



Outbreak of *Salmonella* Saintpaul infections associated with multiple produce items: investigation and preliminary findings

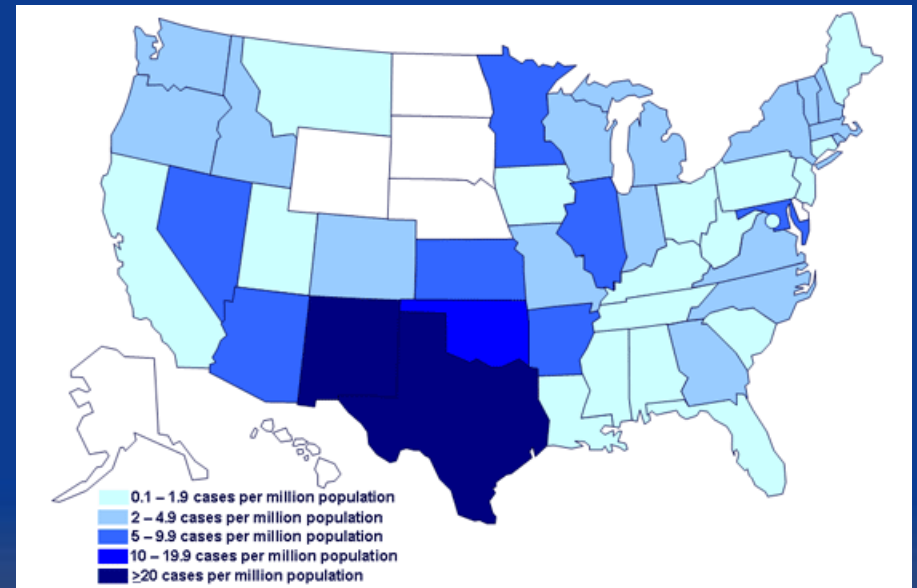
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Outbreak of *Salmonella* Saintpaul infections associated with multiple produce items

- 1,442 persons were infected
- 286 persons were hospitalized
- Cases were distributed among 43 states, District of Columbia, and Canada
- Illnesses began between April 16 and August 11, with most cases in May or June
- The outbreak was the largest U.S. foodborne outbreak in the last 10 years and one of the largest U.S. outbreaks of *Salmonella* infection ever



Cases infected with the outbreak strain, by state, as of August 25, 2008

Public health infrastructure in the United States

- County or city health department
 - The front line of public health
- State health department
 - Epidemiologists, laboratorians, and sanitarians
- Federal agencies
 - CDC: risk identification
 - FDA, USDA, EPA: risk management, regulation

Tiered response to emergencies: CDC provides coordination and support to States



Stages of an outbreak investigation



Stage 1:
Detecting a cluster in the first place



Stage 1: Detecting a cluster in the first place

- Most outbreaks are recognized as a result of:
 - Consumer complaint
 - Information from a healthcare provider
 - Information from strain typing networks (PulseNet)
 - News media reports



What is PulseNet ?

- National network of >75 federal, state, and local public health laboratories
- Perform standardized molecular typing of foodborne disease-causing bacteria by pulsed-field gel electrophoresis (PFGE)
- DNA “fingerprints” are shared and stored in a central database at CDC
 - available on demand to participants
- When a cluster of strains with matching patterns is identified, epidemiologists are notified



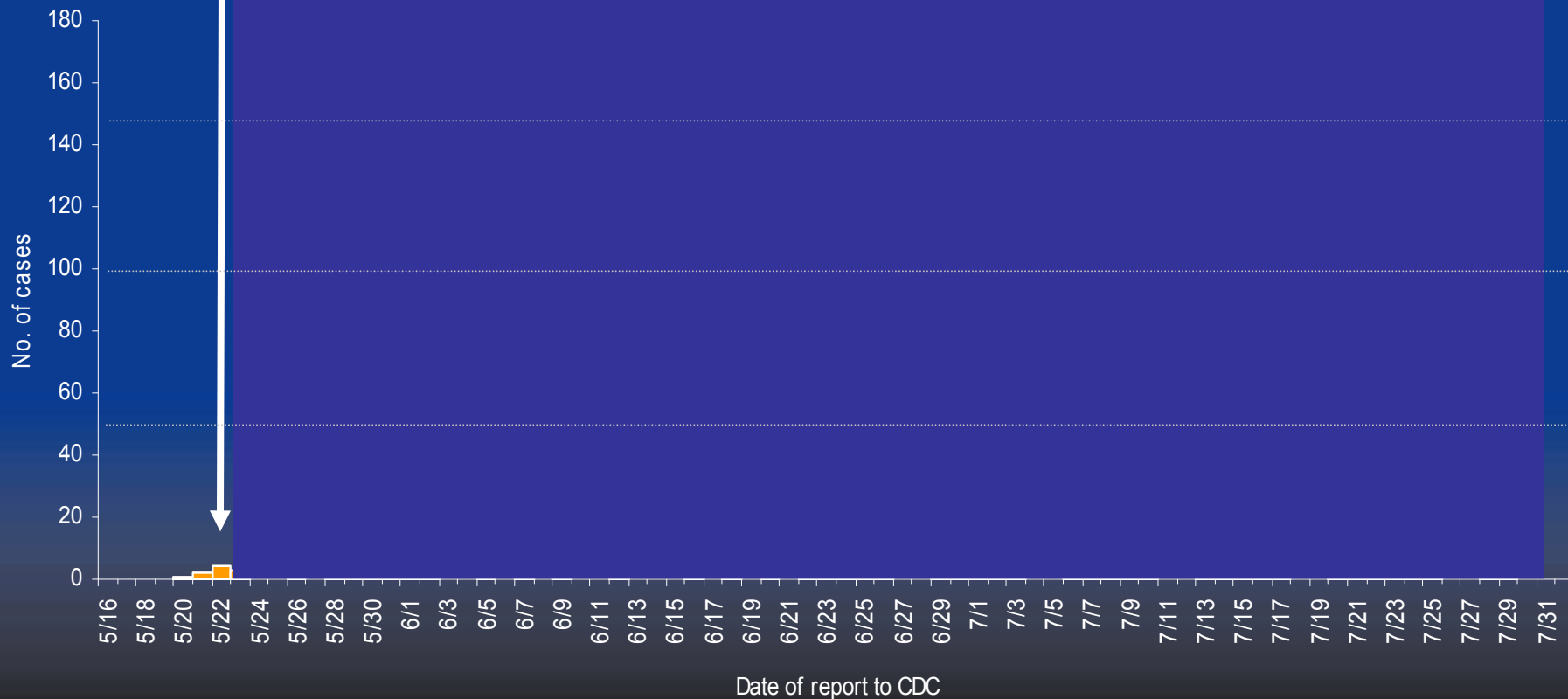
What is PulseNet ?

- If epidemiologic links are found between cases in a cluster, then the cluster is classed as an outbreak
- Molecular subtyping has enabled us to detect dispersed outbreaks of foodborne illness that would otherwise be missed
- There is an inherent delay between the date that an illness starts and the date that the case is reported to public health authorities
 - 2-3 weeks for *Salmonella* infections

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008



Detection of outbreak



Detection of *Salmonella* Saintpaul outbreak



- May 22: New Mexico Department of Health notifies CDC that a cluster of 19 *Salmonella* cases is under investigation
 - Specimen collection dates: 05/08 to 05/20
 - Serotyping completed on 7 isolates: all *Salmonella* Saintpaul
 - PFGE completed on 4 isolates: all had identical *Xba*I patterns
 - PFGE patterns posted to PulseNet
- May 23: More PFGE matches to outbreak strain identified
 - Colorado: 1 case with 04/26 isolation date
 - Texas: 2 cases with 05/08 and 05/10 isolation dates



Salmonella serotype Saintpaul



- Rare serotype:
 - ~400 reported cases per year
 - Outbreak PFGE pattern observed ~25 times a year
 - Outbreak pattern observed 6 times between April 1 – June 30, 2007
- 19 confirmed or suspected outbreaks identified during 1998 through 2006



Stages of an outbreak investigation



Stage 1:
Detecting a cluster in the first place

Surveillance

Epidemiologic investigations

Stage 2:
Generating hypotheses

Stage 3:
Testing hypotheses

Stage 4:
Reconstructing how and where contamination could have occurred

Prevention measures

Targeted applied research





Stage 2: generating hypotheses



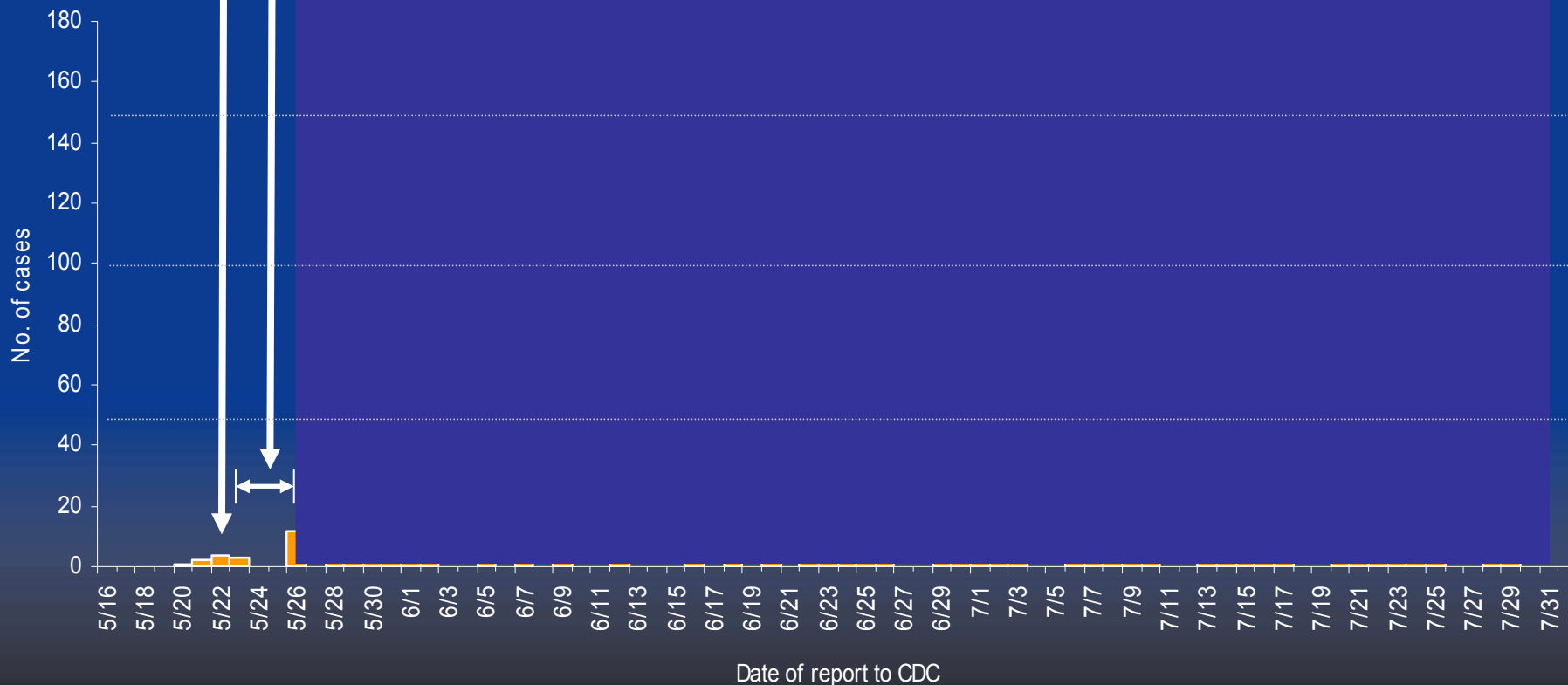
- Even when the source(s) and route(s) of exposure appear obvious at the outset, the obvious answer may be incorrect
- Intensive open-ended interviews of cases (or their surrogates) are often used to identify all relevant exposures during the week before illness began
- A food product is not the source of all outbreaks!

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008



Detection of outbreak

Hypothesis generating interviews





Stage 2: generating hypotheses



- Interviews conducted with 19 ill persons
- Data collected included:
 - Attendance at gatherings; travel; daycare contact; contact with reptiles, pets, and pet treats; contact with farms and farm animals; types and sources of drinking water; history of swimming; eating at restaurants and other venues
 - Consumption of ~ 200 specific food items
 - General categories of dairy, eggs, meat, poultry, seafood, fresh vegetables, fresh fruits, and frozen foods
 - How the food was prepared; the type, variety, or brand; the date eaten; the date purchased; and the store or restaurant where purchased or eaten
 - Open-ended questions about all foods eaten and location of each meal (home or outside of home) for the 5 days before illness began

Results of hypothesis generating interviews

- Raw tomatoes were the most commonly consumed item
 - 84% (16/19) of persons
- Other commonly consumed food items:
 - Milk (74%), chicken (71%), potatoes (68%), eggs (63%); salsa (63%), cold breakfast cereal (58%), raw onion (58%), tortillas (58%), ice cream (55%), and iceberg lettuce (53%)
 - Guacamole (32%), avocado (32%), and cilantro (16%)
- Data not collected specifically on jalapeño peppers
 - 26% of persons reported consuming green bell pepper, none reported red bell pepper, and 28% reported “other peppers”
- Interviews suggested raw tomatoes or one of the other common food items were a possible source of illnesses

Stages of an outbreak investigation



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Testing hypotheses

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Prevention measures

Targeted applied research



Stage 3: Testing hypotheses



- The goal is to assess the relationship between a given exposure and the illness under investigation
- This is done by measuring the statistical association of illness with each exposure
- Two structures of investigation
 - Illness in cases and controls: interview the ill persons (cases) and comparable persons who remained well (controls) about preceding exposures
 - Illness in a defined group (cohort) after an event: interview the whole group about exposures and subsequent illness



Stage 4: Reconstructing how and where contamination could have occurred



- Details of implicated food needed:
 - When and where was it prepared?
 - Details on purchase, brand, lot number of the food
 - Judgment needed: did contamination occur in final kitchen or before?
- If contamination earlier in distribution is likely, trace the food item from different cases back through distribution chain to point where they converge
 - Precision of trace-back depends on invoices, company records and cooperation, and probability
 - Accurate exposure history is critical
- If data converge, does trace-forward from point of convergence explain other cases?

Limitations of the epidemiological method

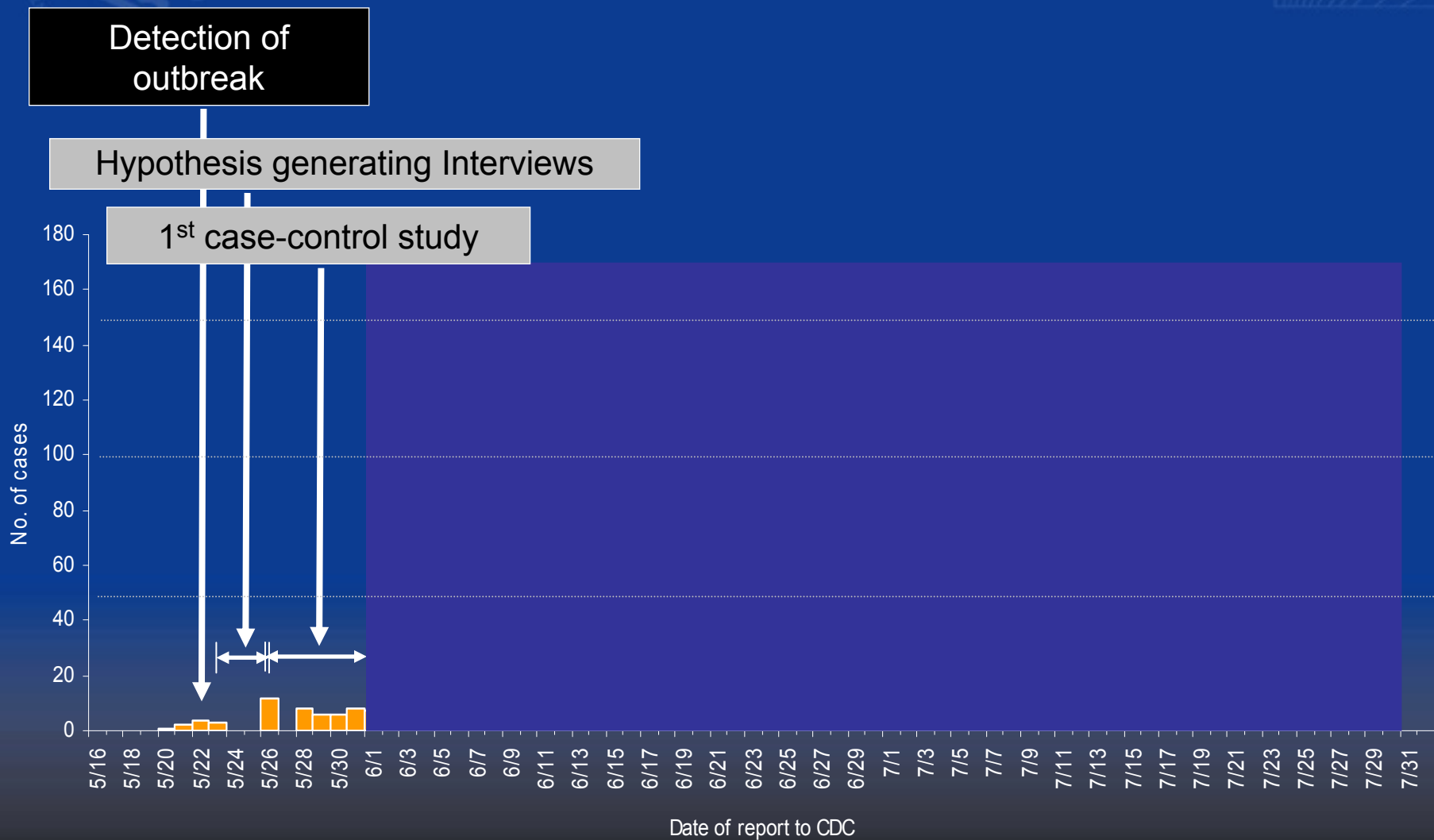
- Depends on information a person knows – if they are not aware of exposure they cannot report it
- Needs sufficient number of cases and controls to achieve statistical power
- If the correct hypothesis is not considered, it may not be found – may need to repeat the process
 - Partial trace-back may be required to test hypotheses
- Implicates the food eaten – not necessarily the original source
- Spurious associations are possible:
 - By chance alone, (probability) or
 - Because the implicated food is connected to the unrecognized true source (confounding)

Laboratory testing of food in an outbreak investigation



- Can provide convincing evidence implicating or exonerating a particular food item
- Can be critical if the number of patients is small, and statistical power of epidemiologic investigation is low
- Can fail to detect the pathogen in the implicated product if:
 - The actual food that caused the outbreak has been consumed, and thus was not collected
 - The food that caused the outbreak was overlooked when samples were collected
 - Contamination is variable within the food
 - The pathogen does not survive long in the food
 - The test is insensitive

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008





Case-control study 1 – methods



- Conducted by NM and TX Departments of Health, Navajo Nation, and Indian Health Service in collaboration with CDC
- Questionnaire included all food items reported by $\geq 50\%$ of ill persons in hypothesis generating interviews
 - Tomatoes, eggs, ice cream, potatoes, milk, tortillas, cold breakfast cereal, raw onion, salsa, ground beef, chicken, and lettuce
- Included avocado and guacamole though consumed by $< 50\%$



Case-control study 1 – results

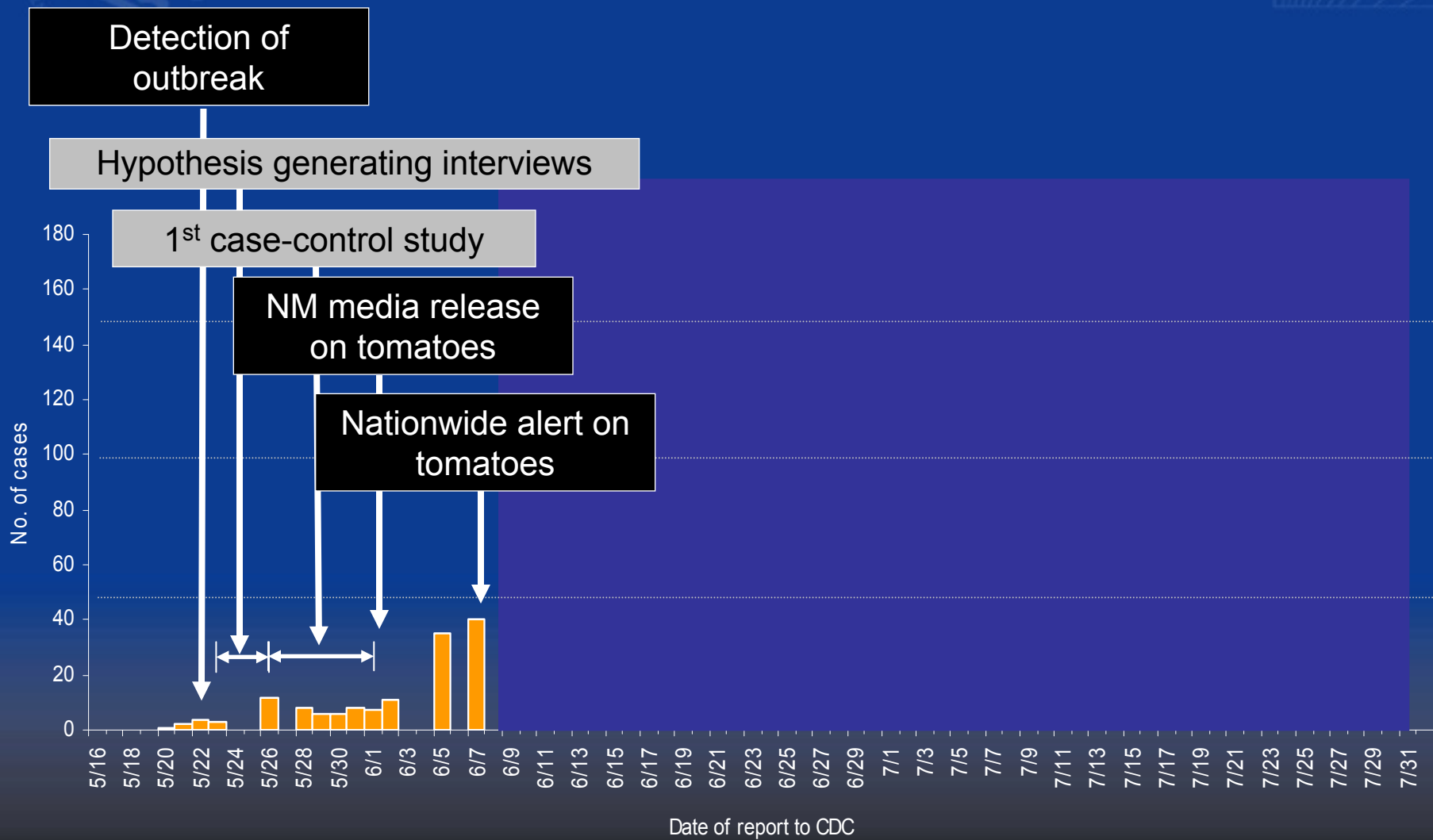
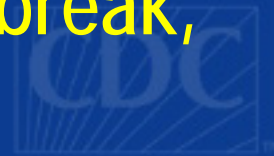


- 51 cases and 106 matched controls enrolled
- Consumption of raw tomatoes significantly associated with illness
 - 88% of cases compared with 64% of controls (OR = 6.7, 95% CI: 1.9 - 36.0, $p < 0.001$)
- Salsa consumption NOT associated with illness
 - 56% of cases compared with 45% of controls ($p = 0.22$)
- Guacamole consumption NOT associated with illness
 - 32% of cases compared with 25% of controls ($p = 0.35$)

Case-control study 1 – results continued

- In multivariable analysis
 - Consumption of raw tomatoes was independently associated with illness
 - Illness was associated with consumption of raw tomatoes independent of consumption of tomatoes in salsa, guacamole, or pico de gallo
 - No other food items were associated with illness
- Type of tomatoes associated with illness could not be determined
 - Most cases could not identify the type of tomato consumed
 - Among case-patients with single or limited tomato exposures Roma and round red tomatoes commonly consumed

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008



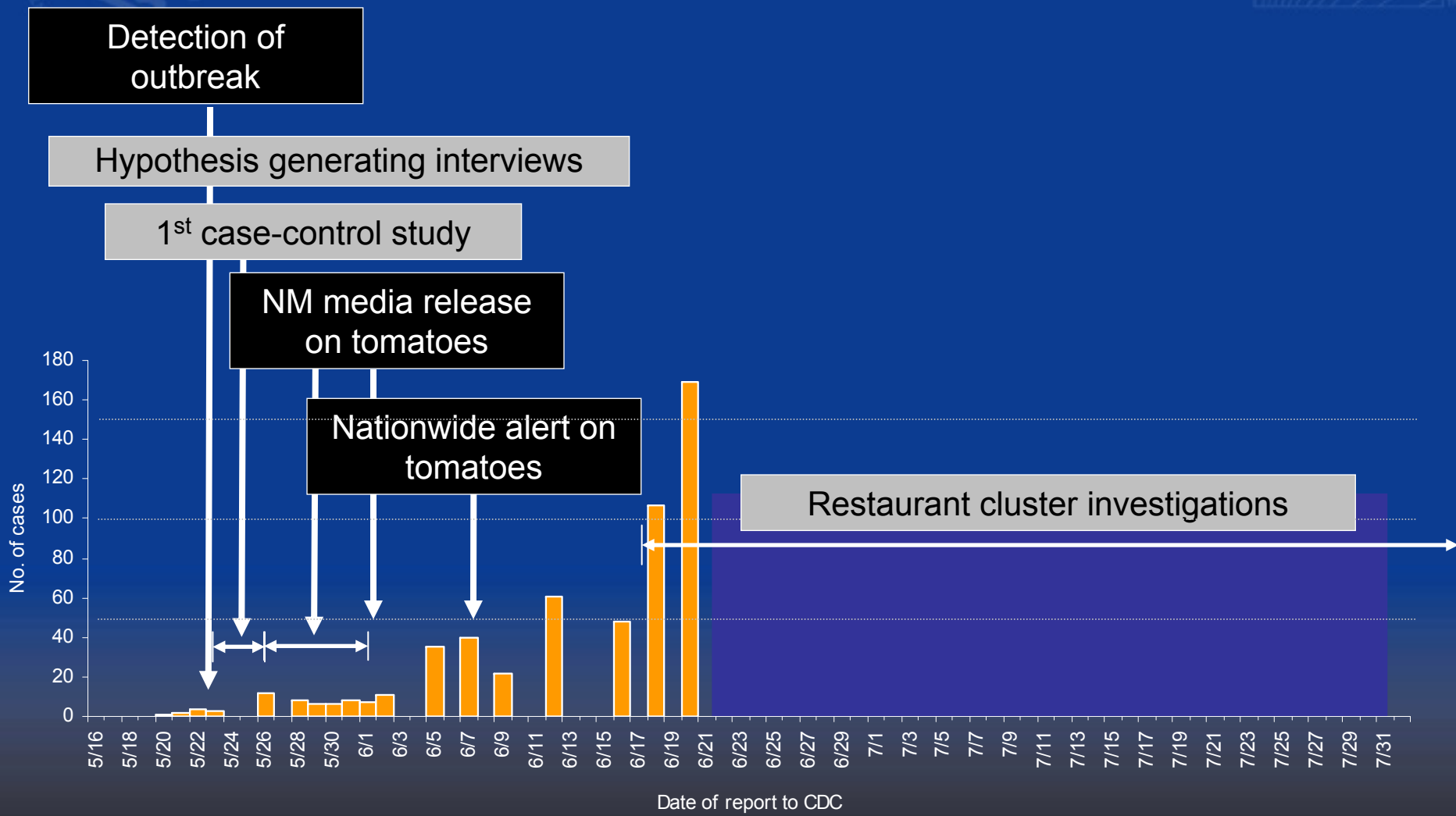
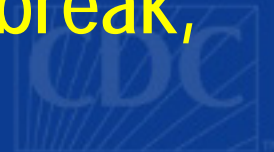
Continued investigations: early-June, 2008

- Ill persons identified after the conclusion of the first case-control study continued to be interviewed
 - 105 ill persons outside TX and NM interviewed by early-June
 - 83% (87/105) reported consumption of raw tomatoes in the week before their illness began
 - Significantly higher than among persons in the 2006-2007 FoodNet Population Survey (70%, $p = 0.002$)
- Preliminary conclusion:
 - Data through early June suggested that *Salmonella* Saintpaul infections with the outbreak strain were associated with consumption of raw tomatoes

Continued investigations: mid-June, 2008

- Increasing number of cases reported
- Clusters in restaurants and at events identified
 - Defined as 2 or more persons attending a common event
 - Facilitated identification of an implicated food item and examination of specific ingredients
 - Facilitated traceback of suspect items

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008



Three restaurant cluster investigations



- Texas: Mexican-style restaurant
 - 47 cases and 36 controls (well meal companions)
 - Illness significantly associated only with eating salsa: OR=62.3 (95%CI 12.4 – 632.1)
 - Salsa contained raw tomatoes and raw jalapeño peppers
- Texas: Mexican-style restaurant
 - 33 cases and 62 controls
 - Illness only associated with salsa: OR=7.5 (95%CI 1.1 – inf)
 - Salsa contained canned tomatoes and raw jalapeño peppers
- Minnesota: Natural food restaurant
 - 19 cases and 73 controls
 - Garnish associated: OR=62.0 (95%CI 12.0 – 321.0)
 - Garnish included raw pre-diced jalapeño peppers

Three restaurant cluster investigations

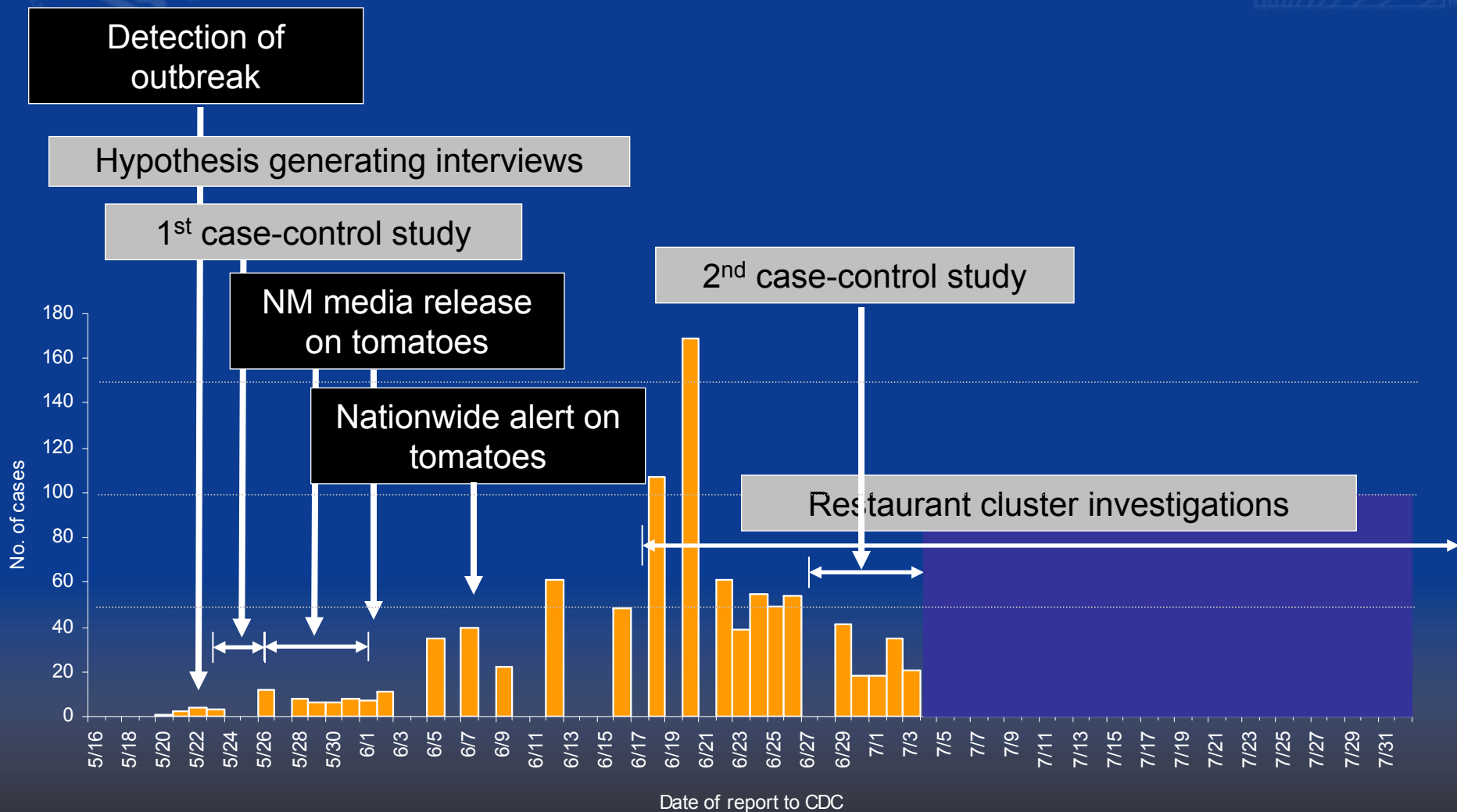
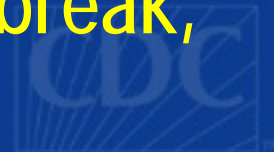


- Preliminary conclusion:
 - Raw jalapeño peppers were the likely source in 2 clusters and common in all 3 clusters
 - Raw tomatoes could explain no more than one cluster

Other restaurant/event cluster investigations

- ~30 restaurant/event clusters identified
 - ~85% involved Mexican style restaurants
 - Median size of cluster = 4 persons
 - ~80% had ≤ 10 lab confirmed cases
 - 12 analytical epidemiologic studies conducted
 - Raw jalapeño peppers not served in 4 restaurants, serrano peppers not served in 19 restaurants, raw tomatoes served in all restaurants
- Preliminary conclusion:
 - Jalapeño peppers cannot explain all the clusters
 - Raw tomatoes or serrano peppers are a likely source

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008





Case-control study 2 – methods



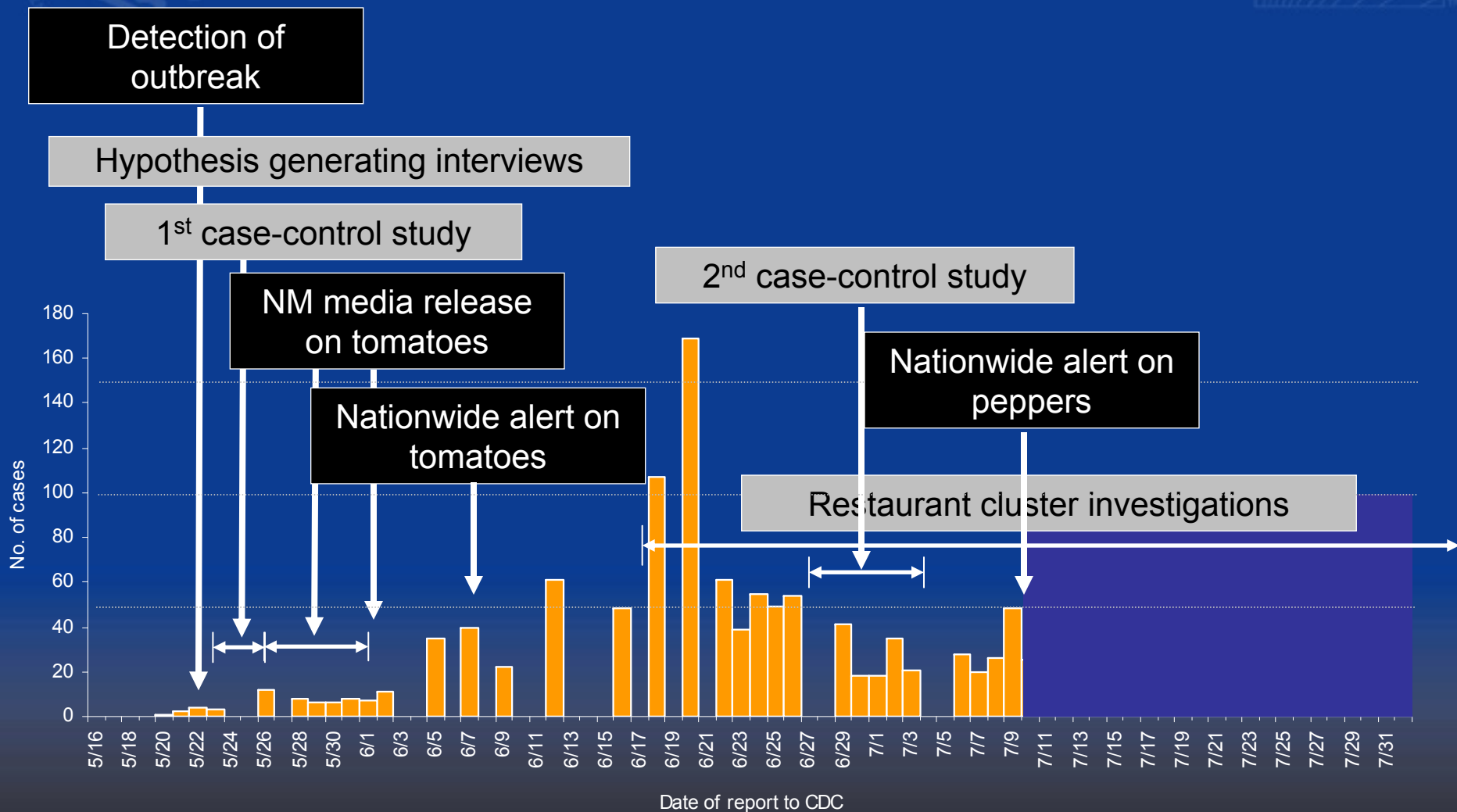
- Undertaken to determine whether illness was associated with consuming:
 - Food from a Mexican-style restaurant
 - Produce items including freshly made salsa, fresh jalapeño peppers, fresh cilantro, and fresh tomatoes in a restaurant, at an event, or at home

Case-control study 2 – results



- 141 cases and 281 matched controls
- Illness was significantly associated
 - with eating at a Mexican-style restaurant: 49% of cases compared with 23% of controls (OR= 4.6, 95% CI: 2.05 – inf, $p < 0.0001$)
 - with consumption of pico de gallo (OR=4.0), corn tortillas (OR=2.3), and fresh salsa (OR=2.1)
- Analysis by ingredient indicated a statistical association with several food items often eaten together including tomatoes, jalapeños, and cilantro, but could not distinguish clear independent risk for any one

Graphic timeline of *Salmonella* Saintpaul outbreak, May 22–August 1, 2008





Case-control study 3 – methods



- Conducted in New Mexico, Arizona, and the Navajo Nation, July 11 – 25
- To collect in-person detailed information from case and control households about how 4 suspect food items (cilantro, jalapenos, serranos, and tomatoes) are brought into, stored, and prepared in the home



Case-control study 3 – results



- 41 case households and 107 matched controls
- Illness was significantly associated with having raw jalapeño or serrano peppers in the household during the week before illness onset
- Preliminary conclusion: Raw jalapeño and perhaps serrano peppers were a likely source for illness among cases occurring after June 1, 2008 not associated with restaurant clusters

Stages of an outbreak investigation



Trace-back and environmental assessment: tomatoes



- Trace-back of tomatoes associated with several ill persons did not converge onto a single packer, distributor, or growing area
- Tomatoes linked to ill persons and tomatoes randomly collected from the distribution chain in several states were cultured, but *Salmonella* was not isolated

Trace-back and environmental assessment: peppers

Texas restaurant cluster



Distributor in McAllen, TX = jalapeño sample with outbreak strain



Packing facility in Mexico



Farm A in Mexico

- Jalapeño sample with outbreak strain found in McAllen, TX likely grown here
- Grows jalapeño, serrano peppers, and Roma tomatoes

Farm B in Mexico

- Serrano pepper and irrigation water sample with outbreak strain
- Grows jalapeño and serrano peppers, but not tomatoes



Provisional conclusions

- Epidemiologic data and environmental investigations indicated illnesses were associated with more than one produce item
 - Tomatoes: 1st case-control study, 2nd case-control study*, and cluster investigations
 - Jalapeño peppers: Cluster investigations, 2nd case-control study*, 3rd case-control study, and lab result
 - Serrano peppers: Cluster investigations, 3rd case-control study, and lab result

* Supported in univariate, not multivariate analysis



Provisional conclusions

- Produce item associated with illness may have changed over the course of the outbreak
- Early investigation showed a strong association between illness and eating tomatoes
 - Association independent of salsa and guacamole
 - Traceback of a culture-positive jalapeño pepper sample led to a farm in Mexico that also produced tomatoes
- Some restaurant clusters can be explained by jalapeño peppers; serrano peppers are a likely source in others; some not explained by either



Final comments



- The entire outbreak cannot be entirely accounted for by any one food item, neither tomatoes, nor jalapenos, nor serranos
- The common source for the illnesses may not be a single produce item, but likely a location where more than one produce item was contaminated
- The outbreak highlighted the recurrent and important problem of outbreaks due to fresh (including imported) produce



Thank you for your attention



This is an ongoing investigation. Future correspondence or reports might present results, interpretations, and recommendations that differ from those contained in this presentation.

The interpretations and recommendations in this presentation are those of the author, and do not necessarily represent the views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

Case-control study 1 – methods continued



- Case: illness that began after April 1, 2008 in a person with the outbreak strain of *Salmonella* Saintpaul or for whom the PFGE was pending
- Control: matched to cases by geographic location and age using two categories: <18 years and \geq 18 years old

Case-control study 2 – methods continued



- Case: Illness that began on or after June 1, 2008, in a person with the outbreak strain of *Salmonella* Saintpaul
- Control: Matched to cases by geographic location and age using two categories: <18 years old and ≥ 18 years old

Case-control study 3 – methods continued

- Case household: Household where there was a diarrheal illness with the outbreak strain of *Salmonella* Saintpaul on or after June 1, 2008
- Control household: Well households matched to case households by geographic location and age using two categories: <18 years and \geq 18 years old