e.g., through tracebacks, food testing).
See: [CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 5.2.4.1.5](#)
- Traceback investigations can be used to increase the specificity of generic commodity exposures reported by cases (in this instance, production information from salad packages was key), and to confirm hypotheses in foodborne outbreak investigations.
See: CIFOR Guidelines for Foodborne Disease Outbreak Response Chapter 5.2.4.1.7 and White Paper on Product Tracing in Epi Investigations

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