

Acute Communicable Disease Control

Special Studies Report

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**FACTORS LEADING TO PROLONGED CAPTURE TIMES FOR
BRUCELLOSIS CASE REPORTS
LOS ANGELES COUNTY, 2001–2005**

BACKGROUND

Brucellosis is a zoonotic bacterial disease found world wide in several animal hosts, occasionally infecting humans. Across the globe there are an estimated 500,000 human infections per year with most reported cases occurring in Syria, followed by Mongolia, Kyrgyzstan, and Iraq [1]. *Brucella* species that are pathogenic for humans are found in cattle (*B. abortus*), goats and sheep (*B. melitensis*), pigs (*B. suis*), and dogs (*B. canis*), with *B. melitensis* and *B. suis* being the more virulent to humans [2]. Routes of infection include inoculation through cuts, ingestion of contaminated food or drink, and inhalation of infectious aerosols. The incubation period can range from 5 to 60 days [3].

B. suis was first weaponized by the American military in 1954 [4]. Accordingly, *Brucella* is currently classified as a category B bioterrorism agent and the timely detection of cases is critical for effective surveillance of this disease. In California, a human case of brucellosis is a reportable disease for both laboratories and health care practitioners. Suspect cases are passively reported to the Los Angeles County Department of Health Services (LACDHS), interviewed with a standardized epidemiological case form, and entered into a database. Only cases with laboratory confirmation are reported to the state. Animal cases of brucellosis are reportable to LACDHS’s Veterinary Department. Brucellosis in livestock in Los Angeles County is seldom seen today, but an increasing number of cases in dogs (*B. canis*) are now being reported. The first human case of *B. canis* was reported to the LACDHS in 2005.

The objective of this study was to assess average case “capture times” (defined as the time from symptom onset to report of case to health department case database) and the impact of demographics, symptoms, or risk factors. Reporting practices of clinicians, hospitals and labs for brucellosis were also examined by reviewing the state’s hospital discharge database, mortality records, and the LACDHS database.

METHODS

Epidemiological case history forms for brucellosis cases from January 1, 2001 to December 31, 2005 were reviewed. Demographics, risk factors, and symptoms were evaluated for their effect on “capture times.” Risk factors for brucellosis that were elicited frequently enough for analysis included consumption of unpasteurized dairy products, occupational exposure to an infected animal, and foreign travel. The LACDHS case database was reviewed to determine reporting sources for brucellosis cases. The California Office of Statewide Health Planning and Development (OSHPD) hospital discharge dataset was reviewed and matched to LACDHS cases in 2003 to determine completeness of hospital reporting.

RESULTS

LACDHS confirmed a total of 41 brucellosis case reports during 2001–2005; 39 case reports containing information on risk factor and symptoms. This represents an average of 8 cases per year (range: 5 to 11) and 7% of cases reported nationally. Brucellosis cases were predominately Latino and evenly divided by gender (Table 1). Overall, the most common risk factors for infection were consumption of unpasteurized dairy products and foreign travel (Table 2); however, most of the risk factors for exposure were either associated with Mexico (i.e., unpasteurized dairy products may have originated in Mexico) or occurred while in Mexico. A few cases (n=5, 18%) did not report a known risk factor for the disease.

Characteristic	%	n
<u>Race:</u>		
Latino	88%	36
White	12%	5
<u>Gender:</u>		
Male	56%	23
Female	43%	18



Symptoms reported by cases were categorized into groups, with flu-like symptoms being the most commonly reported (Table 3), some cases (n=9, 23%) reported solely flu-like symptoms.

Risk Factor	N	Overall		Mexico*	
		%	n	%	n
Unpasteurized Dairy	37	62%	23	91%	21
Foreign Travel	34	80%	25	80%	20
Cattle/ Occupational	36	19%	7	100%	7
At Least 1 Risk Factor	37	82%	32	84%	27
Multiple Risk Factors	37	49%	19	89%	17

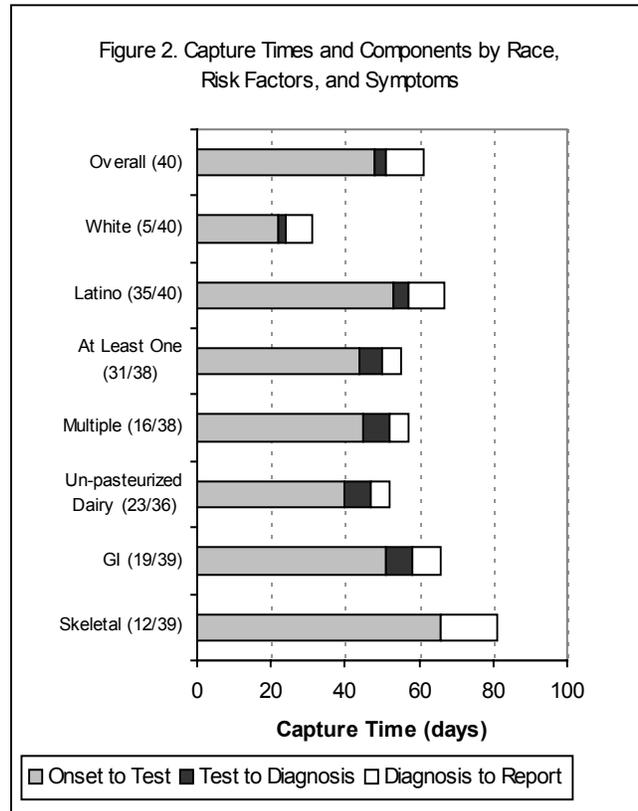
* Exposure either associated with or occurred while in Mexico.

Of the case reports (64%, 25 of 39) that included the infecting *Brucella* species, *B. melitensis* was the most common (60%), followed by *B. abortus* (36%) and *B. canis* (4%).

The average “capture time” (time from onset of symptoms to reporting to LACDHS) was 62 days (range: 0 to 264 days, median 44 days, Figure 2). One in-utero case was dropped from the capture time analysis since this case was not symptomatic and “capture time” was included through the mother. Much of the delay was due to the time required to be seen by a physician and have the proper test performed after

Symptoms ^a	%	n
Flu-Like ^b	87%	34
Gastrointestinal ^c	49%	19
Skeletal ^d	31%	12
Respiratory	8%	3
Rash	3%	1

a. Categories are not mutually exclusive.
b. Fever, chills, sweats, headache, fatigue, body ache, myalgia, cough, malaise.
c. Diarrhea, vomiting, nausea, GI pain, weight loss, decreased appetite.
d. Joint pain, back pain.



symptoms onset (average 48 days). Non-Latinos had significantly shorter capture times (average 31 days, p=0.05, Satterwaite t-test). Having a risk factor associated with brucellosis did little to reduce the capture times.

The sources for brucellosis case reporting included: both physician *and* laboratory (40%), physician only (35%), and laboratory only (25%). Hospital discharge data revealed 13 suspect cases of brucellosis for 2003, compared to N cases reported. Only 6 of these cases (45%) could be matched to reported cases in the LACDHS database. Mortality records revealed one death (2002) with brucellosis listed as a contributing factor. This case was not reported to the health department.



DISCUSSION

Prolonged capture times for brucellosis cases in Los Angeles County may be due to the challenge of diagnosing this rare disease, compounded by the health care access limitations experienced by the Latino population [5]. Having a risk factor associated with brucellosis had little impact on reducing capture times, perhaps because they are very non-specific.

Improving brucellosis capture times involves increasing access to health care, enhancing disease knowledge and recognition by physicians, and timely disease reporting. A clinician's attention to risk factors may lead to an earlier clinical diagnosis of brucellosis cases, and in turn improve capture times. The sooner a disease exposure can be identified (i.e., contaminated food product or intention attack) the quicker an intervention can be set in place to prevent additional cases from occurring.

This study is limited by the small sample size, the use of retrospective data, and incompleteness of case reporting forms.

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PLEASE PASS THE BACTERIA: AN OUTBREAK OF *CLOSTRIDIUM PERFRINGENS* ASSOCIATED WITH CATERED THANKSGIVING MEALS

BACKGROUND

On November 23, 2005, ACDC received a report of possible foodborne illness following a Thanksgiving-themed luncheon held at a large worksite in the San Fernando Valley. The initial report stated that there were 250 people ill with vomiting and diarrhea out of 300 employee guests of the event. Upon investigation, it was revealed that, including the San Fernando Valley luncheon, the implicated caterer, a fast-food restaurant of a popular chain of restaurants, prepared a total of 5 holiday meals/events with more than 400 guests the day prior, November 22. Due to the very large number of ill individuals reported and the alleged involvement of commercial food, ACDC initiated an investigation on November 23.

METHODS

General Investigation: ACDC contacted guests of the initial foodborne illness report (the San Fernando Valley luncheon) to obtain further information regarding who attended the event, the extent and symptoms of illness, and the foods consumed. When it was revealed that the implicated caterer conducted several additional similar orders on the same day, the complete list of orders was requested. ACDC then contacted all parties and inquired about presence of gastrointestinal illness. A menu of common food items was compiled from the catering lists and additional items possibly associated with illness were gleaned from participant interviews.

Case Finding: Two standardized questionnaires were created to survey either guests of the catered parties or restaurant employees in order to identify the cause and extent of illness as well as the possible source of illness. The questionnaires also included questions assessing basic demographic information. The guests were sent questionnaires via email, FedEx and fax, and the restaurant employees were interviewed by private telephone calls conducted by ACDC staff.

Case-Control Study: An outbreak-associated case was defined as any individual who ate one of the catered meals prepared on November 22 or worked at the implicated restaurant on November 22 and had the following symptoms occurring between November 22 and November 24: 1) two or more bouts of diarrhea in 24 hours, and 2) at least one additional compatible symptom (e.g., abdominal cramps, nausea or vomiting). Controls were guests of the events that did not meet the case definition of illness and were available for interview by ACDC staff.

Laboratory: Stool specimens were collected from three patrons of the San Fernando Valley luncheon and sent to the Los Angeles County (LAC) Public Health Laboratory for testing. Illness due to a bacterial toxin was the most likely suspected pathogen due to the quick onset of illness, brief duration of illness, and the implicated foods (e.g., turkey).

Environmental Health Inspection: The LAC Department of Environmental Health, Food and Milk Program (F&M) inspected the restaurant kitchen on November 23 and a hearing with the restaurant management was conducted on November 29. F&M performed a follow-up inspection on November 30.

RESULTS

Employees: During the first visit the inspector made to the restaurant, the management reported that no employees had been recently ill with diarrhea or vomiting. This claim was supported by information gathered from preliminary interviews with restaurant staff—nine out of twelve employees were interviewed via telephone, three could not be reached. Due to lack of cooperation, ACDC was unable to fully survey



the employees, and since there were no reports of illness among the employees, they were excluded from further analysis.

Guests: For a case-control study, ACDC attempted to contact guests of all five parties that had placed catering orders for November 22—four groups responded, all reported some illness among members. A total of 237 questionnaires (187 cases and 50 non-cases) inquiring symptoms and foods consumed were obtained for analysis.

Symptoms	Number of Cases	Percent of Cases
Diarrhea	175	93.6
Abdominal Cramps	158	84.5
Nausea	58	31.0
Headache	38	20.3
Vomiting	25	13.4
Body Aches	19	10.2
Fatigue	25	13.4
Chills	18	9.6
Dizziness	18	9.6
Skin Rash	3	1.6

The majority of respondents (65%, n=154) were male; however the proportion of male versus female patrons was similar among cases and control (69.5% of cases were male, 66% of controls were male). The mean age of the cases was 39 years and controls 42 years. Among the cases, diarrhea and abdominal cramps were the most commonly reported symptoms (Table 1). The median incubation time was 8.5 hours (range 3.5 to 40 hours, Figure 1) and the median duration of symptoms was 18 hours (range 1 to 96 hours, Figure 2). All of the parties reported that none of their guests were ill prior to or during the catered meals.

Among the food items analyzed, both turkey and gravy were significantly associated with subsequent illness (Table 2); however, when analyses controlled one for the other, only turkey remained significant implicating turkey as the most likely cause of illness.

Food Consumed	Number of Cases (n=187)	Number of Controls (n=50)	Attack Rate (%)	Odds Ratio	95% Confidence Interval
Turkey	179	37	82.9	7.86	[3.04 – 20.31]
Ham	153	38	80.1	1.42	[0.67 – 3.00]
Gravy	164	28	85.4	5.60	[2.76 – 11.38]
Stuffing	126	32	79.7	1.16	[0.60 – 2.23]

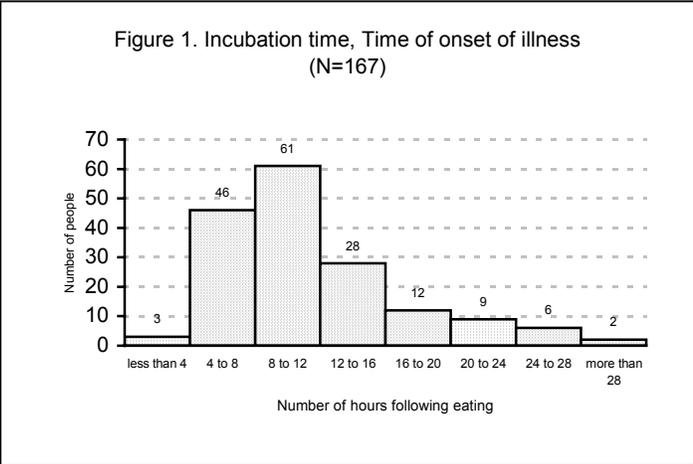
Food	Odds Ratio	95% Confidence Interval
Turkey (Controlled for Gravy)	7.27	[1.35 – 39.05]
Gravy (Controlled for Turkey)	6.75	[0.93 – 49.23]*

* Not statistically significant.

Laboratory Findings: One of three stool specimens submitted for testing was positive for *Clostridium perfringens*. None of the samples tested positive for *Bacillus cereus*.

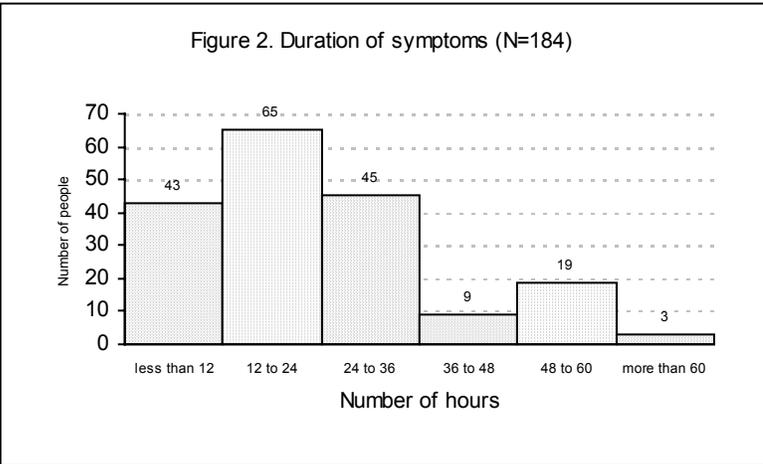


Environmental Health: On November 23, F&M conducted an inspection of the restaurant that catered the meals—this revealed several health violations: foods were maintained at improper temperatures, containers were not properly covered inside the refrigerator; chemicals were stored next to cooking pans, etc. During the hearing held on November 29, the restaurant managers were educated about proper food handling procedures, errors were reviewed and further recommendations for improving restaurant safety were discussed. The following day, F&M returned to the restaurant for a follow-up inspection and noted that all previous known violations were corrected.



DISCUSSION

ACDC’s investigation determined that the cause of illness was most likely *C. perfringens* due to improperly cooked turkey. While the environmental inspections indicated that the restaurant was clean and functional, it was likely operating beyond capacity on November 22—as such space and equipment limitations most likely prevented the restaurant staff from storing and roasting the turkeys at proper temperatures.



During the investigation, the restaurant’s corporate manager and food safety consultant worked closely with ACDC to improve the standards of quality for their chain of restaurants. This experience provided a valuable opportunity to foster cooperation between Public Health and their corporation.

Limitations: This investigation was limited by a few factors. First, responses to the questionnaires were likely hindered by recall bias due to the retrospective nature of the data collection. Similarly, guests of the San Fernando Valley luncheon who had filed the original complaint had predetermined that the gravy was the cause of their illness—thus their responses likely over-emphasized that food as the cause when its association was questionable. In addition, despite the large number of people affected by the outbreak, only a few of the patrons were willing to submit specimens for testing, and the Public Health Laboratory was unable to collect samples of the turkey for testing—thus while *C. perfringens* infection from the turkey was the most likely cause of illness, additional tests could have further validated that finding. Finally, since only a portion of those who did not meet the case definition was available to interview as controls for this study, investigation ay have been limited by self-selection bias.

Recommendations: This outbreak illustrates many of the recommendations that the Los Angeles County Department of Health Services provides to restaurants to avoid food-associated illness. Foremost, restaurants should not exceed workspace capacity when preparing foods since this can contribute to compromising food safety (i.e., limiting proper cooking time, mixing uncooked food and their cooking utensils with cooked food). Moreover, all restaurants need to adhere to the following food handling practices: 1) hot food should be held at 140°F or warmer, 2) cold food should be held at 41 °F or colder, 3) when serving food at a buffet, keep food hot (i.e., with chafing dishes, slow cookers, or warming trays)



and keep food cold by nesting dishes in bowls of ice or use small serving trays and replace them often, and 4) food that is likely to spoil should not be left out more than 2 hours at room temperature.



GIARDIASIS OUTBREAK ASSOCIATED WITH A WOMEN'S GYM

BACKGROUND

On October 14, 2005, ACDC received information from a confirmed giardiasis case stating that her fellow gym members were symptomatic with a similar gastrointestinal illness. ACDC contacted Public Health Nursing in the Foothill Health District (FHD) for further information about giardiasis cases in the area around the gym. A review of giardiasis cases reported since the beginning of August 2005 to October 18, 2005 in the FHD identified 10 laboratory-confirmed cases. Preliminary findings indicated that all cases resided in the same zip code and all were females between 35 and 77 years of age. Nearly all of the confirmed cases (9 of 10) reported attending a particular gym before onset of symptoms and no other common risk factors could be identified from their epidemiological case history forms. Onset of illness for these women ranged from August 30 to September 26, 2005. In comparison, no cases with the same characteristics were reported in the FHD in September of the previous year (2004). Due to the increased number of people reported with giardiasis, the temporal clustering of cases, and the association of the cases with the gym, ACDC initiated an outbreak investigation.

Giardia is a parasite found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. One becomes infected after swallowing the parasite. Asymptomatic carriage rate is high [1]. Symptoms are often self-limiting and consist of diarrhea, gas, abdominal cramping, foul-smelling stools, and nausea. Persons at increased risk for giardiasis include: child care workers, children who attend day care centers especially those who use diapers, international travelers, hikers, campers, swimmers, and others who drink or accidentally swallow water from a contaminated source that is untreated (i.e., not purified by heat inactivation, filtration, or chemical disinfection) [2].

METHODS

ACDC made a site visit to the gym on October 17, 2005. The site supervisor was interviewed about possible drinking water sources, food sources, plumbing problems, and cleaning procedures. A list of self-reported symptomatic members was obtained.

Via a letter to the management, ACDC requested a contact roster of all active members and a listing of members using the gym from August 1 to October 21, 2005. This list was further itemized by specific date and time of attendance. To actively identify additional cases and prevent the spread of infections, ACDC recommended that a letter be mailed notifying the gym members of the giardiasis outbreak and requesting that all ill members with diarrheal symptoms contact ACDC. The gym management mailed their letter on October 27, 2005. The letter also contained health education information regarding common symptoms, route of transmission, and instructions for ill members to consult with their medical provider.

Giardiasis cases were defined by either symptoms or laboratory results. Symptomatic cases (probable cases) were individuals with illness lasting seven days or more and a combination of two or more of six symptoms (diarrhea, flatulence, foul-smelling stools, nausea, abdominal cramps, and excessive tiredness). Culture-confirmed cases were individuals with *Giardia* species identified in their stool.

Outbreak-associated cases were gym members who attended the gym at least once during the suspected time period (from August 25 to 30, 2005) and had onset of symptoms during or after that time period. The suspected time period was chosen as the most likely window of exposure by seeing where the cases overlapped by gym attendance and applying the variable incubation period for giardiasis to the onset of the cases. Only individuals meeting the case definition for *Giardia* and outbreak-associated definition were included as cases in the subsequent case-control study. Only non-ill interviewees attending the gym during the specified time frame could be used as controls.



A case-control study was conducted using a standardized, telephone administered questionnaire of individuals attending the gym from August 25 to 30, 2005. Case-finding was accomplished via the letter distributed by gym management encouraging ill members to contact ACDC and also via the telephone interview. Controls were randomly selected from a group of supposedly non-ill members attending the gym during the implicated exposure period. Stool cultures were not obtained on controls. Only asymptomatic interviewees were included as controls.

To rule out other possible risk factors and to determine a possible common exposure at the gym, cases and controls were interviewed. The comprehensive questionnaire contained questions regarding exposure to known giardiasis cases or ill individuals with a similar type illness, diapered children, community drinking water sources, recent travel, recreational activities (e.g., camping, hiking, swimming), common food sources (e.g., restaurants, grocery stores, take out foods, diet foods), nutritional supplements, pets, group activities, and exercise activities. Questions specific to the gym were asked regarding regular workout schedules, gym towel and bathroom usage, drinking water exposure, food/drink samples received, and whether food/drink was purchased after workout.

Chi-square and Fisher's exact tests were used to calculate odds ratios (OR) and 95% confidence intervals (95%CI), and the *t*-test was used to test the differences of the means in the two groups. To decrease potential misclassification, symptomatic members not fitting the case definition were excluded from the study.

RESULTS

Gym Inspection: An inspection by ACDC revealed no obvious problem areas. The overall appearance of the gym was clean and well maintained. There was one main room containing the circuit of 14 exercise machines with exercise mats between each machine. In this 30-minute workout gym, members advance through all stations (machines and mats) at timed intervals set to music. There was also a bathroom, changing room, back storage room, and small conference room. Per the onsite manager, the exercise machines are cleaned at least twice daily (at 12:30 pm and 8:00 pm) using a common bleach-based spray cleaner and antibacterial wash. Gym towels are cleaned on the premises—usually twice a day. The bathroom is cleaned twice a day; the only plumbing problems reported was the occasional toilet clog, which occurs about once or twice a month. According to the supervisor, no overflow of the toilet was reported during the end of August 2005.

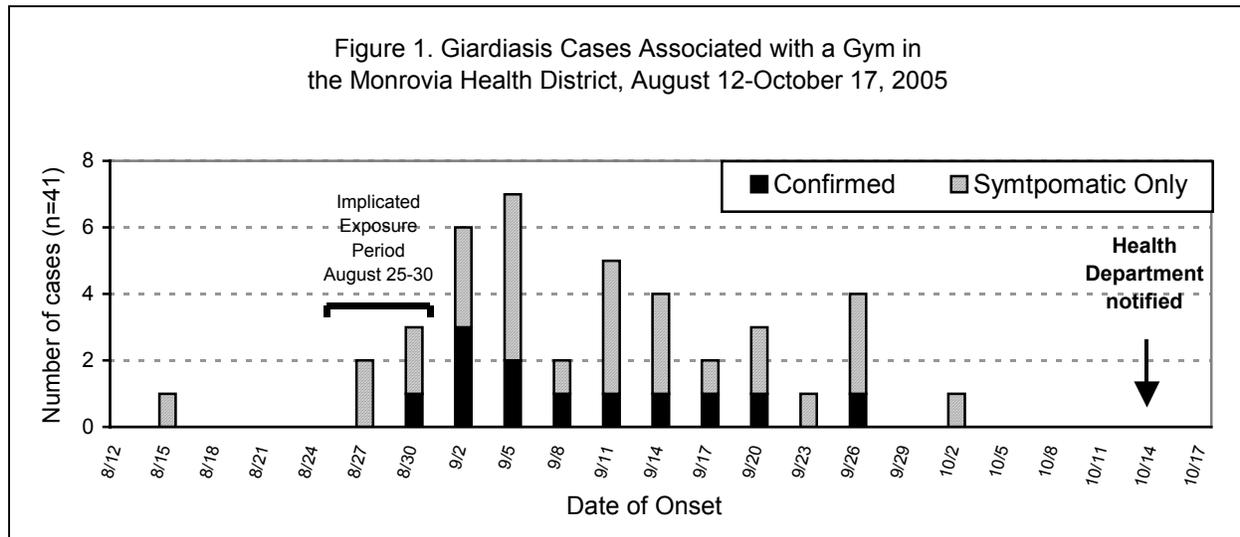
The gym does not serve food but there were two common drinking water sources: individual-sized bottled water for purchase and a common 5-gallon drinking water ceramic crock dispenser. The water in the crock dispenser was usually replenished once a day by the supervisor. During questioning it was discovered that the crock dispenser was not regularly cleaned during the implicated exposure period. Because management suspected that the dispenser might be the source of infection, it had been washed and then totally replaced as of October 16. There was a report of liquid leaking from the ceiling, but not in the vicinity of the water dispenser. Construction was occurring above the gym and there was an incident of water with paint leaking from the ceiling.

Descriptive Epidemiology: A total of 41 cases were identified meeting the *Giardia* case definition. There were 12 culture-confirmed cases and 29 symptomatic only persons (probable cases). The median age for cases was 57 years (range 30–77). All but five cases resided in the 91001 ZIP-code area, and those five resided in adjacent ZIP-codes. The first case had onset of symptoms in mid-August and the last on October 3. The peak of the onset curve occurred on September 6 (Figure 1). Also, no countywide increase in giardiasis for 2005 was observed in the Visual Confidential Morbidity Report surveillance system.

The cases complained of an average of eight symptoms (Table 1). Diarrhea was the most common complaint (98%) followed by fatigue (93%), gas (85%), weight loss (80%), abdominal cramps (80%), foul smelling stool (71%), and nausea (68%). The mean duration of illness was 19 days (range 1–56 days). Most of the cases (59%) continued to go to the gym after illness onset. Of the 30 individuals who sought



medical care and reported a date of medical care, it took an average of 17 days after onset of symptoms before they sought treatment. Of these, three cases (8%) were hospitalized, (hospitalization ranging from 2 to 4 days).



Case-Control Study: The purpose of the case-control study was to determine which exposures were associated with giardiasis illness. The study compared responses from 36 cases and 31 controls. Five individuals were excluded from analysis for not meeting the outbreak-associated case definition—four for not attending the gym during the suspected time period and one symptomatic only individual for having an onset date (8/15/05, first case) before the suspected time period. Controls were obtained from 85 randomly selected participants and qualified by responding to the survey and were asymptomatic or not diagnosed with giardiasis during the study period. No significant difference in the mean age was identified between the cases and controls ($t=0.54$, $p\text{-value}=0.59$).

Symptoms	Cases (n=41)	
	no.	%
Diarrhea	40	98%
Fatigue	38	93%
Gas	35	85%
Weight Loss	33	80%
Abdominal Cramps	33	80%
Foul Smelling Stool	29	71%
Nausea	28	68%
Vomiting	15	37%
Headache	15	37%
Body Ache	13	32%
Fever	11	27%

Only two of the assessed exposure items were significantly associated with illness (Table 2). One, knowing a non-household contact who was diagnosed with giardiasis or had diarrheal illness—although this item was substantially skewed because 40% (6/15) of the reported ill non-household contacts were fellow gym members. The second significantly associated factor, and the most likely cause of exposure, was drinking water from the gym’s dispenser—all of the assessed cases (those both diagnosed and with symptoms only) reported drinking from the dispenser, compared to only 61% of the controls. However, there was no significant difference between cases and controls in the mean number of cups consumed per visit or the mean number of times attending the gym during the implicated exposure period.

Laboratory: ACDC did not collect specimens for testing or confirmation of illness in this study. Instead, test reports were obtained through our standard passive reporting system by the cases’ respective private physicians. A total of 12 cases with stool samples positive for *Giardia* were reported through our surveillance system; of these, six were further identified as *G. lamblia*.

Additional Findings: From extensive case-finding, the first case, although she was not clear about her exact onset date, reported an onset at about August 15. Also, her duration of illness was seven days



Table 2. Case-Control Study Results—Selected Exposure Risk Factors for Illness

Exposure	Cases (n=36)*		Controls (n=31)		Odds Ratio(95%CI) t-test, p-value
	n	(%)	n	(%)	
<u>Gym exposure†</u>					
– Drank from water dispenser	36	(100)	19	(61)	Undefined ⁺
– Avg. number of cups consumed from dispenser	2.6		2.7		t=0.17, p=0.86
– Received food/drink samples	9	(25)	7	(23)	1.14 (0.32–4.09)
– Used gym bathroom (n=35)*	22	(63)	20	(65)	0.93 (0.30-2.86)
– Used gym towels	13	(36)	14	(45)	0.69 (0.23-2.05)
– Brought own water (n=35)*	3	(9)	8	(26)	0.27 (0.04-1.30)
– Avg. number of times attended gym between August 25 and 30	1.9		1.9		t=0.08, p=0.93
<u>Other Select Risk Factors‡¶</u>					
– Outside household contact ill	15	(42)	4	(13)	4.82 (1.39-16.69) ⁺
– Consumed “unusual” foods (n=35)*	7	(20)	2	(6)	3.63 (0.61-38.01)
– Ate diet meals	10	(28)	3	(10)	3.59 (0.79-22.13)
– Diapered children (n=35)*	12	(34)	4	(13)	3.52 (0.89-16.76)
– Recent travel (n=25)*	15	(60)	12	(39)	2.38 (0.71-8.10)
– Consumed community drinking water (n=35)*	26	(74)	16	(52)	2.71 (0.86-8.73)
– Participated in recreational activities with public water sources	16	(44)	8	(26)	2.30 (0.73-7.43)
– Avg. number of times eat out per week (n=35)*	2.6		2.3		t=0.83, p=0.41
* Cases did not respond to all of the questions; when the number of case responses is fewer than the overall total, the number is listed next to its respective question.					
+ Significant finding, p<0.05.					
† Risk factors are specific to the period of potential giardiasis exposure, August 25 to 30, 2005.					
¶ Only includes select risk factors where the Odds Ratio was 2.0 or above.					

compared to an average of 19 days for cases. She did not seek medical care, and she had three symptoms compared to an average of eight symptoms reported among all cases. She attended the gym 3 or 4 times per week and drank three cups from the water dispenser per visit. No outside source of infection for her *Giardia*-like illness could be identified via her standardized case-control study questionnaire. While an exact mechanism for transmission could not be identified, if her onset date was indeed August 15, her onset would predate the outbreak and she could possibly have been the source of infection.

In addition to the cases used in this report, one secondary confirmed case was identified in a household contact to a confirmed case. Plus, another confirmed case was reported—the boyfriend of a non-ill employee. The boyfriend reported onset of symptoms on August 15, although he was noted to have poor recollection. The boyfriend also drank water from the gym crock dispenser that was brought home by his girlfriend. No other risk factors were noted in his epidemiology case history form. The non-ill employee could have been a potential source of contamination for the outbreak. *Giardia* can be shed from an asymptomatic infected person and this employee had routine contact with the implicated water dispenser during the daily water bottle replacement.



INTERVENTIONS

The implicated gym was not closed by DHS because no on-going high-risk conditions could be identified. In addition, there was no indication that the outbreak was continuing. The last case occurred 12 before the health department was notified. The most likely source of infection, the water dispenser, was replaced before the investigation began. The letter notifying the members of the cluster of cases, describing the disease, and encouraging ill members to contact ACDC was beneficial. As noted by the results, it usually took more than two weeks before cases sought medical attention and many cases continued to work out after symptom onset. By encouraging ill individuals to get medical care and educating them about transmission, it decreased the likelihood that they could potentially spread the infection to their close contacts and other gym members.

CONCLUSION

Although a definitive source of infection could not be determined by this study, our investigation indicates the most likely source was the gym water dispenser. An ill employee may have contaminated the dispenser—the person who usually changes the water bottle did not have symptoms, although her boyfriend was a laboratory-confirmed case. For giardiasis, asymptomatic infections are common and the infecting dose is very low. Alternatively, an infectious member could have contaminated the spigot of the dispenser. The spigot required substantial hand manipulation to use—contaminated hands could easily come in contact with the spout, which would be a viable environment for the *Giardia* organisms to live. There was one symptomatic case with an onset date as early as mid-August and she did report drinking from the water dispenser although she was not clear on her exact onset date, her duration of illness was shorter, and her symptoms seem to be less severe than other cases. She did attend the gym two days during the suspected period of exposure. Also other ill members may have been a continuing source because many continued to workout at the gym despite illness.

An important limitation to this study was our inability to adequately test the implicated water dispenser because it had been washed and then replaced with a new ceramic crock when the staff suspected it might be the source of infection—which was before ACDC was involved. It is also of interest to note that the potential quantity of exposure (i.e., the reported amount of water consumed from the dispenser and the number of times a member came to the gym) were not decisive factors. Instead, illness appeared to be associated with having contact with the contaminated dispenser at a specific time when infection was most likely—at sometime between August 25 through 30. Another limitation is that due to the high rate of asymptomatic cases in giardiasis, controls may not have been true non-cases. Additional limitations include potential self-selection bias among the controls and also recall bias among the cases—since the management and many of the cases already presumed the water dispenser was the source of infection long before the health department was involved.

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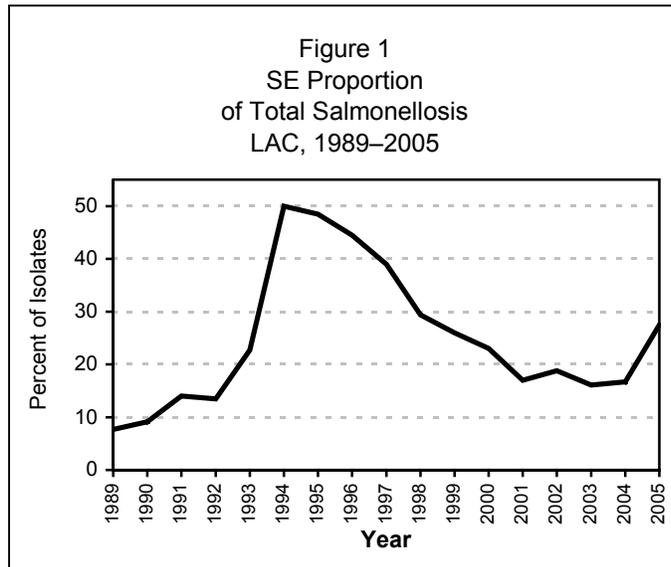
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SALMONELLA ENTERITIDIS LOS ANGELES COUNTY, 2005

Salmonella Enteritidis (SE) is the most common *Salmonella* serotype identified from isolates submitted to the Los Angeles County (LAC) Public Health Lab. After rising to a peak of 1,126 cases and 50% of the total *Salmonella* isolates in 1994, SE steadily decreased until reaching a plateau in 2001 to 2004. In 2005, however, reported SE cases increased by 42%. Of all *Salmonella* isolates, SE represented 18% in 2004 and 29% in 2005 (Figure 1). In 2005, the rate of confirmed infections with SE was 3.2 cases per 100,000 population, compared to 11.3 cases per 100,000 for all confirmed *Salmonella*.

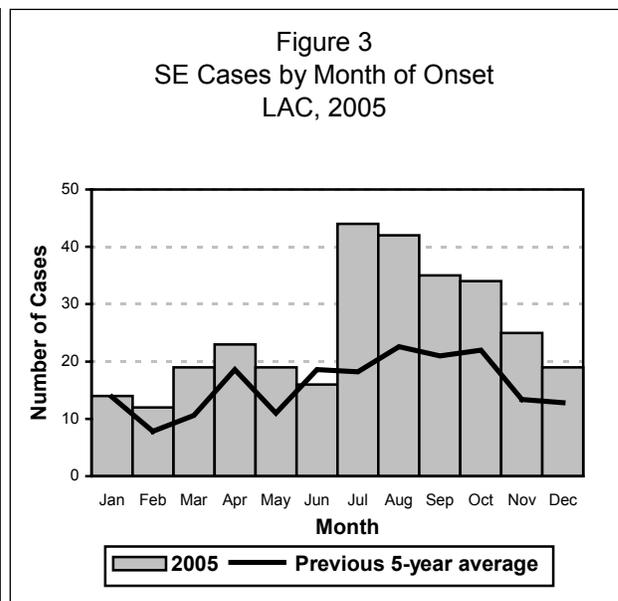
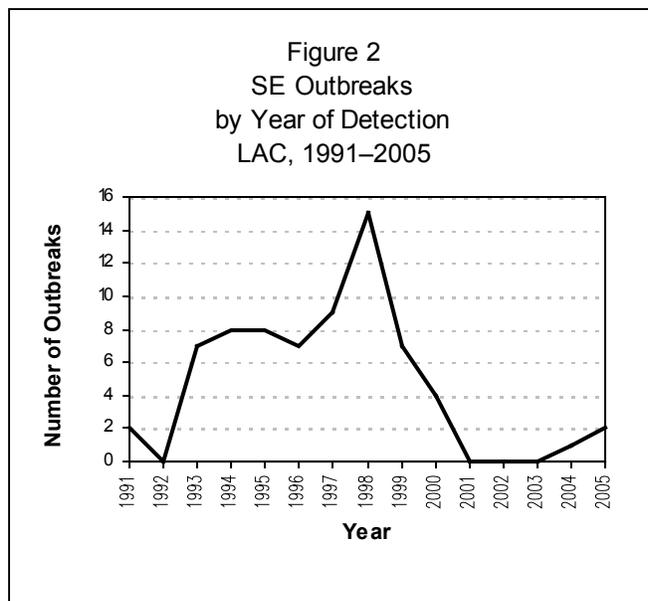


SE was identified most commonly from stool (90%), followed by blood (8%), and urine and other specimens (2%). There were 72 hospitalizations (24%). SE infection was a contributing cause of death in three persons with underlying disease.

The highest frequency of SE cases occurred during July and August (n=44 and n=43, respectively). The summer increase of SE was dramatically higher than the previous five-year average (Figure 3). The highest number of cases (n=78) was in persons aged 15 to 34 years; however, the highest rate (8 cases per 100,000) was seen in children aged 1 to 4 years. There were 1.3 male cases for every female case. Although 25% of all SE cases resided in SPA 2 (n=74), the highest rate (5.4 cases per 100,000) was in SPA 5. Travel was a risk factor for 27% of cases; of these 30% visited Mexico and 25% traveled within the US.

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In 2005, confirmed outbreak-related SE cases accounted for only a very small proportion (3%, n=9) of all confirmed SE cases (N=302). Two of the four *Salmonella* outbreaks investigated by LAC Public Health in



2005 were due to SE (Figure 2 and Table 1) and both were restaurant related outbreaks. In the first one, the source was a dessert containing raw eggs—the restaurant used eggs in the shell for this product. In the other outbreak, the source was not determined, but was suspected to be an ingredient used in multiple menu items such as tomatoes.

Table 1. <i>Salmonella Enteritidis</i> Outbreaks in Los Angeles County, 2005						
Onset Month	Outbreak Setting	Number Ill	Number Culture Positive	Phage Type	Suspected Vehicle	Suspected Source
July	Restaurant	11	6	6a	Dessert	Raw Eggs in the Shell
September	Restaurant	19	3	6a	Unknown	Unknown

SE increased in the 1990s due to contamination of shell eggs [1]. There is concern that the recent increase in SE indicates resurgence similar to that of the 1990s in a food source such as eggs or poultry. ACDC continues to monitor sporadic cases and outbreaks of SE and works with LAC Environmental Health, private industry groups, and the state and federal government to promote food safety. ACDC supports activities aimed at improvement of egg production, egg distribution processes and consumer education in order to decrease the risk of SE infection.

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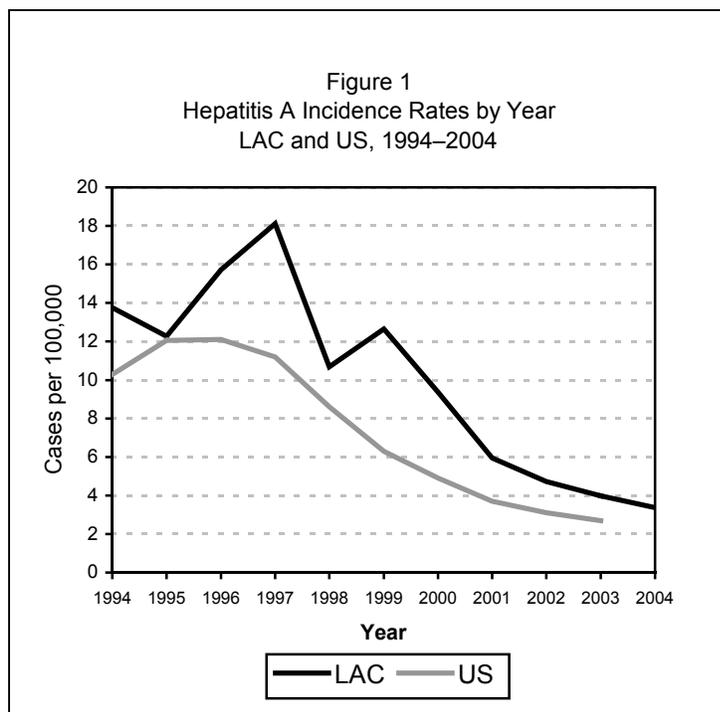
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HEPATITIS A INCREASE AND OUTBREAKS LOS ANGELES COUNTY, 2005

BACKGROUND

In the US, hepatitis A has occurred in periodic epidemics approximately every decade, with the last epidemic occurring in 1995. Since then, rates of hepatitis A have plummeted with the introduction of an effective vaccine introduced in 1995 and with the 1999 recommendation by the Advisory Committee on Immunization Practices (ACIP) to provide universal childhood vaccination against hepatitis A in states (such as California) with the highest rates of the disease. In Los Angeles County (LAC), the last peak annual rate of acute hepatitis A occurred in 1997 (18 cases per 100,000 persons). In 2004, the number of reported cases declined 321 for an incidence of just 3 cases per 100,000 persons (Figure 1).



Prior to 2005, most reports of a positive test for hepatitis A IgM were considered by the LAC Department of Health Services (LACDHS) to represent acute cases of hepatitis A. This meant that persons without hepatitis symptoms and those with possibly false positive IgM tests were counted as cases of acute hepatitis A. But starting in 2005, LACDHS applied the CDC definition of acute hepatitis A to be consistent with the case definitions for acute hepatitis surveillance as published by the CDC and the Council of State and Territorial Epidemiologists (CSTE).¹ This change definition was enacted to ensure comparability of rates among jurisdictions and to better describe populations at risk for hepatitis A.

Using the new case definition from January-July, 2005, LACDHS received the same number of suspect reports of acute hepatitis A each month as in 2004—but the number of cases *confirmed*

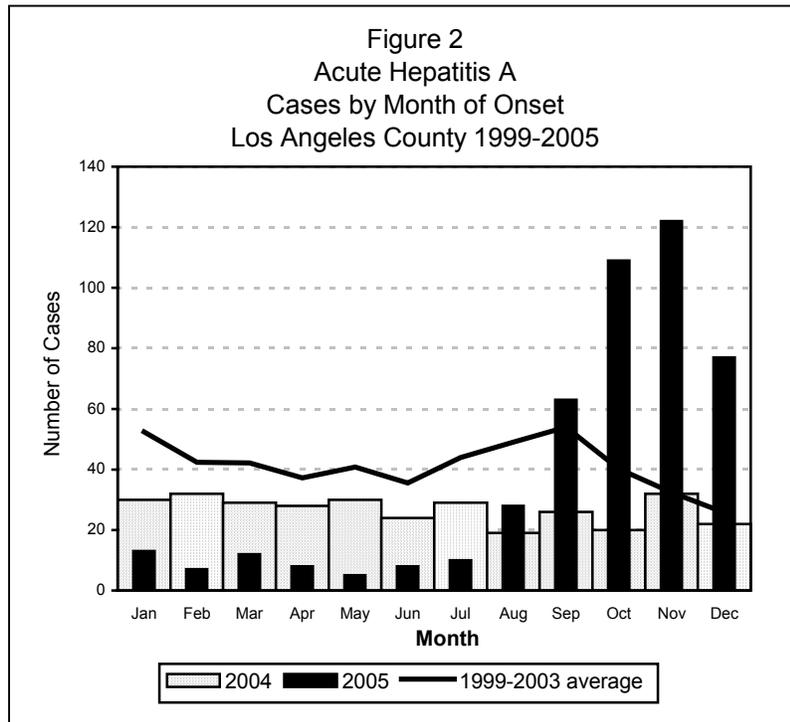
as acute dropped by 70% (Figure 2). However, starting in August 2005, there was a marked increase in the number of both reported and confirmed hepatitis A cases in LAC. By April 7, 2006, there were a total of 466 confirmed cases with onset in 2005 compared to just 321 in 2004. The increase in cases occurred in the latter half of 2005 when 403 confirmed cases with onset between August 1 to December 31 (the “outbreak period”) occurred, versus 119 cases in the same time period in 2004 (Figure 2). Several point source outbreaks were identified, and in particular, the downtown homeless population was recognized as being at increased risk for acquiring hepatitis A.

As a consequence, during the latter half of 2005, LACDHS enacted: multiple outbreak investigations, a general population case-control study, a detailed epidemiologic analysis of all reported cases,

¹ A case of hepatitis A is defined as a person with new clinical findings (i.e., onset date, jaundice, fever, fatigue, etc.) and with appropriate laboratory tests (e.g., hepatitis A IgM+, elevated liver function tests). Later during this investigation, acute cases patients were defined as those who were unable to be interviewed (primarily the homeless), but who had a positive test for HAV IgM and an alanine aminotransferase (ALT) level >300. If a reported case met either case definition, it was closed as “confirmed acute.” Otherwise, the report was closed as “false.”



environmental health investigations (including produce trace-backs), and serologic investigations in conjunction with the CDC for hepatitis A virus strain typing. These actions were taken in an effort to determine the cause(s) of the unexpected increase of acute hepatitis A.



Investigations were complicated by the long incubation period for hepatitis A (2-6 weeks) and the multiple means of acquiring hepatitis A (e.g., contaminated food or water, sex, drugs, travel to endemic countries, etc.). These factors made it especially difficult to link cases and to determine with accuracy a single point source for infection. Furthermore, during the course of our investigations, it was revealed that LACDHS's largest reporting agency had ceased reporting positive laboratory results for HAV IgM since October 2004 due to an error in computer programming after changing laboratory tests for acute hepatitis A. The test change resulted in two outcomes. First, test results were no longer automatically and

electronically reported to LACDHS (or any other Southern California county) for 13 months. Second, the percent of positive HAV IgM test results from this reporting source increased 5-fold. A large number of patients with a positive test for acute hepatitis A had no symptoms or other clinical criteria of hepatitis A. All positive test results (n=300) for the time period October 2004-October 2005 from this reporting source were transmitted to LACDHS on a single day in November 2005 for investigation and follow-up; this greatly increased the challenges in investigating the epidemiologic trends of hepatitis A in LAC.

The following is an overview of the distinct hepatitis A outbreaks and populations that were investigated.

1. Homeless, Downtown Los Angeles:

In October 2005, ACDC identified four cases of acute hepatitis A among volunteers and patrons of a homeless shelter in the downtown "skid row" area of Los Angeles. Since two cases occurred in volunteers who live with and prepare food for other volunteers of the shelter, all volunteers were offered Immune Globulin (IG) to prevent the acquisition of hepatitis A. The subsequent investigation did not confirm linkage between any cases and any homeless shelters. A total of 48 cases with some association with the homeless in downtown Los Angeles, with dates of onset or diagnosis between September-December 2005, were confirmed. The monthly number of confirmed cases in the homeless peaked in October (N=17)—which was prior to the peak in the general population. No baseline data of the prevalence of hepatitis A in the homeless prior to September 2005 exists, but local healthcare providers noted that cases of hepatitis A being treated were above "normal levels." Because of the multiple overlapping exposures to several soup kitchens, food sources, and shelters, and due to the inability to interview many homeless cases, no point source was identified. ACDC worked with the DHS homeless services coordinator to distribute hygiene and prevention messages to healthcare providers and homeless shelters in the downtown Los Angeles and across the county. Serum from a homeless patient was sent to CDC for hepatitis A viral sequencing.



2. Mexican Restaurant, Downtown Los Angeles:

A total of 17 cases of hepatitis A were confirmed in persons who ate at a downtown Mexican restaurant on September 14 or 15, 2005. A case-control study was not conducted because the link between the restaurant and cases was not identified until November, when many cases of acute hepatitis A with onset in October were re-interviewed with an extensive food history questionnaire. The LACDHS Food and Milk Program investigated the restaurant in November and found no food handling violations, no evidence that food handlers were ill in September or contemporaneously, and no produce suppliers that could be specifically linked to the other outbreaks in LAC during 2005. Food handlers were not tested for acute hepatitis A and no serum specimens from the cases were available for viral sequencing.

3. Workplace Setting, San Gabriel Valley:

In November of 2005, ACDC investigated an outbreak of 19 people with acute hepatitis A who had all eaten at a movie set on October 3, 2005. A case-control study was enacted to determine risk factors for illness. A case was defined as a person who ate at the worksite on October 3, 2005 and who was IgM positive and symptomatic. Controls were those that ate at the worksite on the same day, but were well and did not have any of the following exclusion characteristics: clinical symptoms of hepatitis A, past diagnosis or vaccination for hepatitis A, or a history of receiving immune globulin in the preceding 3 months. Food-handlers were tested for hepatitis A IgM and IgG; all tested negative.

Ultimately, 116 of the 246 people (47%) who were on the set that day were contacted—40 met the exclusion criteria, 18 cases and 58 controls were identified (one additional case was identified after the case-control study was concluded). After interviewing cases and controls, a stratified analysis suggested that of the 65 food items provided, only the following accounted for more than half the cases:

- the salad bar stratifying by the jerk chicken (OR=5.3, 95%CI: 1.08-26.24),
- the mixed greens stratifying by the jerk chicken (OR= 5.06, 95%CI: 1.52-16.84),
- the jerk chicken stratifying by the salad bar (OR=4.06, 95%CI 1.26-13.15),
- and the jerk chicken stratifying by the mixed greens (OR=4.65 95%CI 1.39-15.48).

Since the jerk chicken had no raw ingredients, lettuce (pre-washed mixed baby greens) was implicated as the most likely cause of this outbreak. A trace-back performed by the LACDHS Food and Milk Program revealed that the caterer purchased the lettuce from a produce vendor who bought the lettuce from *another* vendor who bought ultimately bought it from a farm outside of LAC. LACDHS was unable to determine where, and if, the contamination of the lettuce occurred between the farm and the movie set. Given that no other outbreak implicated that farm or the other two lettuce vendors, a detailed trace-back and investigation of these food purveyors was not conducted. No sera were collected from cases in this outbreak.

4. Café, Downtown Los Angeles:

Between November 29 and December 7, five employees of a downtown restaurant were diagnosed with acute hepatitis A—four of them, including a cook, worked while ill. Because several food-handlers worked while symptomatic, a public announcement was made and IG was provided at no cost to the public (>650 doses) and to the other employees at the restaurant (50 doses).

Serum specimens for hepatitis A IgM were collected from the other employees (n=51); none positive; no new employee cases were identified. Employees that had left this employment prior to the discovery of the outbreak also were contacted. At this restaurant, employees were served a “family style” meal before each shift. As the five employees diagnosed with hepatitis A had worked multiple overlapping shifts in the 2-6 weeks before they became ill, it was impossible to determine the source of illness. A cohort study of food preferences of restaurant employees was performed, but no individual food item that could account for the cases was identified. In addition, no cases among patrons were definitively linked to eating at this restaurant. There were no commonalities between the produce suppliers for this restaurant and those for the other restaurant and movie set and no other ill employees were identified, which eliminated the likelihood that another employee was the originating



source of infection. Sera were collected from the employee cases and from an additional case (who ate at this restaurant) were sent to CDC for strain typing.

5. Group Home, Antelope Valley:

Two confirmed cases of hepatitis A infection were identified at a substance abuse treatment facility in the Antelope Valley. Onset of jaundice occurred between December 6 and 10, 2005. Both cases lived in the facility during their entire incubation periods. Approximately 22 other residents complained of nausea/vomiting, diarrhea, muscle aches, and fever starting on November 24. A total of 33 residents, including the 22 ill residents, were tested and all were negative for acute hepatitis A. No common source was identified for the two cases and all other members of the treatment facility were offered IG to prevent acquisition of hepatitis A. Sera from both patients was sent to CDC for strain typing. No additional cases occurred.

RESULTS

General Population Case-Control Study: Because of the generalized increase in hepatitis A throughout LAC, ACDC conducted a matched case-control study of confirmed hepatitis A cases with onset in October that were not part of any identified cluster or outbreak. Controls were identified through random digit dialing; telephone numbers were generated in stepwise progression (either up or down) from the matched case's phone number. In total, 21 cases and 42 matched controls were interviewed. Univariate matched analysis resulted in the following significant odds ratios (OR):

- bagged salad (OR 4.5, p value .013, 67% of cases exposed),
- spring mix bagged salad (OR 8.0, p value .0041, 43% of cases exposed),
- eating downtown (OR 5.5, p value .0025, 62% of cases exposed), and
- being currently employed (OR 2.8, p value .07, 86% of cases exposed).

Conditional logistic regressions using multiple models were subsequently used to examine which of the risk factors remained significant in the presence of other risk factors. Eating downtown remained strongly associated with illness (OR range 3.5 to 4.1 with all models being significant) and spring mix bagged salad remained slightly associated (OR range 3.1 to 4.2 with some models being marginally significant and others not being significant). Produce such as cilantro and green onions—which have been implicated in previous hepatitis A outbreaks—showed a significant protective effect. The results suggested that eating downtown was the most probable risk associated with acquiring hepatitis A. Although no sera was sent to CDC for sequencing from the October general population cases, sera was sent from November cases.

Environmental Health Inspections: The Environmental Health Food and Milk Program performed inspections of several food service purveyors in the investigation of the discrete outbreaks. This included restaurants (n=2), soup kitchens (n=7), produce vendors (n=2), and a catering truck. Their investigations included assessing employee health, hygiene conditions, produce suppliers and sources, opportunities for cross contamination. There was no evidence that the outbreaks of acute hepatitis A were associated with any personnel, common produce supplier, or poor food handling techniques.

Hepatitis A Virus Strain Typing: A total of 68 blood samples from LAC residents were sent to the CDC for viral strain typing. Of these, 40 tested positive for the presence of hepatitis A virus nucleic acid by PCR; 80% of these samples (n=32) were found to be a unique strain, not previously identified in North America. Samples from cases associated with the downtown restaurant, the homeless, and the group home (Antelope Valley) cluster matched the unique strain.

Epidemiologic Analysis of Confirmed Cases: Comparing the first seven months of 2005 (baseline period, January to July 2005) against the last five months of 2005 (outbreak period, August to December 2005), some differences appear (Table 1). First, outbreak cases were slightly older (mean age 38 years versus 34 years) and more likely to be within the age group for working age adults—82% of the outbreak cases occurred in adults aged 21-64 versus 64% of the cases during the baseline period. The gender ratio also skewed toward males; by the end of 2005, 64% of the cases occurred in men versus 57% during the



baseline period, and only 50% in 2004. Another notable finding was that the proportion of cases that were Black increased from 4 to 14% during the outbreak period.

The overall increase in hepatitis A cases was widespread throughout LAC—all health districts reported an increase during the outbreak period as compared to the same time period in the previous year, 2004. But despite the widespread increase, a notable cluster occurred—16% of the cases during the outbreak period were reported from the Central Health District compared to just 3% of the cases during the same time period in 2004.

Table 1. Comparison of Confirmed Hepatitis A Case Characteristics Before (January–July) and During (August–December) the Outbreak Period Los Angeles County, 2005			
Characteristics	Time Period		
	January–July (N=392)		August–December (N=63)
Age in Years			
Mean	34		38
Median	33		37
Range	1-89		1-86
Age Category	n	(%)	n (%)
<1	0	(0)	0 (0)
1-4	2	(3)	5 (1)
5-14	8	(13)	17 (4)
15-20	7	(11)	27 (7)
21-34	22	(35)	128 (33)
35-44	8	(13)	77 (20)
45-54	8	(13)	77 (20)
55-64	2	(3)	39 (0)
≥65	7	(11)	22 (6)
Gender	n¹	(%)	n (%)
Male	36	(57)	249 (64)
Female	27	(43)	162 (36)
Race/Ethnicity	n²	(%)	n³ (%)
Asian	7	(13)	30 (9)
Black	2	(4)	44 (14)
Latino	21	(38)	102 (32)
White	26	(46)	143 (45)

1 N=391

2 N=319

3 N=56

DISCUSSION

The clusters of illness identified in two downtown restaurants, the homeless in downtown, and the results of the general population case control study suggest that the most likely source of infection may have originated in downtown Los Angeles. While the caterer from the workplace outbreak, the homeless



shelter, both restaurants, and the group home all received some produce from distributors located in downtown Los Angeles, no further commonalities could be identified. Furthermore, produce that is most likely associated with hepatitis A outbreaks—green onions and cilantro—was not implicated in any of the outbreaks or in the general population. Additionally, the general population case control study actually showed a protective effect for both food items.

Consequently, the source of the outbreaks remains questionable. It is possible that this new hepatitis A strain was introduced to the community in August, spread at modest levels that month and in September, and reached a critical mass in October and November. It is clear that the distribution of the strain was widespread in that 80% of the samples had the same strain type and this strain. It is possible that this particular strain may be more infectious than others previously seen in Los Angeles, but the comparative virulence of this strain is unknown. In other communities, outbreaks have been sustained by, often asymptomatic, transmission of the virus between children and to adults. However, since there was no increase in the percentage of cases seen in children or in the percentage of cases with a connection to a school or daycare, this source of transmission is not likely.

The number of reported and confirmed cases decreased each month since November (Figure 2) and no further discrete outbreaks were reported. Despite the decrease in cases since December 2005, the number of reported cases in March 2006 was still double that at the same time in 2005 (the “baseline period”). Accordingly, ACDC continued to monitor the situation.



SERRATIA MARCESCENS OUTBEAK ASSOCIATED WITH CARDIO-THORACIC SURGERY

BACKGROUND

Serratia marcescens is an aerobic Gram-negative bacillus that thrives in moist environments. This species of bacteria has been shown to contaminate solutions and hospital equipment and has been documented in a number of common source outbreaks [1]. In the US, *Serratia* species cause 1.4% of nosocomial bloodstream infections (BSI) [2].

On January 14, 2005, ACDC received a call from an acute care hospital reporting seven post-operative cardio-thoracic (CT) surgery patients with symptoms of systemic infection occurring within 24 hours after surgery over a 10-day period. At that time, blood cultures from three patients were positive for *S. marcescens*. The California Department of Health Services (CADHS) and CDC were consulted. Elective cardiac surgery was canceled by the hospital.

After extensive environmental cleaning and staff education, CT surgery resumed on January 24 with preliminary recommendations—this included appropriate environmental cleaning, medication management, hand hygiene, and antibiotic coverage. Despite compliance, four of the seven patients (57%) operated on after surgery resumed developed post-operative fever. CT surgery was cancelled again. According to the prior agreement of infection control implemented when reinstating this surgical procedure, all patients received prophylactic antibiotics during surgery to cover for *Serratia* infection. Blood cultures on all of these febrile patients were negative for bacterial infection. At this time, ACDC requested the assistance of the CDC Division of Healthcare Quality Promotion Epidemic Intelligence Service (EIS). And on January 25, the officer accepted the invitation to assist with the investigation.

Since no ongoing transmission of *S. marcescens* was demonstrated, CT surgery was resumed January 28 with the usual surgical prophylaxis regimen. Surveillance blood cultures were obtained from all CT surgery patients for a total of 5 weekdays to assist in early detection of *S. marcescens* bacteremia.

No additional cases of *S. marcescens* BSI among CT surgery patients were identified after five days. At that time, usual methods of post-operative infection surveillance were resumed. No further cases were identified.

METHODS/RESULTS

Observational and Environmental Studies: The day following receiving the report of illness (January 15), ACDC conducted a site inspection. This included reviewing policies and procedures; interviewing representatives of the operating room (OR), Cardiac Surgical Unit (CSU), and pharmacy; inspecting the OR and CSU; and obtaining numerous environmental specimens for bacterial culture by the hospital laboratory, hospital reference laboratory, and Los Angeles County Public Health Laboratory. Specimens included open vials of medication including multidose medication and drips, medication tubing, gel for echo sonogram, water samples from faucets and ice machine in the surgical unit, swabs from OR equipment, scrub sinks, and the ice machine filter. The bags that transported many of the specimens (one for each OR room) were also cultured.

Review of infection control procedures identified no major breaches. No *S. marcescens* was cultured from samples collected from the environment and open medications (Table 1).

Background *S. marcescens* Rate: Microbiology records at the hospital were reviewed for *S. marcescens* cultures from January 2004 to January 2005 and compared the rate of *S. marcescens* BSI prior to the

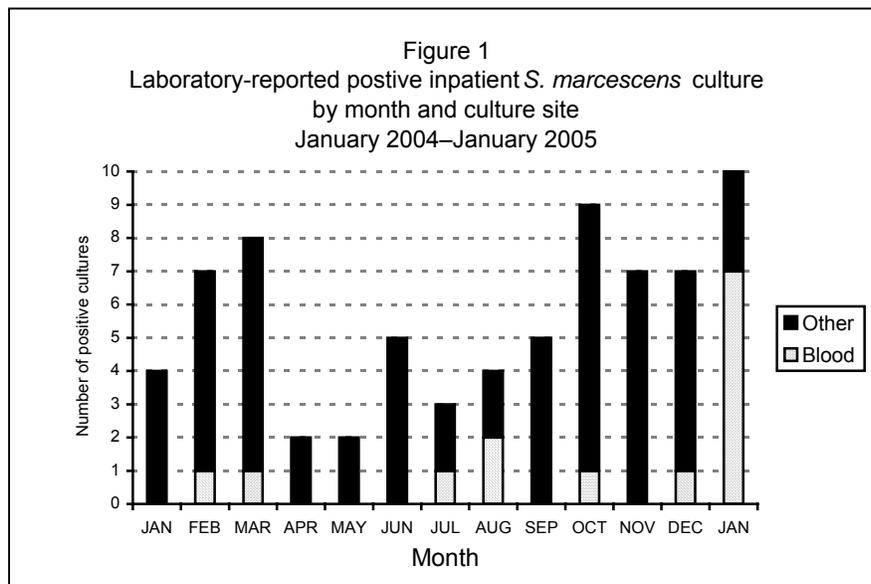


outbreak period (January 2004 to December 2004) to the rate during the outbreak period (January 2005) to determine if it had significantly increased.

Source	Number of Specimens	Results
Open medication vials	51	No <i>Serratia marcescens</i> isolated
Medication tubing	1	No <i>Serratia marcescens</i> isolated
Echusonogram gel	4	No <i>Serratia marcescens</i> isolated
Water samples	3	No <i>Serratia marcescens</i> isolated
Equipment	22	No <i>Serratia marcescens</i> isolated
Scrub sink soaps and lotions	21	No <i>Serratia marcescens</i> isolated
Ice machine filter	1	No <i>Serratia marcescens</i> isolated
Transport bags	4	No <i>Serratia marcescens</i> isolated

The rate of *S. marcescens* BSI cultures to total *S. marcescens* cultures during the outbreak period in January 2005 was 60% (6 of 10), which was significantly higher than the year before the outbreak period, which had a rate of 11% (7 of 63), $p < 0.001$.

Cohort Study Analysis: Two initial cohort studies of operational risk factors were conducted on all patients with CT surgery from January 10 to 15, 2005. In the first study, a case was defined as a patient with a positive blood culture for *S. marcescens*. In the second study the case definition was expanded to include patients with a positive blood culture for *S. marcescens* or a fever spike noted within 72 hours after surgery. In both cohorts, a non-case was a patient with no fever spike noted within 72 hours after surgery. Patient charts were reviewed for risk factors including personnel, equipment, medications, procedures, locations, and patient characteristics. All data were collected on standard forms, entered into Microsoft Access 2000, and analyzed by SAS 9.1.



The initial cohort and environmental studies of OR risk factors conducted by ACDC did not show any significant associations between OR risk factors (e.g., personnel, equipment, medications, procedures, locations, patient characteristics) and cases. No environmental or medication contamination was identified.

Molecular Epidemiological Analysis: The Los Angeles County Public Health Laboratory performed and interpreted pulsed-field gel

electrophoresis (PFGE), using standard methods and criteria, on *S. marcescens* isolates from all seven post-operative CT surgery patients as well as many reference samples from 2004 and 2005. A case was



subsequently defined as a patient with a *S. marcescens* blood isolate indistinguishable by PFGE banding pattern.

Using PFGE, six case-patients were infected with an indistinguishable strain of *S. marcescens*.

Baseline Temperature Study: To establish a baseline for the proportion of post-operative CT surgery patients with temperature spikes, a random sample of 29 CT patients operated from January 2004 to November 2004 (a non-outbreak period) was analyzed. Post-operative temperatures were analyzed as greater than or equal to 38.0°C, 38.2°C, and 38.5°C respectively.

Results showed 58% of post-op patients developed temperatures >38°C (Table 2). These data indicated that the rate of post-operative fevers in patients since resuming elective surgery (57%) remained at baseline.

Temperature	No. of Cases	% of Total	% of Fever Cases
≥ 38.0°C	14	58%	100%
≥ 38.2°C	10	42%	71%
≥ 38.5°C	5	2%	36%

Case-Control and Retrospective Cohort Study Analyses: A matched case-control study and a retrospective cohort study were also enacted. The case-control study compared case patients to randomly selected controls (1:3) who were present in the CSU within four hours of the case patients. The cohort study involved all patients in the cohort period (January 10, 2005 at 6:01am to January 16, 2005 at 3:00am) or until the patient was discharged from the CSU. All data were collected on standard forms, entered into Excel 2000 spreadsheets and analyzed using SAS software, version 8e.

Results from the matched case-control study showed the only risk factor of significance was magnesium sulfate [odds ratio (OR) 6.4, confidence interval (CI) 1.1-38.3]. Intravenous magnesium sulfate was administered within 24 hours to 100% (6 of 6) of the cases and 39% (7 of 18) of the controls. The cohort study showed significant associations between receipt of amiodarone (OR 4.9, CI 1.1-22.7), propranolol (OR 10.3, CI 4.1-26), calcium chloride (OR 10.3, CI 4.1-26), cell saver (OR 10.3, CI 4.1-26), or fresh frozen plasma (OR 10.3, CI 4.1-26) with *S. marcescens* infection.

Observational Studies: To identify potential sources and risk factors for transmission, several observational studies were performed. CSU and OR staff were interviewed regarding daily procedures, staff member roles, and infection control practices. Practices of cleaning, disinfection and sterilization of equipment were also assessed. Several patients were followed from the OR through the initial pre-operative and induction procedures in the CSU. Additional environmental samples were collected from the CSU to complement a complete environmental study of the OR that had been done previously by the ICP and DHS investigators.

Review of infection control procedures again identified no major breaches. No *S. marcescens* was cultured from over 36 samples from the environment and open medications.

Three case isolates were sent to the CDC Division of Healthcare Quality Promotion laboratory where they were confirmed to be *S. marcescens* with PFGE banding patterns indistinguishable from one another and matching a strain of *S. marcescens* cultured from an unopened bag of magnesium sulfate solution compounded by a single common pharmacy and from the blood of five patients in New Jersey.



DISCUSSION

Both the epidemiologic and microbiologic evidence support contaminated magnesium sulfate solution as the cause of this outbreak. In this outbreak, a major CT surgery center was closed and the situation was made public at the onset by a press release created and disseminated by the hospital. Given the nature of the outbreak (e.g., the severity of disease, rapid onset post-surgery, and complexity of the surgeries) a direct intravenous bolus of bacteria was suspected. ACDC focused attention in its initial investigation on procedures and personnel in the OR. For this reason, the initial studies conducted by ACDC failed to implicate the magnesium sulfate—since it was administered post-operatively in the CSU.

Though both the matched case-control and retrospective cohort studies included the CSU, only the matched case-control study implicated magnesium sulfate. This is probably due to the small sample size and the fact that the cohort study included a broader period of risk.

This investigation led to the eventual discovery of a multi-state outbreak caused by the same product that was compounded and nationally distributed by single common pharmacy in Texas. The US Food and Drug Administration issued an alert on one lot of the company's magnesium sulfate solution on March 18, 2005 [3]. The implicated common pharmacy initiated a nationwide magnesium sulfate solution recall of all 50 ml admixtures of MgSO₄ in 5% dextrose on April 8, 2005 [4]. As a result of this outbreak several public health concerns associated with compounding have been noted by FDA and CDC and will be explored.

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METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* OUTBREAK IN A BURN UNIT: THE EMERGENCE OF A RARE MRSA CLONE LOS ANGELES COUNTY, 2005

BACKGROUND

Methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged as a major cause of hospital morbidity and mortality throughout the world [1–3] and is now one of the most common infections acquired in the hospital setting. Hospital specialty units—such as the intensive care unit (ICU), neonatal ICU, and burn and transplant services—care for patients who are medically fragile, frequently immunocompromised and at increased risk for nosocomial MRSA infection. Burn patients, without the skin's protective barrier over large body surfaces, are particularly susceptible to nosocomial MRSA infection. Additional risk factors for nosocomial MRSA acquisition include antibiotic use and length of hospital stay [4].

On October 3, 2005, the ACDC was informed of 7 patients with MRSA infections in the burn unit of an acute care hospital in LAC. At the time of the call, the census in the burn unit was 15. Five of the initial infections occurred within an eight-day period at the end of September; one each occurred in August and the middle of September. Prior to August 2005, there had only been 4 MRSA cultures from patients in this unit during 2005. ACDC initiated an investigation to determine the source of the infections and to develop control measures.

METHODS

Setting: The burn unit is housed in a separate building attached by hallways to the main hospital building. The unit is licensed for 30 beds, though only 15–20 are generally in use. Locked double doors restrict public access to the unit, which houses both adult and pediatric patients. In addition to in-patient services, same day surgical services and outpatient clinic services are also provided.

Case Definition: A case was defined as an in-patient or out-patient of the burn unit during the outbreak period (August 22, 2005 to November 24, 2005) who had culture-confirmed MRSA isolate identical to the predominant outbreak clone either by pulsed-field gel electrophoresis (PFGE)—or if no isolate was available for PFGE—by antibiotic sensitivity pattern (antibiogram) that demonstrated sensitivity to only rifampin, vancomycin, and linezolid. Cases either had clinical symptoms or were identified by surveillance culture. Hospital charts of inpatients were reviewed for age, gender, admitting diagnosis and date, surgical procedures and dates, and outcome.

Case Identification: From October 3, 2005 to December 8, 2005 surveillance cultures were obtained from all inpatients twice a week. Surveillance cultures were obtained from multiple sites (wound, skin, nares) during dressing changes or surgical debridement procedures when appropriate to minimize patient discomfort.

Environmental Surveillance Cultures: A variety of environmental surfaces (patient rooms, recovery room, hyperbaric room, and tub room and hydrotherapy room) accessed by patients and staff were cultured before and after terminal environmental cleaning by ACDC personnel. In addition, hospital personnel performed environmental cultures on the burn unit operating rooms, staff soap dispensers and nursing counter area. All cultures positive for MRSA were submitted for PFGE.

Staff Identification and Surveillance: To determine which staff had the most contact with the cases, ACDC staff reviewed the hospital charts and recorded the physicians and ancillary personnel who had hands-on contact with the patients and their wounds. ACDC also reviewed the nurse assignment rosters for 3–5 days before cases had a positive culture for MRSA to identify those whose primary assignment was to eight or more cases.



ACDC also requested surveillance cultures from the healthcare workers (physicians, nurses, assistants, and others) who had contact with all or most of the cases. In addition, we also requested surveillance cultures from the primary housekeeping personnel. The facility chose to culture additional clinical personnel. Culture sites included nares, axilla, groin, stool, and, in selected cases, hands.

Molecular Epidemiologic Investigation: PFGE was performed on all available MRSA isolates (patient, staff, and environmental) by the LAC Public Health Laboratory. Individual DNA fingerprint patterns were produced for isolates using the restriction enzymes *SMA I* and *Eag I*. Isolate relatedness was determined according to the criteria by Tenover. Isolates were compared to others gathered in LAC and to national databases. The Centers for Disease Control and Prevention were consulted regarding the identification of the predominant outbreak clone

Infection Control Evaluation and Measures: On October 4, 2005, ACDC closed the unit to all new admissions through October 7, 2005. The unit re-opened for one week. However, on October 14, 2005, after notification that 3 of 6 previously MRSA negative patients were now surveillance culture positive, the unit was closed to elective admissions. The decision was made to keep the facility closed until it could be demonstrated that MRSA transmission had ceased for an entire week as evidenced by no new positive surveillance or clinical cultures for MRSA.

During the temporary closure, emergency admissions were permitted with the permission of the ACDC administrative officer of the day, and day surgeries were permitted only if patients and surgical and recovery room staff were kept separate from the unit staff and waiting room. ACDC also approved elective day surgery admissions to a separate floor as long as contact precautions and other control measures were maintained. Prospective patients were notified of the outbreak before admission.

Standard infection control measures including staff education, contact isolation for all patients (with or without MRSA), cohorting patients and staff, and terminal cleaning were implemented in a stepwise progression during the outbreak period. Terminal environmental cleaning of all bedside equipment and environmental surfaces¹ was performed several times during the outbreak, including steam cleaning the tub, shower and hydrotherapy rooms. All disposable supplies and equipment were discarded.

Personnel from the California Department of Health Services, Health Facilities Division, made a site visit and observed infection control practices in the facility and during surgery.

All patients in this unit were discharged by November 26, 2005 and the unit remained empty until November 28, 2005. Terminal cleaning of all surfaces took place in this time period and staff were decolonized as per protocol. ACDC recommended that selected healthcare personnel (those with hands on contact with the cases) be decolonized with a five-day treatment with intranasal mupirocin ointment and chlorhexidine soap. Treatment was to commence after the last contact with patients known to have MRSA.

RESULTS

Case Characterization: Between August 22, 2005 and November 30, 2005, 27 patients were identified with positive MRSA cultures, of which 23 (85%) met the case definition. Of these 23 cases, 20 were male (3 children, 17 adults) and 3 were female (1 child, 2 adults). Ages ranged from 11 months to 75 years, with a median age of 33 years. While one case was admitted for repair of keloid scars, the remaining (n=22) were admitted with some type of acute burn injury (e.g., tar, hot oil, or flash burns). Most (n=15, 56%) were admitted with second or third-degree burns. Of the 23 cases, 8 (38%) had symptoms of clinical infection (3 bloodstream, 5 wound) and 15 were colonized and identified by nasal and/or wound surveillance cultures. Many of the wound surveillance cultures were obtained during surgical debridement

1. As determined by both hospital policy and the 2003 Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee available at: www.cdc.gov/ncidod/hip/enviro/guide.htm.



procedures, which were the only time the bandages were removed from the wounds. One critically ill case with MRSA in the blood died; it is unknown if the MRSA was a direct cause of death.

Of the 23 cases, 4 were identified by surveillance cultures while they were receiving outpatient treatment for their burns by burn unit personnel. The date of discharge to positive culture date had a range of 70 (9 to 79 days), and a median of 15 days. Of the 19 cases who were hospitalized at the time of culture, the time between admission to the burn unit and positive culture date ranged from 4 to 13 days with a median of 10 days.

Surgical debridement procedures were performed on 14 of 16 cases with available medical information; 12 received multiple surgical debridement procedures during their hospitalization. One case had a surgical repair as a result of a past burn injury and did not undergo surgical debridement, and one case did not have any surgical procedures.

Four other patients were diagnosed with MRSA due to a variety of other strains during this time period, including three patients with clinical infections and one who had positive surveillance cultures.

Environmental Surveillance: Of the 25 burn unit samples obtained prior to terminal cleaning, 10 were culture positive for MRSA (hydrotherapy room bed, cabinet, and radio; shower handrails; patient room nurse recall control and bathroom door knob; nurse desktop; hyperbaric room videos; patient room bedrails; recovery room chart counter/desktop drawers). After terminal cleaning, 15 repeat environmental cultures were obtained and included 10 previously MRSA positive and 5 MRSA negative sites. All previously positive sites returned negative, but one previously negative site (tub-room silver railing) was positive for MRSA. Of the 13 burn OR samples obtained, 1 was culture positive for MRSA (lamps in OR #1). Neither of the soap dispenser sites nor the nursing counter area were positive for MRSA.

Staff Identification and Surveillance: The study identified five nurses who had the greatest number of contacts with cases as compared to the number of contacts with the control group. ACDC requested staff surveillance cultures from 17 health care workers (10 physicians, 1 physician assistant, 5 nurses, 1 burn technician) who had the most frequent contact with the cases and 3 environmental services (housekeeping) staff. The hospital staff cultured an additional 33 healthcare workers, for a total of 53 staff who received surveillance cultures. Of the 53 staff members tested, 3 were MRSA positive on initial culture (a nurse and two physicians).

MRSA Phenotypic and Genotypic Characterization: Review of the antibiotic sensitivity patterns showed that five of the initial seven cases had essentially identical multi-drug resistance patterns. These isolates were sensitive to only rifampin, vancomycin and linezolid—which is consistent with MRSA of healthcare origin. Also, isolates from 13 additional MRSA positive patients identified through surveillance cultures had the same antibiotic resistance pattern. Two cases had isolates that were sensitive to several antibiotics (including rifampin, vancomycin, linezolid, tetracycline, trimethoprim-sulfamethoxazole, amikacin, ciprofloxacin, gentamycin, imipenem and moxifloxacin).

Most (24 of 27) of the MRSA isolates were available for PFGE; of these, 21 were indistinguishable from each other with zero band differences. The CDC identified this strain as the “Brazilian” clone. One isolate was determined to be “untypeable” by PFGE and two isolates were different from the outbreak strain and from each other.

PFGE tests were also performed on 12 environmental isolates; and 7 isolates (all from pre-cleaning) appeared to have a similar if not indistinguishable PFGE pattern to the USA 300 community-associated (CA) MRSA strain; three had a similar if not indistinguishable PFGE pattern to the outbreak strain (including an OR sample, a pre-cleaning sample, and a post-cleaning sample), and the remaining two (pre-cleaning samples) were indistinguishable from each other but did match any other strains associated with this outbreak.



As determined by PFGE, one of the physicians and the nurse (both nares isolates) had the outbreak strain. The other physician (hand isolate) did not have the outbreak strain.

Outcomes of Infection Control Measures: Because of the closure of the unit by ACDC, the census in the facility went from a daily average of 12 (for the months of August, September and October) to a daily average of 4 in the month of November. Some elective patients chose to be admitted elsewhere when told of the ongoing outbreak. Repeated site visits and monitoring by the infection control practitioner revealed good adherence to standard and enhanced infection control measures (contact precautions, washing hands, limiting of visitors). However, the DHS Health Facilities evaluator identified several problems in the operating room that seemed minor at first, but when taken as a whole, showed a significant breakdown in surgical infection control (i.e., keeping the operating room suite doors open during procedures, etc.). The Health Facilities Unit's deficiency report of findings resulted in the facility providing a plan of corrective action and permanent operating room policy and procedure changes.

ACDC recommended decolonizing the two staff members with the outbreak strain of MRSA. Staff identified as MRSA surveillance culture positive were restricted from direct patient contact until fully decolonized and repeatedly negative on subsequent cultures. After the decolonization protocol, the 2 staff members with the outbreak strain tested negative for MRSA. The other physician was felt to be transiently colonized with a separate strain (repeat cultures, before decolonization, were negative) and the decolonization protocol was not required. As a precaution, the hospital decided to decolonize *all* burn unit staff; a total of 51 staff followed the decolonization protocol.

DISCUSSION

This report describes a prolonged MRSA outbreak, the measures taken to identify and interrupt the source of transmission, and the discovery of a rare MRSA clone. Several studies document the role of nursing workload and staffing patterns in the spread of MRSA and closing the unit to new admissions as an effective control measure [6]. However, decreasing workload (by closing the unit to new admissions) and good adherence to infection control did not appear to play a significant role in the limiting the spread of this pathogen, since MRSA transmission continued to occur, despite generally good adherence to contact precautions, environmental cleaning, and reduced census. MRSA transmission was ultimately contained after the unit was completely closed and terminally cleaned, and after all staff received decolonization and culture positive staff were barred from treating patients until they testing negative. A single source for this outbreak was not identified but we surmise that personnel were the most likely source of the MRSA given the continued spread of MRSA despite adequate infection control and that the nurse and physician who tested positive for the outbreak strain had significant contact with all the patients and their wounds. Of note, 4 patients were identified after discharge while they were receiving outpatient therapy for their burns and their only ongoing connection to the facility was personnel who treated both in and outpatients. However, other forms of transmission could not be ruled out.

Upon CDC review of the PFGE pattern, it was determined that the outbreak isolate was the Brazilian "clone" rarely seen in the United States. The Brazilian clone is the most common type of MRSA in parts of South America and has been reported in Hungary and Portugal, Argentina, Uruguay, Chile and the Czech Republic [3]. We know of only one other report of this strain causing an outbreak in the United States. In previous publications, it has been recognized that a substantial number of hospital-acquired infections are caused by unique MRSA epidemic clones, and these organisms should be recognized as a major global health problem [1,5]. Also, in addition to the outbreak strain there were five distinct MRSA strains identified among the patients and staff, and three distinct MRSA strains identified in the environmental cultures, of which two of the environmental MRSA strains were not represented in the patient strains and two of the patient strains were not found in the environment. It is notable that the majority of environmental isolates were the community-associated, USA 300 strain, which has been linked to outbreaks of skin infections, yet no patient had evidence of this strain. It is possible that the adherence to infection control prevented the spread of this strain (and the other non-outbreak strains) from the environment to the patients.



This persistent MRSA outbreak lasted 2 months. The organism endured in the burn unit despite enhanced infection control measures and the diligence of the staff. It is controversial to screen healthcare personnel for MRSA during an outbreak. Our standard policy is to not perform surveillance cultures on healthcare personnel as part of the initial response to controlling an outbreak because it is unclear what to do with non-epidemiologically linked personnel who are colonized with significant organisms. However, in the situation of continued transmission despite aggressive infection control, early screening of epidemiologically linked staff for MRSA and surveillance cultures may be helpful to determine the source of transmission and prevent further transmission.

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COMMUNITY-ASSOCIATED METHICILLIN RESISTANT *STAPHYLOCOCCUS AUREUS* IN THE LOS ANGELES COUNTY JAIL: A 4-YEAR REVIEW

BACKGROUND

Methicillin resistant *Staphylococcus aureus* (MRSA) is well known as a nosocomial (healthcare acquired) pathogen. However, since the 1990s, MRSA has been increasingly recognized as a community pathogen. Community associated MRSA (CAMRSA) is distinguished from healthcare associated MRSA (HAMRSA) by clinical and molecular characteristics—HAMRSA is associated with invasive disease (pneumonia, bloodstream infections, surgical site infections) in older persons who have significant exposure to healthcare while CAMRSA causes mostly skin and soft tissue infections, which are often misdiagnosed as “spider bites.” CAMRSA tends to be sensitive to many oral antibiotics whereas HAMRSA, especially in intensive care units, may only be sensitive to intravenous antibiotics. CAMRSA is further distinguished from HAMRSA by the presence of genes for Panton-Valentine leukocidin (PVL), a potent toxin that causes tissue necrosis, and is associated with skin inflammation. Furthermore, CAMRSA and HAMRSA have distinctly different pulsed-field gel electrophoresis (PFGE) patterns, indicating that they derived from different strains of *S. aureus*.

Outbreaks of CAMRSA have been frequently documented in sports teams, the military and correctional facilities where close, crowded living conditions, sharing personal items, and suboptimal hygiene prevail. Outbreaks in correctional facilities are particularly important because in 2004 more than 2 million people were held in correctional facilities in the United States and were therefore at increased risk for acquiring this disease. Despite several reports of CAMRSA in correctional facilities, there are few reports describing the changing epidemiologic trends in this environment. Here we describe four years of epidemiologic trends of MRSA infections in the Los Angeles County Jail—the largest jail in the United States.

Inmates at the Los Angeles County Jail (LACJ) started to complain of “spider bites” in September 2001. In response, the Jail Medical Services instituted a “spider bite” protocol that consisted of, in part, culturing the lesion and treating the inmate an oral antibiotic, an antihistamine, and painkillers. MRSA was first identified in such lesions in February 2002. Several spiders were captured in the spring of 2002 and identified as non-biting species by the Los Angeles County Department of Health Services (LACDHS) entomologist, but nonetheless, the LACJ applied pesticides to inmate quarters. When application of pesticides did not abate the cases of MRSA skin infections, LACJ contacted the ACDC. An investigation was launched to determine the incidence of newly acquired MRSA in the inmate population; treatment and control measures were also recommended.

METHODS

Setting: The LACJ is comprised of seven facilities, of which only one is dedicated to women. Male inmates are routinely transferred between facilities for security purposes. LACJ primarily uses one hospital for all hospital care (reference hospital “A”). From 2000–2004, there were 162,406–179,314 admissions per year. The average daily inmate population fell from ~20,000 (19,297) in 2000 to 17,451 in 2004 primarily because of early release programs instituted during this time. Hygiene standards are regulated by Title 15 of the California Code of Regulations which require that inmates be offered the opportunity to shower three times a week and new underwear be offered twice a week while new jumpsuits and bedding need only be offered once a week. During this time period, females lived primarily in large, open dorms with access to showers 18 or more hours per day. Males lived in a combination of open dorms with daily access to showers and 4–6 man cells with limited shower privileges.

Epidemiologic Investigation: An incident case was defined as an inmate of the LACJ who had a MRSA positive culture from a wound site or blood specimen from January 2002 through December 2005. Cases were identified by staff at LACJ and from a monthly list of positive culture results from the LACJ reference laboratory that processed all cultures taken on non-hospitalized inmates. Cases diagnosed at a referral



hospital used by the LACJ (hospitalized inmate cases) were recorded separately and are not part of this analysis. Inmates with more than one positive MRSA culture during a LACJ admission were counted as an incident case in the first month a positive culture was recorded and subsequent positive MRSA cultures from the same inmate were not recorded as incident cases though additional wound sites and antibiotic susceptibility results were abstracted.

Reference laboratory reports were used to identify the susceptibilities of the MRSA isolates to the following antibiotics: gentamicin, trimethoprim-sulfamethoxazole (TMP-SMX), clindamycin, erythromycin, vancomycin, and tetracycline. In addition, personnel at LACJ provided the following demographic and supplemental information: birth date, gender, admit date to the Jail, Jail facility at the time of culture, culture date, wound site, and antibiotic treatment. Race/ethnicity was a variable added in mid-2005. LACJ personnel also provided data regarding the total number of admissions to the Jail each year.

Cases were analyzed by month of culture date, gender, age, race/ethnicity, wound site, LACJ facility at the time of culture, and by time (in days) between admission to the Jail and date of culture. Cases cultured ≤ 5 days after the date of admission to LACJ are presumed to have acquired their infections from the community and those cultured >15 days are presumed to have acquired while in LACJ. Antibiotic susceptibility trends for MRSA skin and soft tissue cultures were analyzed yearly.

Data were entered into an Access 2002 database and were analyzed using SAS version 9.1. Analyses are presented as whole numbers and percentages.

Laboratory Investigation: In 2002, randomly selected MRSA isolates from outpatient (n=7) and hospitalized (n=5) inmates with wound infections were analyzed by PFGE at the Los Angeles County Public Health Laboratory and compared to a national database of MRSA isolates.

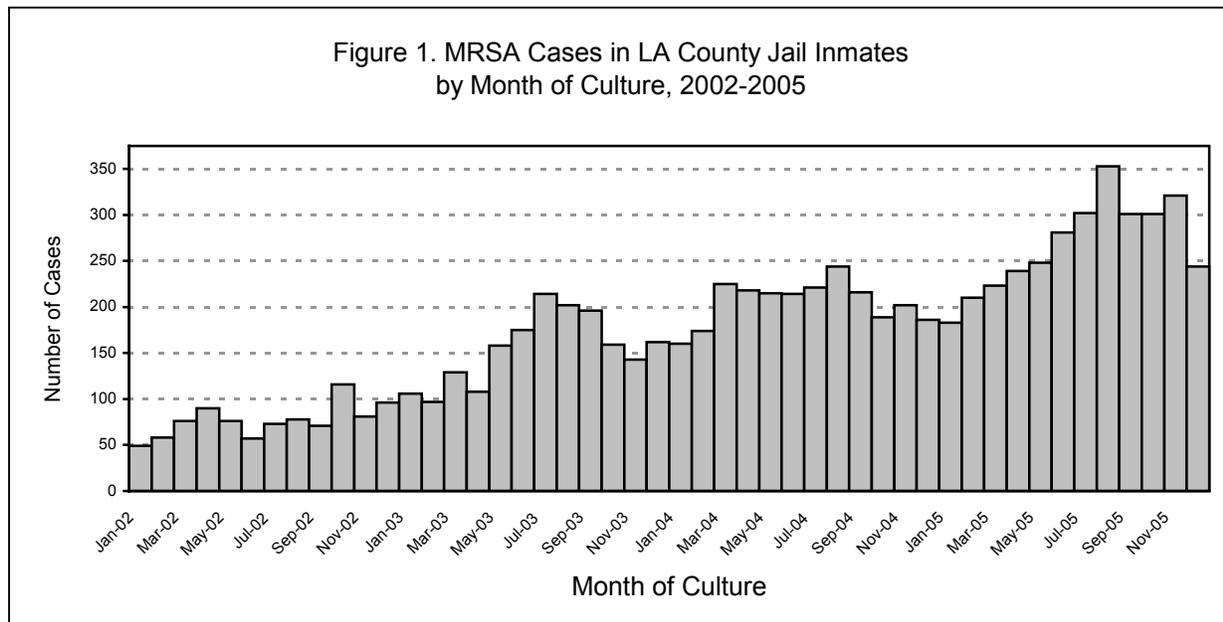
Infection Control: In August 2002, LACDHS issued the following recommendations: screen inmates on admission to the Jail for skin lesions; culture all inmates with skin infections; use empiric antibiotics (if needed) for skin infections that cover MRSA including clindamycin or TMP-SMX; double the laundry exchanges, increase environmental cleaning, and educate inmates and guards about MRSA. Targeted education about MRSA was developed by LACJ and ACDC. These recommendations were supplemented with monthly (later bi-monthly) task force meetings with LACJ and ACDC personnel.

RESULTS

Epidemiology: A total of 921 cases in 2002, 1,849 in 2003, 2,464 in 2004, and 3,214 in 2005 were identified (Figure 1). The incidence of MRSA cases in men increased from 6.1/1000 jail admissions in 2002 to 13.8 in 2005. The incidence of MRSA cases in women increased from 4.3/1000 jail admissions in 2002 to 12.0 in 2005, peaking at 13.8 in 2004 (Table 1). The mean age of cases was 36 years (median 36 years, and range: 17–86 years). The majority (83%) of cases were male. There were no differences in age between male and female cases. Both age and gender distributions were stable over the four years of surveillance. Since mid-2005, most cases were Black (36%), followed closely by Latino (34%), then White (29%). More male cases were Latino than White (36% v. 26%) whereas more female cases were White than Latino (39% v. 26%).

Year	Male	Female
2002	6.1	4.3
2003	11.1	10.6
2004	13.5	13.8
2005 [†]	13.8	12.0

* Number per every 1,000 admissions.
[†] Data unavailable for July, October through December.



Trends in the acquisition of outpatient MRSA varied over time. The percentage of infections identified >15 days after admission to LACJ (and hence presumed to be acquired in the LACJ) decreased from 76% in 2002 to 41% in 2005; whereas the percentage of infections assumed acquired from the community (those identified ≤5 days) increased from 9% to 36%. However, the total number of jail-acquired cases increased each year from 2002 to 2005 (553 cases to 1729 cases). By the end of 2005, both the number and proportion of community-acquired and jail-acquired MRSA infections approached parity. Acquisition patterns varied by gender—CAMRSA infections were usually identified earlier in female inmates than in male inmates. By the end of 2005, about half (51%) of the female cases were identified in the first 5 days after admission, versus 43% of the cases in male inmates.

Though the overall number of cases of MRSA in the LACJ increased, the absolute number of cases entering from the community increased faster than the absolute number of cases acquired in the facility. Furthermore, the number of cases in inmates diagnosed at referral hospital A increased by 7% from 2004 to 2005 (104 to 111 cases) compared to a 30% increase in the number of cases diagnosed at the LACJ in those years, suggesting that many of the cases identified in 2005 at the LACJ were relatively minor or that LACJ personnel were able to identify cases earlier in their course and provide adequate treatment, forestalling hospital admission treatment.

A seasonal trend in MRSA incidence emerged. Beginning in 2002, case counts peaked during the summer months (July or August) and declined between November and March (Figure 1). Three other peaks in the data are notable including October 2002, March 2003, and March-April, 2004. During these peak months, personnel from LACDHS provided education to healthcare personnel at the LACJ, including reinforcing the recommendation to culture all wound infections. The peaks in cases that month may reflect better surveillance for cases.

MRSA infections were identified on all areas of the body. The predominant locations were legs and feet (30%), followed by arms and hands (23%). MRSA isolates have remained susceptible to clindamycin, rifampin, and TMP-SMX, ranging from 94% to 99% susceptibility since 2002 (Table 2). Of note, there was an increasing susceptibility to tetracycline over the surveillance period.

In 2002, over 50% of incident wound infections each month cultured positive for MRSA and the percent of incident *S. aureus* infections by month that were due to MRSA varied between 66% and 84%. Analyzing



available aggregate data in 2002–2004, the percent of wound infections and percent of *S. aureus* that were methicillin resistant (i.e., MRSA) were 56–65% and 73–78% respectively.

Antibiotic	Year			
	2002	2003	2004	2005
Clindamycin	97	97	96	94
Tetracycline	65	76	82	84
TMP-SMX	98	99	99	99
Rifampin	100	99	99	99

Molecular Epidemiology: PFGE results demonstrated one predominant strain seen in all cases, the USA 300-0114 CAMRSA strain. This strain was also seen in several other MRSA skin infection outbreaks since 2002 in Los Angeles County including among men who have sex with men, an athletic team, and hospital newborn nurseries.

DISCUSSION

This summary provides a review of the largest outbreak of CAMRSA known to date. More than 1% of the population in the LACJ acquired a CAMRSA infection each year, more than the current estimate of a general population prevalence of CAMRSA colonization of 0.5%–1%. While the overall number of infections has continued to rise over the four years, there are notable trends that indicate that infection control measures have slowed the growth of jail-acquired CAMRSA. First, the greatest increase in the rate of MRSA occurred from 2002 to 2003 when increased surveillance, not just increased disease incidence, may have accounted for much of that increase. While the number of LACJ identified infections increased by 30% from 2004 to 2005, the number of infections identified by the reference hospital in inmates increased only by 7%. Furthermore, there was a more rapid increase in the number of infections coming from the community in the past 4 years (those identified within 5 days of admission to the LACJ) than the number of jail-acquired infections (identified >15 days after admission to the LACJ). The increase of community acquired MRSA infections is not surprising since it has been noted that the proportion of skin infections seen in a Los Angeles County emergency room due to MRSA increased from 29% in 2001 to 64% in 2004. Others in California have documented CAMRSA in homeless and drug using populations and these populations are disproportionately represented among LACJ inmates. The continually increasing number of infections coming from the community will challenge strategies to control MRSA in the LACJ.

Our analysis employed a cut-off of 5 days after admission to the LACJ to designate cases as “community-acquired” and 15 days after admission to designate cases as “LACJ acquired.” This range was used based on the average incubation period for a *S. aureus* skin infection plus a few days because of the potential delay in being tested at the LACJ. We realize that these designations are arbitrary and that an infection identified in the first 5 days may be a fast growing infection in a recently admitted and exposed inmate or may be due to exposure to MRSA during a previous incarceration and therefore represent LACJ acquired disease. Conversely, those infections identified more than 15 days after admission to the LACJ may be secondary to colonization acquired prior to admission to the LACJ or may be due to a slow growing infection or inmate who did not present to the medical staff upon first onset of symptoms. However, we believe that by dividing the cases into 5 and 15 days after admission, we have balanced sensitivity and specificity in our case definitions.

Several other trends are notable including the seasonal (summer) increase in infections, gender disparities, and antibiotic susceptibilities. Warm weather peaks of CAMRSA have been seen in other studies and the increased incidence of CAMRSA during this time might be due to increased skin-to-skin contact due to outdoor, physical activities with decreased skin coverage by clothes. The greater prevalence of MRSA among women entering the LACJ may be explained by women’s greater healthcare



seeking behaviors and a greater proportion of women incarcerated for drug charges than men in correctional facilities; drug use is a risk factor for CAMRSA. Finally, despite the heavy use of TMP-SMX, clindamycin, and rifampin for empiric treatment of wound infections, this jail strain of MRSA is remaining largely susceptible to these antibiotics. Furthermore, with a decrease in the use of tetracycline as a first line treatment for skin infections (as had occurred prior to 2002), MRSA is becoming more susceptible to this antibiotic.

This study is descriptive and has limitations, which might both under- and over-estimate the number of MRSA infections reported at the LACJ. At the beginning of the outbreak, many LACJ physicians did not culture wound infections so that the number of MRSA infections is probably undercounted early in the outbreak. It is certainly possible that the doubling of cases of CAMRSA from 2002 to 2003 was due to better surveillance. Evidence for this is seen in the peaks of MRSA cases in October 2002, March 2003, and March/April 2004 after DHS physicians directly emphasized to LACJ healthcare personnel the need for expanded culturing of wound infections. Overall, the number of cases recorded here are probably an undercount of the true number of cases associated with the LACJ for the following reasons: inmates may not have felt comfortable approaching security or medical personnel, medical personnel may not have cultured a lesion or the infection (like cellulitis) was not able to be cultured, only skin/soft tissue and blood infections were counted and MRSA can affect the entire body, and inmates may have been exposed to MRSA while in LACJ but not exhibit symptoms of infection until after discharge from the LACJ and those cases would not be counted. Furthermore, we were only able to identify inmates by their booking number, which is unique for each arrest (not each person). Therefore, inmates who had a case of MRSA on one admission to the LACJ and also presented with MRSA on subsequent admissions to the LACJ will be counted as two (or more) incident cases, rather than one. Depending on the recidivism rate, the number of MRSA cases might be artificially inflated. Finally, by only counting incident and not repeat cases of MRSA, we may have underestimated the burden of this disease on this population because we did not count recurrent disease which is a common manifestation of this pathogen.

Jails are short-term correctional facilities and have a high turnover. Unlike a hospital or a sports team, where the goal of complete eradication of MRSA is feasible, the goal in this situation is to mitigate the spread of MRSA in the facility. Current guidelines focus on improving diagnosis, treatment, and personal and environmental hygiene; but it is hard to maintain increased vigilance given the high turnover of inmates and the limited resources that most correctional facilities face. The control measures we recommended were not able to eradicate MRSA from LACJ for several reasons including limited financial resources and limited personnel to ensure cleaning, education, and screening. Furthermore, it is clear that as long as MRSA is prevalent in the outside community, it will be continually re-introduced in the LACJ. More research is needed into determining the greatest preventable risk factors for MRSA in these situations and the most efficacious interventions.





HUMAN RABIES DEATH IN LOS ANGELES COUNTY: FIRST HUMAN CASE IN 30 YEARS

On January 21, 2005, ACDC received a call from the Los Angeles County (LAC) Coroner to report pathology findings highly suspicious for rabies. The decedent, a 22-year-old man who was born in El Salvador, had been in Los Angeles for 15 months prior to his death on October 26. Additional specimens for rabies testing were sent to the CDC, which subsequently confirmed the rabies diagnosis. On January 27, CDC reported that the rabies variant is one not present in the US, but is a canine variant from El Salvador. Interviews with local household contacts and family members in El Salvador revealed no history of animal bites or exposures—however, canine rabies is enzootic in El Salvador, Guatemala, and Mexico, the route he traveled to come to the US. Contact tracing identified at least 30 friends and family members to whom rabies post-exposure prophylaxis was highly recommended. In addition, 9 of 76 healthcare workers at risk were identified to receive post-exposure prophylaxis.

Prior to death, the decedent was seen at three separate LAC healthcare facilities. First on October 19, 2004, the decedent was seen at a clinic complaining of nausea, vomiting, and right lower back pain—a urinary tract infection was diagnosed and he was given antibiotics and pain medication. On October 20, he returned to the clinic for follow up—kidney stones were diagnosed and he was again given pain medication. Later that day he presented to a hospital emergency department with continued right-side flank pain. He was afebrile; records note he had also complained of throat tightness. Evaluation was found to be consistent with kidney stones and he was discharged. That evening, according to household members, he became agitated and confused, and had increased salivation. On October 21, the decedent was admitted to a second hospital with lower back pain and was evaluated for kidney stones. Records show that throughout the course of hospitalization he was combative, confused, and agitated, and displayed excessive salivation. Computerized tomography showed evidence of kidney stones. Records also indicate he had fevers and elevated peripheral white blood cell count. In addition, the decedent became increasingly violent—at one point biting a friend on the wrist and scratching a nurse.

A review of the medical records at the second hospital indicates that the infectious disease physician who evaluated the patient on October 26 included rabies in the differential diagnosis—but Public Health was never notified. The patient's clinical status rapidly declined and he was evaluated for a possible surgical emergency. On October 26, the patient went into cardiopulmonary arrest and died. Specimens for rabies testing and encephalitis work-up were ordered, but could not be completed due to his sudden cardiopulmonary arrest. The LAC Coroner subsequently assumed responsibility for this case.

California law mandates that rabies cases, including suspected cases, be reported immediately by telephone to the local health officer (California Code of Regulations, Title 17, Section 2500). Had this rabies case been recognized and reported sooner, Public Health could have assisted in the diagnosis, and numerous individuals would have likely avoided exposure, injury and prophylaxis.

This case illustrates the importance of considering the complete patient history, especially country of origin and travel history, during diagnosis. While human rabies is very rare in the US, it is more common in other countries—and in particular, in countries whose citizens frequently immigrate to Los Angeles. In fact, the last confirmed human death due to rabies in Los Angeles County, in 1975, was a 16-year-old girl from Mexico who had been living in Los Angeles for eight months—investigation revealed that a dog bit her while she was in Mexico. California is home to the largest number of legal immigrants nationwide, and over one-third of these immigrants settle in LAC. In a 1999 LAC Health Survey, almost one-third of respondents stated they were born outside of the US. In addition, travel and foreign visitors are very common in LAC. In terms of air travel alone, almost 55 million travelers come through the Los Angeles International airport every year, making it the nation's third busiest airport. Moreover, many serious diseases (e.g., SARS, avian influenza) have nonspecific presentations that can easily be misdiagnosed—but it is the epidemiologic factors (i.e., exposure and travel history) that are critical for accurate diagnosis.



With rabies, another important factor that must be considered is the importation of infected animals. While rabies is uncommon among domesticated animals in LAC, in 2004, Public Health investigated two separate incidents—both resulted from the importation of suspected rabies infected dogs [1]. In both instances many individuals were potentially and unwittingly exposed to a deadly disease. Rabies, therefore, should not be excluded from differential diagnosis in LAC. Moreover, all cases suspicious for rabies should be reported immediately to Public Health.

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CORRELATION OF INFLUENZA AND RESPIRATORY SYNCYTIAL VIRUS WITH TOTAL VOLUME OF EMERGENCY DEPARTMENT VISITS IN LOS ANGELES COUNTY

BACKGROUND

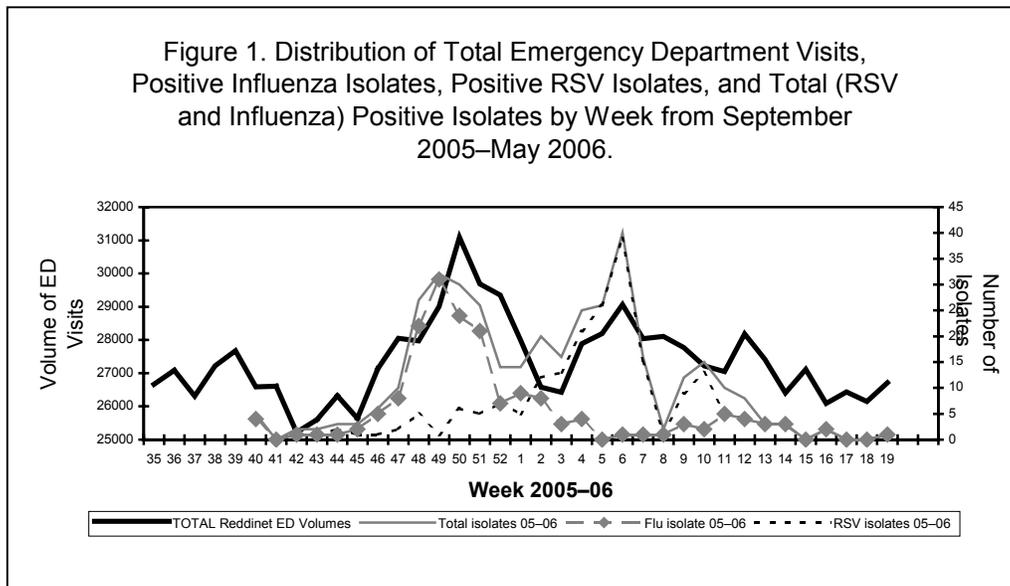
This study describes the ability by which total volume of emergency department (ED) visits correlate with influenza activity in the community. In Los Angeles County (LAC), the ReddiNet[®] system has been employed to survey: total daily volume of emergency department visits, intensive care unit (ICU) admissions, hospital admissions, and deaths from participating hospitals.¹ The system has been utilized to facilitate the early detection of large, sudden increases in volume of ED visits. Currently, ReddiNet is a complementary system to enhance influenza surveillance in the community.

METHODS

For the ReddiNet system, an electronic poll collects ED volume data for the previous day from 65 participating hospitals throughout LAC. Utilizing total volume of ED visits collected by the ReddiNet system, hospitals with >90% daily reporting (39 hospitals) during the 2005–06 influenza season were selected for this retrospective analysis. Selected hospitals were well-distributed geographically, representing 57.7% of total licensed beds. Positive influenza and respiratory syncytial virus (RSV) isolate counts were obtained from the LAC Public Health Influenza Surveillance project for comparison.²

RESULTS

The distribution of total emergency department visits for the selected hospitals revealed a first peak corresponding with total volume of laboratory positive influenza isolates and a second peak corresponding with total volume of laboratory positive respiratory syncytial virus (RSV) isolates. Due to the biphasic nature of this trend, a correlation coefficient ($r=0.73$; $p<0.0001$) was calculated between total ED volume and total number of laboratory positive isolates (influenza and RSV), suggesting the two temporal trends are strongly correlated. Taken separately, a strong correlation was found between total ED visits and influenza ($r=0.63$; $p=0.001$); however, the correlation observed between total ED visits and RSV was not statistically significant ($r=0.26$; $p=0.2160$).



1. Additional information about the ReddiNet system is available at: www.reddinet.com

2. The methods for obtaining influenza and RSV isolates for Los Angeles County surveillance have been described previously at: <http://159.225.130.92/acd/docs/flu%20special%20report.pdf>



DISCUSSION

ED volume surveillance systems strongly correlate with virologic test results. Studies are under way to evaluate additional algorithms for assessment of ED volume data to further enhance detection of influenza prospectively. Future studies would profit from collaborative studies with syndromic surveillance systems to obtain syndrome and age categories of ED visits for further assessment of disease burden from RSV and influenza in LAC [1]. The main limitations of this study were the inability to stratify data by age or syndrome categories, and the lack of information regarding total number of influenza and RSV tests performed. In addition, increasing sentinel influenza surveillance sites could capture a more representative population of LAC.

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A SUBURBAN NEIGHBORHOOD OUTBREAK OF MURINE TYPHUS SOUTH PASADENA, MAY 2005

BACKGROUND

Murine typhus is an acute febrile illness resulting from infection with *Rickettsia typhi*—a small Gram-negative, obligate intracellular bacterium. It is transmitted to humans by flea bites and contamination of the bite site or skin abrasions with *Rickettsia typhi*-containing flea feces. Murine typhus is known to be endemic in southern California and Texas—most cases in these two regions have occurred in the absence of the classical transmission cycle; i.e., the flea vector (*Xenopsylla cheopis*, and the oriental rat flea) and the rodent host (*Rattus norvegicus*, the brown rat). However, peridomestic opossums and their fleas have shown to play an important role in murine typhus transmission—especially in urban and suburban areas of Los Angeles County (LAC). Annually, approximately 8 to 17 murine typhus cases are reported in LAC. Most cases are residents of central LAC foothills. Transmission of infection is most likely due to reservoir animals such as opossums and rats that live in these areas with heavy foliage.

In mid-May 2005, ACDC investigated an outbreak of murine typhus involving residents a single street block in South Pasadena. The index case was hospitalized on May 14 at a medical center in the San Gabriel Valley with a febrile-rash syndrome and was initially suspected of having West Nile virus (WNV) infection. Subsequent serologic laboratory studies supported the diagnosis of murine typhus. Further investigation was prompted when ACDC subsequently received telephone calls from the index case's neighbors experiencing similar compatible symptoms. Ultimately, two confirmed, two probable and two possible cases were documented (see case definition below).

METHODS

Case Finding: Murine typhus is on the list of reportable communicable diseases within LAC. The index case was diagnosed and reported from a large medical center in the San Gabriel Valley on May 14, 2005. Following this report, the LAC Department of Health Services (DHS) Communication Office drafted and disseminated a press release that: 1) described the ongoing investigation of murine typhus, 2) advised clinicians to report suspect cases to Public Health, and 3) recommended that individuals with signs and symptoms consistent with murine typhus seek medical care. The press release was circulated to local newspapers in known typhus endemic areas and posted on the LAC DHS website. In addition, a health alert network (HAN) communication summarized the press release and was disseminated to emergency rooms and clinicians. Residents of households within three blocks were notified of the ongoing investigation, provided with health information, and were requested to seek medical attention should they develop compatible symptoms. Finally, since an elementary school was located across the street from the investigation site, a letter was sent to all parents and students of this school that advised them of the outbreak investigation and recommended that they seek medical attention should they develop consistent symptoms of infection.

Investigation: An ACDC public health nurse interviewed each suspected case, completed a standardized case history report and reviewed hospital or clinic medical records if available. The Alhambra district public health nursing unit assisted with obtaining specimens for confirmation of these suspected cases.

Laboratory Testing: Free serological testing by immunofluorescent antibody (IFA) was provided through the LAC Public Health Laboratory (PHL) for diagnosis and confirmation of cases. In addition, serum already tested at commercial laboratories were also sent to LAC PHL for additional confirmatory IFA testing.

Environmental Investigation: On May 25, LAC DHS sent an environmental health specialist, an epidemiologist, and a public health nurse to conducted interviews and inspect the homes and yards of three of the four suspect households. The environmental health specialist inspected the properties for



overgrown foliage, rats, and opossums. Educational materials on murine typhus was distributed to the households within three surrounding blocks of the suspected households and to the local elementary school located across the street of the index case.

Case Definitions:

- **Confirmed:** Laboratory confirmation of murine typhus infection plus consistent clinical signs and symptoms including at least two of the following: fever, headache, myalgias, rash or fatigue with supporting. Confirmation was defined as paired serological specimens showing at least a four-fold rise in IgG antibodies between acute and convalescent sera.
- **Probable:** At least two clinical signs and symptoms consistent with murine typhus infection without a supporting alternative diagnosis, but only a single supportive positive serological test suggesting recent infection (IgM > 4 times and/or IgG > 4 times normal).
- **Possible:** At least two clinical signs and symptoms consistent with murine typhus infection without supporting alternative diagnosis, but no laboratory results to support the diagnosis.

RESULTS

Surveillance for cases revealed a total of six cases (Table 1), two female (including the index case) and four male. The average age of the cases was 46.7 years (median 49 years). Of the six cases, illness was confirmed in two cases (the index case and her son), probable in two cases and possible in two cases. Onset of symptoms occurred within roughly 2 weeks of each other during March 2005.

Index Case (Case 1): The index case was a previously healthy 49 year-old female who reported symptom onset on May 6, 2004. She reported a history of fevers up to 104° F, nausea vomiting, fatigue, muscle pain and a faint macular-papular rash on her chest and abdomen. She sought medical care and was diagnosed with a viral syndrome by her primary care physician. After eight days of persistent symptoms, she was admitted to a local medical center with a diagnosis of fever and dehydration. Her treatment revealed elevated transaminases five times normal values; however, a viral hepatitis panel was negative. Her blood and urine cultures were negative and radiological studies were normal. During her hospitalization, an infectious disease consultation was completed where animal, mosquito, travel, and flea exposures were queried. She reported she had recently found three dead possums on her property and has two indoor/outdoor cats with recent histories of flea bites. Both murine typhus and WNV serologies were subsequently ordered. Acute murine typhus serology revealed borderline positive IgM and negative IgG. Convalescent serology drawn two weeks later was strongly positive—both IgM and IgG had increased 16-fold since her acute serology (Table 1). Her WNV serology was IgG positive but IgM negative. The case was treated with a short course of doxycycline and improved quickly.

Case 2: Approximately 10 days after her symptom onset, her 10 year-old son also reported experiencing fevers, fatigue, and muscle weakness without rash. He was seen by his pediatrician and was diagnosed with a “viral syndrome.” Upon request, murine typhus serologies were obtained, but did not support the diagnosis of acute infection. Convalescent titers, obtained two weeks later, were strongly positive (1:1024 IgM and IgM), thus supporting the diagnosis of murine typhus. The son’s symptoms resolved on without treatment.

Cases 3 through 6: Four additional suspected cases were investigated—all residing in households on the same street as the index case. Two of the four cases (Case 3 and Case 6) were classified as *probable* since both had clinical signs and symptoms consistent with infection and a single supportive serological specimen; these cases were not hospitalized, but treated with doxycycline and improved rapidly. Both had convalescent serologic evaluation taken 10 and 18 days after symptom onset. Case 3 had IgG and IgM titers 16 times the normal value and Case 6 had IgM two times normal and IgG eight times above the cut off.

Two additional cases (Cases 4 and 5) had symptoms suggestive of murine typhus without any other explanation. In both cases, serologic testing either did not support the diagnosis or was not obtained. As such, both were classified as *possible* cases. Because of his age (81 years), Case 4 was hospitalized to



rule out sepsis and was found to be hypotensive. His onset date was 17 days after the index case. An acute murine typhus serology was obtained during his hospitalization, but being within the normal cut off values this did not support the diagnosis of murine typhus infection. Unfortunately, Case 4 would not consent to convalescent serologic laboratory testing. Case 4 was presumptively treated with doxycycline and recovered. Case 5 was the nephew of Case 4 and also resided in the same household. He reported fever and chills for seven days—nine days after index case's onset. Case 5 refused any offers to have serologic testing. He recovered without treatment.

Environmental Investigation: A site investigation conducted May 24 did not reveal any opossums (live or dead) on the four properties of the six cases; however, the cases of three of the households (representing Cases 1, 2, 3, and 6) self-reported the presence opossums. Most notably, the index case reported that three dead opossums had been removed by animal control a few weeks earlier—this is significant considering the index case and her son (Case 2) were the only cases with confirmed infection in this investigation.

In addition, during the environmental investigation tree rats were noted on the property of the index case and her son (Case 1 and Case 2) and on one of the neighboring households (Case 3). In addition, significant overgrown vegetation was noted on all four properties. No additional trapping for opossums or rats, cat serological testing, or flea collection was completed during this investigation.

DISCUSSION

Murine typhus is an established endemic vector-borne disease in LAC. Surveillance has demonstrated it is localized to hillsides and adjoining communities of Pasadena, Alhambra, South Pasadena, and Los Feliz. Fortunately many clinicians, especially infectious disease clinicians, in these endemic areas are aware of the risks and order appropriate diagnostic testing.

Despite extensive outreach to find additional murine typhus cases, only two definite, two probable, and two possible cases were found on one street block of adjacent houses—no additional cases were found on adjoining streets. Although small clusters of murine typhus cases have been documented in past years, this is the largest outbreak of cases that ACDC has documented. It is interesting that the outbreak involved four households within one city block in South Pasadena. Cases occurred within a 17-day period in May after a large opossum die-off was noted by the index case. Three of the four households (representing four of the six cases) reported seeing opossums in their yards and also had indoor/outdoor cats. It is possible that cat fleas (*Ctenocephalides felis*) were infected with *R. typhi*. Since, none of the domestic cats or neighborhood cats was tested for evidence murine typhus infection, it is unknown whether cat fleas were the source of the human infection.

Murine typhus is generally benign but may cause severe disease including hepatitis, pneumonia, meningitis, and rarely death. Two of the cases in this investigation (Case 1 and 4) required hospitalization. The index case, Case 1, appeared to have the most severe disease with evidence of hepatitis. And Case 4, the elderly neighbor, had a septic picture with mental status changes. A thorough infectious disease work-up could not pinpoint an etiology; acute serological specimens were in normal range, but the patient refused convalescent blood testing.

For both Cases 1 and 2, convalescent titers were available to confirm the diagnosis of murine typhus. Most infectious disease and public health specialists recommend convalescent titers when the diagnosis is suspected. Currently, there is no established national or state case definition for murine typhus; however, in many serologically diagnosed viral diseases, both acute and convalescent serologies are required to make the diagnosis. In our index case, Case 1, although she experienced compatible symptoms for at least 10 days, she had normal IgG with a strongly positive IgM acutely, and her convalescent test demonstrated a four-fold rise in IgG with a four-fold decline in IgM. Interestingly, her son (Case 2) had normal IgG and IgM acutely, but his convalescent tests were both strongly positive (> 4 fold rise). It is possible that many cases in LAC are missed because clinicians obtain only an acute serology, which can be negative early in infection.



Murine typhus infection can be prevented through flea control measures on pets and in the yard. Foliage in the yard should be kept trim so that it does not provide harborage for small mammals. Screens can be placed on windows and crawl spaces to prevent entry of animals into the house. It is possible that heavy seasonal rainfall in 2005 contributed to overgrowth of plantings and increased populations of opossums.

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Table 1. Murine Typhus Investigation, South Pasadena, California, May 2005

Patient Suspect	Household	Case Status	Age (yrs.)	Sex	Date Symptom Onset	Symptoms	Hospitalization	Acute Serology*	Convalescent Serology*	Other Tests	Animal Exposures
Index Case 1	1	Confirmed	49	F	5/6/05	Fever, rash, headache, myalgia, nausea/vomiting	3 days 5/14/05 to 5/17/05	5/16/05 IgM 1:256 IgG <1:64	6/2/05 IgM 1:512 IgG 1:512	WNV+ IgG Elevated tranaminases	3 outdoor cats; 1 dog; 3 dead opossums noted in backyard.
Case 2	1 (Son of Index Case)	Confirmed	10	M	5/16/05	Fever, headache, chills, myalgia	None	5/20/05 IgM <1:64 IgG <1:64	6/7/05 IgM 1:1024 IgG 1:1024	None	Same as index. (above)
Case 3	2	Probable	59	M	5/13/05	Fever, headache, chills, myalgia	None	5/27/05 IgM >1:1024 IgG >1:1024	Not completed	None	No cats. Rodents and opossums noted nearby and under home within 2 weeks of onset.
Case 4	3	Possible	81	M	5/23/05	Fever, headache, chills, myalgia	None	5/24/05 IgG <1:64 IgM <1:64	Not completed	None	Unknown**
Case 5	3	Possible	26	M	5/15/05	Fever, headache	None	Refused testing	Not completed	None	Unknown**
Case 6	4	Probable	49	F	5/14/05	Fever, headache, chills, myalgia	None	6/17/05 IgG 1:128 IgM 1:512	Not completed	None	1 outdoor/indoor cat; 2 dogs. Rodents observed in house, garage and neighborhood. Opossums seen outside home.

* All listed results completed by the Los Angeles County Public Health Laboratory.

** While animal exposures are unknown, this household is nearby the households of the other cases and substantial overgrowth was noted during environmental investigation.





VARICELLA ACTIVE SURVEILLANCE PROJECT (VASP) 2005 SUMMARY ANTELOPE VALLEY, CALIFORNIA

BACKGROUND

While usually a mild childhood disease, varicella tends to be more severe in adults, neonates, and immuno-compromised persons and has the capacity to lead to complications that may include pneumonia, encephalitis, and sometimes death. Prior to 1995, about 4 million cases of varicella occurred annually in the US. Of these cases, approximately 11,000 were hospitalized and 100 died (CDC, unpublished data, 1999). When the varicella vaccine was approved for use in 1995, the Los Angeles County (LAC) Department of Health Services (DHS) and the Center for Disease Control and Prevention (CDC) entered into a cooperative agreement to establish active surveillance for varicella in Antelope Valley. The resulting program, the Varicella Active Surveillance Project (VASP), has collected baseline data on varicella incidence, outbreaks, and vaccine coverage since 1995. In 2000, surveillance was enhanced with the addition of herpes zoster (HZ)—for children and adolescents 19 years of age and younger, case interviews and chart reviews have been systematically completed since 2000. As a consequence, the collection of baseline adult HZ and PHN incidence will be an important public health priority. VASP will be collecting detailed case history on all reported cases of HZ and has also added surveillance sites that will better capture adult HZ with the addition of all skilled nursing facilities, dermatology practices, pain management clinics, and additional internal medicine practices. It will be important to track the impact of this new vaccine with regards to its impact on morbidity and hospitalization due to adult HZ.

METHODS

Population Demographics: The Antelope Valley (AV) is a well-defined geographic area, covering approximately 2,000 square miles in the northern eastern section of LAC and includes over 35 communities. In 2005, there were an estimated 350,000 residents: 51% White, 30% Hispanic, 18% African American, and 4% Asian.

Case Definitions: For the purposes of our surveillance the following definitions were employed.

- *Varicella case*—has illness with acute onset of a diffuse papulovesicular rash without other known cause diagnosed or reported by a healthcare provider, school nurse, or parents/guardians.
- *Breakthrough varicella case*—has had documented varicella vaccine at least 42 days prior to onset of varicella.
- *HZ case*—has a unilateral macular-papular or vesicular rash, involving at least one dermatome, diagnosed by a licensed healthcare provider.

Each HZ or varicella case with a completed case interview and/or chart review that validates the case definition and resides within the surveillance area is considered a *confirmed case*. If a provider, reports a HZ or varicella case that cannot be validated with case interview or chart review it is considered a *probable case*.

Data Collection: In 2005, 286 surveillance sites participated VASP's project. Sites included: public and private schools, day care centers, public health clinics, pain management clinics, long term care facilities, adult day care, hospitals, private practice physicians (pediatrics, family practice, neurology, dermatology, and internal medicine), health maintenance organizations and correctional facilities. All reporting sites submitted a "Varicella/Zoster Surveillance Case Log" to VASP on a biweekly basis and applicable reporting sites submitted a "Varicella Vaccine Log" on a monthly basis—this reports all administered varicella doses administered that month.

A member of VASP conducted a structured telephone interview with each case or their parent/guardian. This provided detailed demographic, clinical, and health impact data, as well as identified any additional cases or susceptible contacts within the household. Previous varicella vaccine exposure was documented



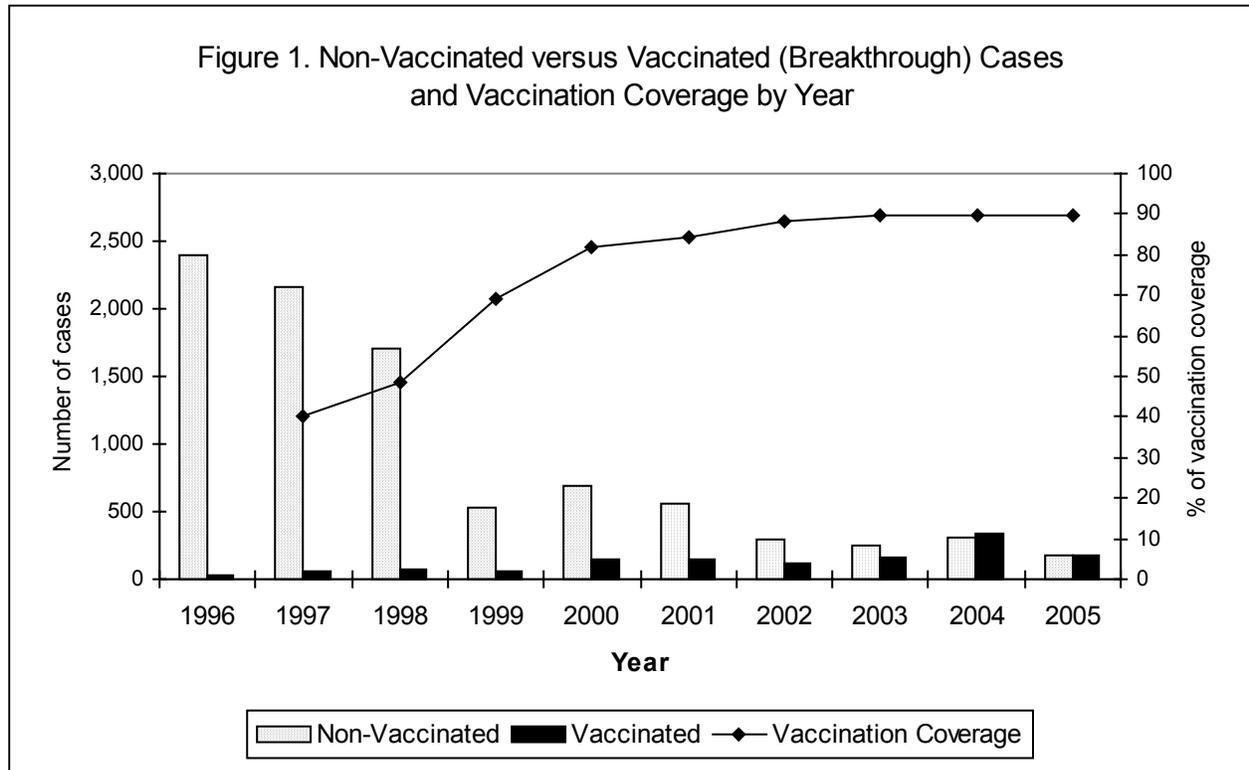
by one of three methods: provider documentation, vaccine card, and school vaccine records. Data entry for varicella and HZ was entered into an MS Access database and analysis performed with SAS 9.1. Completeness of reporting was estimated using capture-recapture methods.

RESULTS

Varicella Disease: Compared to the number of verified varicella cases reported in 1995 (2,934 cases), cases declined by 87% in 2005 (355 cases). This corresponds to an overall decline in varicella incidence from 10.3 per 1,000 persons in 1995 to 1.0 per 1,000 persons in 2005. Looking specifically at 2001 through 2003, the overall varicella incidence remained relatively unchanged (1.2 per 1,000 persons); however, in 2004, varicella incidence increased to 1.8 cases per 1,000 persons and then declined to 1.0 per 1,000 in 2005. Since 1995, the 5-9 year-old age group has had the highest varicella incidence of any age group. The 10-14 year old age group has shown the second highest rates with 3.7 per 1000 persons in 2005. There has been a consistent trend of increasing age of varicella cases—the mean age increased from 9.6 to 10.5 years in 2004 and 2005, respectively.

Since 1995, the hospitalizations from varicella infection have significantly declined. In 1995, 12 hospitalizations due to varicella were reported. In contrast, from 2000 to 2005, between zero to three hospitalizations were documented annually—no hospitalizations due to varicella were reported in 2005. The number of complications after varicella infection also was significantly less in 2005—only 1 (0.28%) case reported complications (otitis media), compared to 17 (4.2%) and 22 (3.4%) cases with complications reported in 2003 and 2004, respectively.

The proportion of reported and verified breakthrough varicella cases has steadily increased since initiating this project from 1% in 1996 to nearly 49% of cases in 2005 (Figure 1). Yet the cumulative breakthrough cases as a percentage of the cumulative vaccine doses remained almost unchanged with 1.97% and 2.0% reported in 2004 and 2005. The median age of breakthrough cases has steadily increased; the median age was 5.7 and 8 years in 2000 and 2005, respectively.





The number of documented varicella outbreaks has shown a consistent decline from 81 reported in 1995 to 7 in 2003. However, in 2004, the number of documented outbreaks increased dramatically to 25. In 2005, the number returned to a level similar to 2003 with eight documented outbreaks (104 cases). Of these eight outbreaks, six occurred in elementary schools and two middle schools. These outbreaks had an average of 13 cases per outbreak. The mean age of the varicella cases was 11.3 years; 48% of the cases were classified as breakthrough.

HZ Surveillance Among Those Younger Than 20 Years of Age: Both verified HZ cases and HZ incidence rates for children and adolescents younger than 20 years of age have steadily decreased during the past six years of surveillance. The overall incidence among those younger than 20 years of age was 67 per 100,000 persons in 2000 then decreased to 49 per 100,000 in 2005. The decline in HZ incidence has been even more significant among those younger than 10 years of age—from 76 per 100,000 persons in 2000 to 27.8 per 100,000 in 2005. Overall, most cases have been older than age 10—in 2005, 42.8% reported from the 15-19 year old age group, 33.9% from the 10-14 year old age group, the median age was 15 years. Increasingly, reported cases of HZ have had a natural history of varicella infection compared to those with a history of previous vaccination. In 2005, 78% (n=44) of the HZ cases had a positive history of varicella, 12.5% (n=7) had a history of vaccination, 3.5% (n=2) recalled both, and 5.4% (n=3) could not be documented. There were no hospitalizations in children and adolescents due to HZ in 2005.

Over the past five years, an average of 341 cases per year of adult HZ (aged 20 years and older) were reported to VASP. Reported adult cases were not verified by medical chart review or case interview. In 2005, 366 cases were reported with a mean age of 56.6 years. Racial data was not consistently reported for this group. In 2005, the highest age-specific incidence was noted among those 70 years and older with 4.7 cases per 1,000 persons.

DISCUSSION

Over the length of the study, there has been a rising proportion of reported varicella that can be classified as breakthrough varicella disease. In more recent years, the proportion has increased from 15% in 2000 to 49% in 2005. This increase of breakthrough varicella in both outbreak and non-outbreak settings provides supports for the recent Advisory Committee on Immunization Practices (ACIP) discussions for the need for a second varicella vaccine booster dose for elimination purposes.¹ The timing of the booster varicella dose remains under discussion by ACIP at this time. However, the ACIP has recommended that, in varicella outbreak situations, a second varicella dose should be provided to individuals who have been previously vaccinated. The implementation of this recommendation will be a challenge and is under discussion with the Immunization Programs at both the State of California and LAC.

The consistent documentation that HZ incidence has remained unchanged in the under 20 group, and has significantly declined among those the under 10 years old, should allay fears that varicella vaccination might actually *increase* the risk of future HZ in children. These findings have been summarized in a manuscript describing the epidemiology of HZ in pediatrics and adolescents in the Antelope Valley. The manuscript has been submitted for consideration to the *Journal of Infectious Disease*.

In 2005, much effort has been put into the preparation of an adult HZ case report form and strengthening surveillance by increasing methods that will capture adult HZ. This has lead to increased outreach to skilled nursing facilities, dermatology, internal medicine and to pain management clinics by VASP. In 2006, VASP plans to implement the new adult HZ case report and follow-up on individual HZ cases that are experiencing post-herpetic neuralgia. We hope obtain accurate baseline incidence rates prior to the implementation of the adult HZ vaccine.

1 CDC. Prevention of Varicella—Provisional Updated ACIP Recommendations for Varicella Vaccine Use. Available at: www.cdc.gov/nip/vaccine/varicella/varicella_acip_recs.pdf, last accessed June 1, 2006.



ONGOING RESEARCH PROJECTS

- **Knowledge, Attitudes and Practices (KAP) of Healthcare Providers Regarding Varicella Vaccination.** Surveys were sent to all identified pediatric and family practice physicians, physician assistants, and nurse practitioners in the Antelope Valley to assess their knowledge, attitudes, and practices regarding varicella vaccination 10 years after its introduction. Questionnaire data has now been completed and data analysis is in progress.
- **Validity of Self-Reported Varicella History among Women in an Antenatal Clinic Population.** The objectives of the project are to assess overall varicella seroprevalence among women in an antenatal clinic population, assess the validity of self-reported varicella disease history compared with varicella-zoster virus (IgG) antibody results, and assess follow-up vaccination rate among seronegative enrollees. The project was conducted in collaboration with both CDC's Herpes Viruses Team and Varicella Zoster Virus laboratory. Overall seropositive rate of enrollees was 97.2% (95% CI: 95.4-98.4); this rate was comparable to NHANES III rate of 96.3% (95% CI: 95.7-96.9). The positive predictive value (PPV) of self-reported varicella disease history among enrollees was 99.7% (95% CI: 98.2-100) and the negative predictive value (NPV) of a negative or uncertain disease history was 6.3% (95% CI: 3.5-10.4). Study findings indicate that self-report history of varicella continues to be a strong predictor of positive serology (varicella immunity) while negative or uncertain history is still a poor predictor of negative serology. A poster presentation was completed at the 40th National Immunization conference in Atlanta summarizing the findings from VASP in the Antelope Valley. A manuscript summarizing the combined findings from VASP West Philadelphia and Antelope Valley will be submitted in 2006.



DEATHS AND ILLNESS FROM HYDROGEN SULFIDE AMONG SHIP WORKERS LOS ANGELES, CALIFORNIA

BACKGROUND

On September 2, 2005, ACDC was notified of three deaths occurring in the propeller room of a cruise ship docked in the Port of Los Angeles. Initial reports suggested that the deaths were related to hydrogen sulfide poisoning occurring while crewmembers were attempting to fix a pipe in the propeller room on the ship. This situation is the first known cluster of deaths caused by hydrogen sulfide poisoning on a cruise ship.

Hydrogen sulfide, a colorless gas and asphyxiant produced from decaying sulfur-containing materials, is the second leading cause of toxin-related deaths in the US. The gas has a noxious odor of “rotten eggs” and is found in industries including rayon dye production, heavy water production, petroleum refining, natural gas, asphalt, waste management, and the fishing industry. Hydrogen sulfide has a density slightly greater than that of air and is therefore commonly found in confined spaces on the bottoms of tanks, hot springs [1], manure pits [2], and holding spaces on ships that contain decaying food [3]. Additionally, hydrogen sulfide is generated by decay of organic material by anaerobic bacteria.

Acute hydrogen sulfide exposure may cause symptoms ranging from mucous membrane irritation to neurologic impairment and cardiopulmonary arrest. Hydrogen sulfide gas is commonly called a “knock-down agent” because acute exposure may lead to rapid loss of consciousness and death. Many case reports have described this rapid toxicity that leads to death in both those primarily exposed and in those who try to rescue the primary victim [4]. Inhaled levels of hydrogen sulfide greater than 700 ppm² are immediately fatal [5]. According to the Census of Fatal Occupational Injuries (CFOI), a database run by the United States Bureau of Labor Statistics (USBLS), 52 workers died of hydrogen sulfide poisoning between 1993 and 1999. One fifth of these 52 deaths were accompanied by a co-worker fatality [4]. The majority of fatalities were reported in white males in their first year of employment, most commonly working in waste management, petroleum or natural gas work.

METHODS

On September 2, 2005, ACDC received a call from the Port of Los Angeles to report three deaths in the propeller room of a cruise ship and 19 possibly ill crewmembers that responded to this event. An investigation began at 2:00pm September 2, 2005. ACDC staff conducted interviews with port authorities, port police, cruise ship authorities, and receiving. An informal environmental inspection was conducted at 8:00am the following morning. Clinical information on the three deceased workers and 19 responders including autopsy reports was collected.

ACDC staff interviewed cruise ship staff including engineers who usually work in the propeller room—five of the 19 people who responded to the situation, and the medical staff on board. Questions were asked to elucidate what happened, understand the physical set up of the propeller room, and identify clinical symptoms of the responders.

Measurements of the room where the deaths occurred were obtained and the Office of Hazardous Materials Safety (Hazmat) collected environmental air samples. Additionally, medical records and autopsy results were obtained for the three deceased and medical records were obtained for those who responded to the scene and were subsequently hospitalized.

Summary of Events: Interviews revealed that at 6:00am on September 2, 2005, 3 staff undertook a routine repair of a “leaky pipe” in the propeller room of a cruise ship docked at the Port of Los Angeles. Because the propeller room was not considered a confined space by the staff of the cruise ship, no workers were wearing any personal protective respiratory equipment. During the repair, all 3 workers



were overcome by fumes and fainted. Nearby workers cried out for help, which prompted the ship's staff to administer a ship wide call for help or "Alpha Alert." This call prompted all medical staff to respond without any protective gear. As a result, additional crew members—including doctors and nurses—responded, but they became dizzy and some passed out. Ultimately 19 crewmembers were taken to an emergency department at various hospitals on shore. Most were either fellow engineers or medical staff on board. No passengers were affected.

According to the chief engineer on board the ship, the volume of the propeller room was measured at 215m³ (7,593 cubic feet) and the ventilation was 1100 m³/hour (38,846 foot³/hour). Hazmat obtained an environmental air sample at 11:00am on September 3, 2005—5 hours after the incident in the propeller room—measuring 100 ppm of H₂S. The OSHA Permissible Exposure Limit (PEL) for General Industry states that "exposures shall not exceed 20 ppm (ceiling) with the following exception: if no other measurable exposure occurs during the 8-hour work shift, exposures may exceed 20 ppm, but not more than 50 ppm (peak), for a single time period up to 10 minutes [6]." Therefore, environmental levels of hydrogen sulfide 5 hours after the incident exceeded the maximum limit by 100%.

Upon further investigation, it was discovered that the leaky pipe was a pulper line that conducts solids and remaining liquids from food waste to be expelled into the ocean. The pulper line was running through the ballast tank which functions to keep the boat steady. It was discovered that the pulper line was cracked in the portion that ran through the wall of the ballast tank. Over time, food waste (also known as pulp) slowly leaked into the ballast tank from the pulper line. This waste, in the anaerobic environment of the ballast tank, produced hydrogen sulfide that filtered into the pulper line and collected over time. When the leaky pipe was being fixed, it burst and released the collection of hydrogen sulfide gas.

The three workers in direct contact with the pulper line (males aged 41, 47 and 48), died instantly. Coroner reports revealed levels of 16 mcg/g and 3.2mcg/g of thiosulfate by ion chromatography after correcting for creatinine in two out of three of the deceased. The normal range is 1-5mcg/g. The 19 responders experienced symptoms including dizziness, headaches and throat irritation. No blood samples were obtained and none were known to have experienced prolonged effects beyond the first 24 hours after exposure.

DISCUSSION

Fatalities and acute illness resulted from this unfortunate situation; yet substantial literature notes that working in confined spaces on cargo ships is a risk factor for hydrogen sulfide poisoning and death [3]. The majority of hydrogen sulfide poisonings (approximately 86%) occur in confined spaces and many poisonings are the direct result of others trying to help co-workers in need [5]. However, this is the first known cluster of deaths caused by hydrogen sulfide poisoning on a cruise ship.

The levels of thiosulfate, as determined by the coroner, probably do not reflect the true concentration of hydrogen sulfide that the deceased were exposed to. Thiosulfate is formed by oxidation of sulfide, is one of the predominant metabolites of sulfide, and can indicate the probable dose of H₂S to which the victim was exposed [7]. However, the blood level peaks in 12 hours after acute exposure and declines rapidly thereafter and coroner blood specimens were obtained more than 12 hours after death.

Because of the confined spaces typical of ships and boats, all captains, regardless of vessel type, should have plans to prevent hydrogen sulfide poisoning. In addition, in light of the rapid manner in which co-workers often respond to on-board emergencies, plans should also include the proper methods of response.

The National Institute for Occupational Safety and Health defines a confined space as:

"a space which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy. Confined spaces include but are not limited to storage tanks, compartments of ships, process



vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines [8].”

While by this definition the propeller room of the cruise ship may be considered a confined space, ultimately the definition, and the considerations that go along with it, are open to interpretation—and the crew of the ship did not consider the propeller room to be a confined space. As such, the ship staff was not required to wear respiratory personal protective equipment (PPE) while working in that area. Additionally, workers did not carry a gas monitor that was available on the ship for detecting hazardous gases such as hydrogen sulfide.

We therefore recommend that a broader definition of what constitutes confined space be considered for ships and that appropriate PPE be worn when working in these spaces. Additionally, it would be advantageous for ships to purchase additional gas monitors to be available for all who plan to work in confined spaces. As an example, the portable Multiwarn monitor, EntryRAE, or similar instruments and a stationary gas monitor with an alarm system are able to detect hydrogen sulfide levels from 0-100 ppm and thus could have warned workers in the propeller room if the pipe was leaking before they began to fix it. While uncommon, this situation demonstrates that appropriate preventative steps must be taken by cruise lines and other industries that employ workers in confined spaces to prevent fatalities associated with hydrogen sulfide poisoning.

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