To identify sources of transmission for area clusters, in 2007 the Houston Department of Health and Human Services conducted an 8-month study of enhanced surveillance of Salmonella infection. Protocol included patient interviews and linking the results of interviews to clusters of pulsed-field gel electrophoresis patterns detected by the local PulseNet laboratory.

Because PFGE patterns obtained by a local health department may appear to be sporadic or unrelated to a more generalized process (2), local public health practitioners may gain a larger perspective by receiving notification of state and national clusters (4,5). During 2002–2005, before this study was conducted but during a time HDHHS was in routine communication with PulseNet, most local PFGE patterns were not recognized as linked to statewide or nationwide clusters.

In this study, HDHHS sought to determine more rigorously the utility of PFGE in local surveillance (as opposed to national surveillance) in detecting area clusters and vehicles of transmission. Another goal was to determine how local PFGE patterns and clusters are associated with larger-scale clusters. The study was approved by the Committee for the Protection of Human Subjects, University of Texas Health Science Center.

The Study

During an 8-month period, May 1 through December 31, 2007, HDHHS received 145 Salmonella case reports in which patients resided in Houston. The HDHHS laboratory performed PFGE for 106 (73%) isolates from the Houston case-patients. The laboratory performed PFGE for all isolates it received. The remaining 39 Houston cases had been reported by providers that did not forward the isolate to HDHHS. The HDHHS laboratory used a standardized PulseNet Salmonella protocol for PFGE and compared PFGE patterns for these isolates by using Bionumerics 4.0 software (Applied Maths, Sint-Martens-Latem, Belgium). Using a hypothesis-generating questionnaire, immediately upon receiving the case the first author interviewed 96 (91%) of the 106 case-patients with an assigned PFGE pattern. Follow-up was not feasible for the remaining 10 case-patients. Table 1 provides the demographic characteristics of the 106 case-patients. The HDHHS laboratory posted the PFGE patterns weekly to HDHHS epidemiologists, who then further investigated the clusters attempting to identify common sources.

Epidemiologists considered a group of Salmonella cases to be a cluster if 1) PFGE patterns of all isolates were indistinguishable; and 2) specimens were collected each within 90 days of at least 1 other case. A more inclusive 90-day interval was used, rather than the 60-day interval used by PulseNet, because the number of cases in a local PFGE cluster is typically small. A case that was not in a cluster was considered a singlet case.

Analysis of 106 Salmonella isolates from Houston residents yielded 74 distinctive PFGE patterns, of which 66 were forwarded to the Texas Department of State Health Services (DHS) for comparison with the DHS laboratory’s database and to further identify clusters. Eight singlet patterns were not further analyzed because of lack of
staff in the laboratories. The DSHS returned a list of state ID numbers and county of residence for case-patients with matching isolate PFGE patterns, and HDHHS and DSHS epidemiologists conferred about the data.

Of the 106 Salmonella cases with identified PFGE patterns, 42 assembled into 10 clusters, with 2–13 cases per cluster. PFGE patterns for 8 of these clusters matched patterns in the DSHS statewide database, and patterns of 5 clusters matched those in other states obtained during the same period (Table 2).

HDHHS identified a likely exposure for 3 local PFGE clusters (Table 2). The first cluster, S. enterica serovar Braenderup JBPX01.0516 (PulseNet nomenclature), included 2 Houston case-patients and 5 case-patients residing in adjoining counties. Two persons reported travel to Matamoros, Mexico, before getting sick. Four isolates in the DSHS database had this PFGE pattern, of which 3 had been obtained from case-patients who resided in Brownsville, Texas, near Matamoros. HDHHS posted the PFGE pattern on PulseNet Listserve, and the Ohio Department of

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**Table 1. Cases of Salmonella infection reported to HDHHS, incidence rates, and PFGE results, May 1, 2007–December 31, 2007*"**

| Case-patient characteristic | No. cases reported to HDHHS (%), n = 145 | Incidence rate,† n = 145 | No. (%) case-patients assigned a PFGE pattern, n = 106 | No. (%) case-patients assigned a PFGE pattern and interviewed, n = 96 |
|----------------------------|------------------------------------------|--------------------------|------------------------------------------------------|---------------------------------------------------------------|
| Sex                        |                                          |                          |                                                      |                                                               |
| M                          | 65 (44.8)                               | 10.0                     | 50 (47.2)                                            | 45 (46.9)                                                      |
| F                          | 80 (55.2)                               | 12.3                     | 56 (52.8)                                            | 51 (53.1)                                                      |
| Age, y                     |                                          |                          |                                                      |                                                               |
| <1                         | 27 (18.6)                               | 119.3                    | 21 (19.8)                                            | 19 (19.8)                                                      |
| 1–4                        | 40 (27.6)                               | 47.3                     | 31 (29.2)                                            | 27 (28.1)                                                      |
| 5–19                       | 21 (14.5)                               | 7.3                      | 11 (10.4)                                            | 11 (11.5)                                                      |
| 20–34                      | 9 (6.2)                                 | 2.6                      | 7 (6.6)                                              | 7 (7.3)                                                        |
| 35–54                      | 20 (13.8)                               | 5.5                      | 15 (14.2)                                            | 13 (13.5)                                                      |
| 55–74                      | 16 (11.0)                               | 10.4                     | 13 (12.3)                                            | 11 (11.5)                                                      |
| >75                        | 12 (8.3)                                | 25.4                     | 8 (7.5)                                              | 8 (8.3)                                                        |
| Race/ethnicity             |                                          |                          |                                                      |                                                               |
| White                      |                                          |                          |                                                      |                                                               |
| Non-Hispanic               | 37 (25.5)                               | 9.2                      | 27 (25.5)                                            | 25 (26.0)                                                      |
| Hispanic                   | 70 (48.3)                               | 14.4                     | 45 (42.4)                                            | 43 (44.8)                                                      |
| Black                      | 23 (15.9)                               | 7.1                      | 20 (18.9)                                            | 17 (17.7)                                                      |
| Asian                      | 9 (6.2)                                 | 13.1                     | 9 (8.5)                                              | 9 (9.4)                                                        |
| Unknown                    | 6 (4.1)                                 | ‡                        | 5 (4.7)                                              | 2 (2.1)                                                        |
| Total                      | 145                                     | 11.1                     | 106                                                  | 96                                                             |

*HDHHS, Houston Department of Health and Human Services; PFGE, pulsed-field gel electrophoresis. †Rate was calculated as number of cases/100,000 population/year, based on the 8-month study period. ‡Rate was not calculable.

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**Table 2. Ten Salmonella pulsed-field gel electrophoresis clusters among residents of Houston, Texas, USA, and 2 Houston singlet cases linked by PFGE to national outbreaks, detected May 1, 2007–December 31, 2007*"**

| Serotype               | PFGE pattern, Xba† | No. cases in Houston | No. other cases in DSHS database | Associated national outbreak | Common exposure or other link          |
|------------------------|--------------------|----------------------|---------------------------------|-------------------------------|----------------------------------------|
| Braenderup             | JBPX01.0516        | 2                    | 4                               | PulseNet outbreak 0708HUJB-1c  | Traveled or resided in southern Texas |
| Corvallis              | SCVX01.0014        | 2                    | 0                               | –                             | Egg consumption                        |
| Enteritidis            | JEGX01.0004        | 13                   | Numerous                        | PulseNet outbreak 0801PAJEG-1 | Unknown                                |
| Enteritidis            | JEGX01.0005        | 6                    | 25                              | –                             | Unknown                                |
| Infantis               | JFXX01.0022        | 3                    | 5                               | –                             | Unknown                                |
| Infantis               | JFXX01.0041        | 5                    | 1                               | –                             | Unknown                                |
| Paratyphi b var. java  | JKKX01.0014        | 4                    | 2                               | PulseNet outbreak 0710NCJKX-1c | Contact with miniature turtles         |
| Typhimurium            | JPXX01.0276        | 2                    | 0                               | –                             | Unknown                                |
| Typhimurium            | JPXX01.0621        | 3                    | 3                               | PulseNet outbreak 0801ORJPX-1c | Unknown                                |
| Typhimurium            | JPXX01.0006        | 2                    | 3                               | Possible bovine outbreak      | Unknown                                |
| Typhimurium            | JPXX01.1037        | 1                    | 0                               | PulseNet outbreak 0704WWWS-1c  | Packaged vegetable product‡            |
| Typhimurium            | JPXX01.1354        | 1                    | 1                               | PulseNet outbreak 0703MLJPX-2c | Contact with hamsters‡                 |

*PFGE, pulsed-field gel electrophoresis; DSHS, Texas Department of State Health Services. †PulseNet nomenclature. ‡The case was linked by PFGE to a PulseNet cluster, but the patient denied having been exposed to the hypothesized epidemiologic link.
Health responded with information regarding a concurrent outbreak of the same strain in a church group whose members became ill while visiting southern Texas. S. enterica serovar Enteritidis JEGX01.0004, one of the most common patterns in the HDHHS and DSHS PFGE databases, was noted by HDHHS to be occurring at above expected levels in December 2007. The Pennsylvania Department of Health posted outbreak clusters in Pennsylvania with the same strain, associated with the consumption of improperly cooked eggs. Nine of the 13 (69%) Houston case-patients reported eating eggs during the week before illness onset. In 2 Houston households, persons became sick after eating eggs purchased in farmers’ markets. The North Carolina Division of Public Health linked a third PFGE cluster, S. enterica serovar Paratyphi B var. Java, JKXX01.0014, to miniature turtles (7). Two of 4 Houston patients and another patient in Victoria, Texas, reported having contact with miniature turtles.

During the 8-month study, the HDHHS laboratory also sent patterns for 56 (87%) of the 64 singlet isolates to DSHS, which coupled 11 (20%) of these with more cases in their statewide database. Isolates from 2 Houston singlet cases had patterns matching 2 concurrent multistate outbreak patterns. An isolate of S. enterica serovar Typhimurium JPXX01.1037 matched a PulseNet PFGE cluster pattern attributed to a nationally distributed packaged vegetable product. The other isolate, S. enterica serovar Typhimurium JPXX01.1354, matched a pattern linked to an outbreak investigated by Wisconsin Division of Public Health in which case-patients were exposed to hamsters. For these singlets, HDHHS was unable to confirm an epidemiologic link between the Houston case and the national outbreak (Table 2).

Conclusions

Using PFGE patterns, HDHHS discerned vehicles of transmission for local clusters. Such findings could enable a local health department to intervene to address outbreaks currently in progress. Even small clusters are strong indicators because the actual number of cases in an outbreak is typically vastly larger.

Consistent cooperation between HDHHS and DSHS epidemiologists enabled them to see Houston PFGE patterns in a context of statewide and national patterns and clusters. A Houston PFGE pattern that was part of a local cluster was quite likely to match a DSHS (statewide) or CDC (national) pattern. This finding is in contrast to results for 56 singlet patterns; only 11 were found to match patterns of cases outside the local area.

Analysis of PFGE clustering assisted this surveillance system in detecting outbreaks successfully. Findings on PulseNet helped HDHHS epidemiologists identify sources of bacteria in local clusters. HDHHS conducted prompt interviews of 91% of the Houston patients. Of course, a 100% follow-up would have been better, but this study demonstrates the successes that are possible through routine surveillance by a local health department, given its resources. In an ideal situation, a PulseNet-certified laboratory performs local surveillance in sustained close cooperation with epidemiologists who conduct timely investigations based on laboratory findings.

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