

Legionellosis Outbreak-Genesee County

May, 2015 – October, 2015

Full Analysis

[Updated 04/08/16]

Michigan Department of Health and Human Services

With contributions from:

Genesee County Health Department

Legionellosis Outbreak — Genesee County, May 2015 – October 2015

Contents

Legionellosis Outbreak — Genesee County, May 2015 – October 2015.....	2
Summary.....	3
Working Case Definitions	4
Data Sources	4
Epidemiology	4
Epi Curves.....	5
Five-year History.....	5
Outbreak 1: June 2014–March 2015 (Previous Cases).....	6
Outbreak 2: May 2015–October 2015 (Cases Analyzed in Current Report)	6
Cases by Residence Water Source	7
Healthcare Exposure	7
Healthcare Exposure by Residence Water Source	7
Healthcare Exposures by Hospitals Location and Residence Water Source	7
Healthcare-associated Legionellosis Cases by Hospital Location.....	8
Prior Inpatient Hospitalization Cases by Length of Stay and Residence Water Source	9
Epi Curve by Hospital A Exposure.....	9
Legionellosis Questionnaire Results	10
Interview Status by Healthcare Exposure.....	10
Interview Status by Residence Water Supply.....	10
Water Changes at Residence.....	11
Work and Travel	12
Community Exposures.....	13
Water Exposures in the Home.....	15
Water Exposures Outside of the Home.....	15
Comorbidities by Healthcare Exposure and Residence Water Supply	16
Health Behaviors by Healthcare Exposure and Residence Water Supply	16
Epi Summary of Cases with No Known Healthcare Exposure.....	17
Cases with No Known Healthcare Exposure and Residence not on City of Flint Water Supply	18
Case Flow-chart	18
Epi Curve.....	18
Laboratory Testing	19

Statement of Purpose

This is an ongoing investigation. This update's primary purpose is to report the case data that has been collected to date. All of the new cases were identified by MDHHS personnel from hospital testing data that was recently forwarded to the department. Of the three additional cases, two had not been appropriately reported to the public health system. The third case was reported in a different jurisdiction and there was no epidemiologic information available to link it to the outbreak. MDHHS has provided additional guidance to the hospital to assist them in providing accurate reporting. This update does not draw conclusions regarding the source, or ultimate extent of, the outbreak, but is a factual summary of the events and data known at this time. This report also makes recommendations to local health departments and health providers.

Summary

From May 2015 to October 2015, 46 legionellosis cases, all confirmed Legionnaires' disease (LD), were reported as part of an outbreak in Genesee County, Michigan. Three additional cases have been added to the count since the last report [Mar 17, 2016] as a result of continued case finding. Forty-three of these cases were among residents of Genesee County. In addition, 3 case-patients from outside of Genesee County were hospitalized in Genesee during the 2 weeks prior to their onset. Seven individuals have died. The Michigan Department of Health and Human Services (MDHHS) assisted the Genesee County Health Department (GCHD) during their investigation.

Data were collected from patient medical record review, the Michigan Disease Surveillance System case report form, and interviews with case-patients or their proxies using an enhanced legionellosis questionnaire. In an attempt to identify community sources, case-patients or proxies were interviewed about travel, work, and locations visited during the 2 weeks prior to symptom onset (considered the incubation period for LD during an outbreak investigation).

Median patient age was 69 years (range: 35–89); 25 (54%) were male. Illness onset dates ranged from May 2, 2015 to October 29, 2015 and peaked in July and August with 13 cases each month. Case-patients were interviewed by the local health departments using an enhanced questionnaire; interviews were conducted for 42 of 46 (91%) case-patients.

Healthcare-associated LD was suspected for a subset of cases. Over half of the case-patients (27/46) had an exposure (inpatient, outpatient, or visitor) to at least one Genesee County hospital facility in the 2 weeks prior to their illness onset. In addition, all 27 case-patients had at least one exposure to the same hospital facility within the 2 weeks prior to onset.

The source of water at the residence where the case-patient lived during the 2 weeks prior to onset was evaluated. Ten of 46 (22%) cases occurred in individuals whose residence was serviced by the City of Flint municipal water system. Seven of those 10 individuals also had an exposure to the same Genesee County hospital during their incubation period. Among the 36 individuals whose residence is not serviced by the City of Flint municipal water system, 20 had an exposure to a Genesee County hospital during the 2 weeks prior to onset. In total, 16 out of 46 case-patients did not reside on the City of Flint water system and had no known healthcare exposure.

Questionnaire interview data were evaluated for other potential common community exposures. No other common community locations, beyond the healthcare facility, were reported by more than 4 individuals. Three different grocery stores and one home improvement store were each reported to have been visited by 4 individuals in the 2 weeks prior to their onset. These 3 grocery stores and the home improvement store are not located on the City of Flint water system.

All 46 cases were laboratory confirmed by *Legionella* urinary antigen test. Twelve sputum specimens were submitted to the MDHHS Bureau of laboratories (BoL) for *Legionella* culture and pulsed-field gel electrophoresis (PFGE) testing. Four samples were unsuitable for PFGE typing (3 were culture negative and one was received contaminated). The remaining 8 specimens were culture-positive and all 8 isolates were PFGE typed; 2 isolates had matching PFGE patterns, while 6 were unique (non-matching patterns). Seven of the 8 isolates were from individuals who did not reside on the City of Flint municipal water system. The remaining isolate was from a case-patient with a residence serviced by the City of Flint water system and was 1 of the 2 isolates obtained from case-patients with a hospital exposure during the 2 weeks prior to illness onset.

No common community exposures were identified from case-patient interviews for environmental evaluation and/or testing. In October, 2015, MDHHS was provided with a summary of the environmental testing conducted at the Genesee County hospital where 27/46 case-patients had a healthcare exposure. The report indicated that environmental samples collected at that facility in August of 2015 tested positive for *Legionella*. MDHHS has not tested any environmental samples collected from the hospital.

Enhanced surveillance will continue in 2016. From 2009–2013, an average of 9 confirmed legionellosis cases per year (range 5–13 cases per year) were reported in Genesee County. No new cases of legionellosis were confirmed in Genesee County between November, 2015 and February, 2016. However, MDHHS recommends continued vigilant legionellosis awareness and surveillance, including interviewing of case-patients or proxies with the enhanced legionellosis questionnaire within one week of reporting. MDHHS also recommends the assistance of the clinical community in LD surveillance through identification, testing, and reporting of all suspect cases. **Prompt collection of clinical respiratory specimens in addition to, and at the same time as, urinary antigen testing is of critical importance in these increased surveillance efforts.** Because *Legionella* bacteria are commonly found in the environment, clinical culture isolates are necessary to interpret the findings of an environmental investigation in an outbreak. MDHHS has distributed updated legionellosis guidance to health care providers via the Michigan Health Alert Network.

Working Case Definitions

Confirmed Legionnaires' Disease (LD) – meets the CDC clinical and laboratory case definition for confirmed LD and illness occurred since May 1, 2015 in residents of Genesee County or those who had visited the Flint area in 2 weeks prior to their LD illness onset date.

Data Sources

1. Legionellosis Case Report Form in Michigan Disease Surveillance System (MDSS)
2. Medical record review from:
 - a. Hospital A; Flint, MI
 - b. Hospital B; Flint, MI
 - c. Hospital C; Grand Blanc, MI
3. Case-patient/proxy interview using Genesee County specific Legionellosis Questionnaire
4. City of Flint water distribution map

Epidemiology

Number of lab-confirmed cases of Legionnaires' disease: 46

Geographic distribution: 43/46 Genesee County (15/46 City of Flint residence), 3 non-Genesee County residents

Case-patients with residence on the City of Flint water system: 10/46 (21.7%)

Age: Range: 35-89 years

Average age: 67.8 years

Median age: 69 years

Sex: Males, 25/46 (54.3%)

Range of illness onset dates (N=46): 5/2/2015–10/29/2015

Death associated with legionellosis was defined as one that occurred during hospitalization, within 30 days of hospital discharge, or where Legionellosis was listed as a cause of death on the death certificate. (Ref. Mykietiuk A et al. Clin Infect Dis. 2005 Mar 15;40(6): 794-9.)

Deaths: 7/46 (15.2%)

6/7 (85.7%) individuals had an inpatient Genesee County hospital exposure in the 2 weeks prior to illness onset

0/7 (0%) individuals lived at a residence on the City of Flint water system in the 2 weeks prior to illness onset

Case-patients interviewed: 42/46 (91.3%); 40 completed plus 2 partial interviews

Case-patients hospitalized for legionellosis illness: 46/46 (100%)

Case-patients with an inpatient (overnight) Genesee County hospital exposure in the 2 weeks prior to illness onset: 26/46 (56.5%)

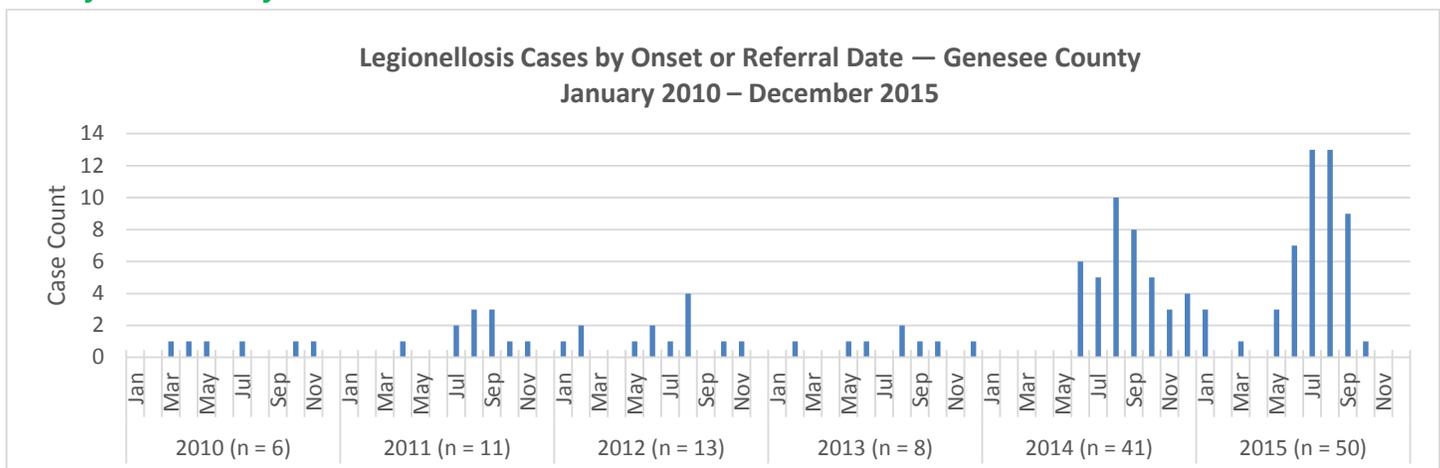
Case-patients with any healthcare exposure (inpatient, outpatient, or visitor) to a Genesee County hospital in the 2 weeks prior to illness onset: 27/46 (58.7%)

Case-patients with ≥ 1 comorbidity: 38/46 (82.6%)

Case-patients who are current or former smokers: 33/46 (71.7%)

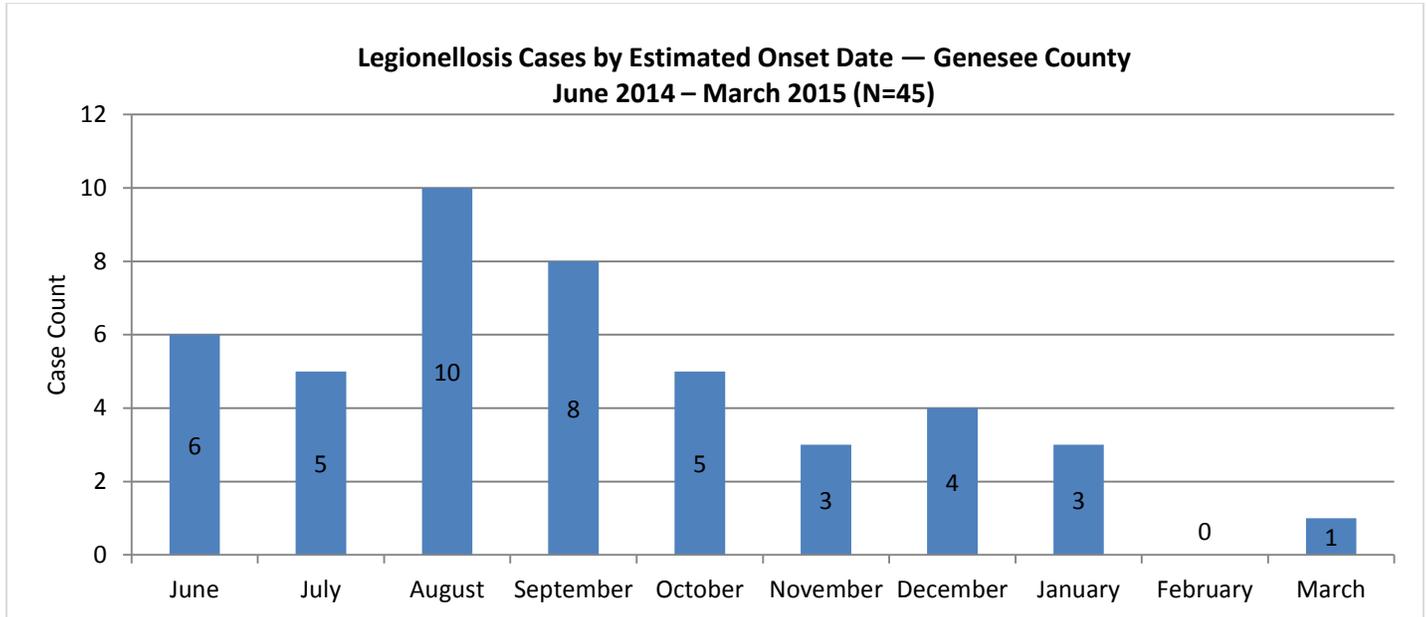
Epi Curves

Five-year History



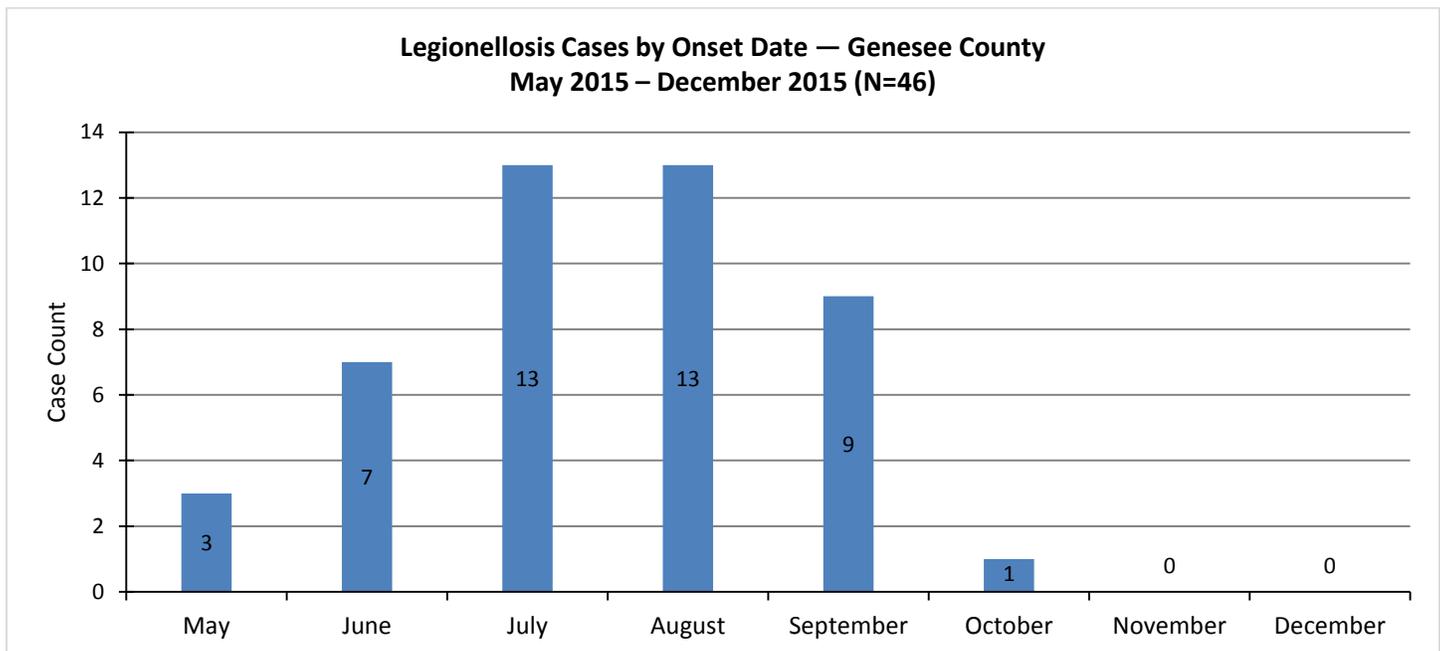
Note: If onset date was not available, referral date was used (i.e., date that the case was referred to public health). The graph includes four cases (one in 2014, three in 2015) in non-Genesee County residents who were hospitalized in Genesee County during the 2 weeks prior to illness onset.

Outbreak 1: June 2014–March 2015 (Previous Cases)



Outbreak 2: May 2015-October 2015 (Cases Analyzed in Current Report)

This report summarizes data collected from 46 confirmed legionellosis cases that were reported May, 2015 through October, 2015. The final case included in the analysis had an illness onset at the end of October, but was reported to public health the beginning of November.



Cases by Residence Water Source

Residence water source refers to the source of tap water at the case-patient's home residence during the 2 weeks before symptom onset and was determined by case-patient interview and verified by the City of Flint map. Of the 46 cases, one case-patient had exposure to both a private well and other municipal source during the 2 weeks prior to onset, accounting for the increase in the total (N=47) in the table below.

Water Source at Residence	Total N=47	
	N	%
City of Flint water	10	21.3
Other municipal water system	15	31.9
Private well	18	38.3
Flint Township Water	0	0
Unknown*	4	8.5

*Represents four questionnaires that were not completed. Per the Flint map, these residences are not located on the City of Flint Water system; it is unknown if the residence water sources are private wells or other municipal water systems.

Healthcare Exposure

A person was defined as having a healthcare exposure if they visited a hospital in Genesee County as an inpatient (overnight), outpatient, or visitor during the 2 weeks prior to their legionellosis symptom onset date. Hospitals A, B, and C are located in Genesee County. The City of Flint supplies water to Hospitals A and B.

Healthcare Exposure by Residence Water Source

Residence Water Source	Healthcare exposure n=27		No known healthcare exposure n=19		Total N=46	
	n	%	n	%	n	%
City of Flint water	7	25.9	3	15.8	10	21.7
Other water at residence	20	74.1	16	84.2	36	78.3

Healthcare Exposures by Hospitals Location and Residence Water Source

Healthcare exposure in 2 weeks prior to legionellosis symptom onset	Residence on City of Flint water	Residence NOT on City of Flint water	Total N=46
Hospitalized at Hospital A	5	18	23
Hospitalized at Hospital A and Hospital C	1	0	1
Hospitalized at Hospital A and Hospital Y*	1	0	1
Hospitalized at Hospital A and Hospital Z*	0	1	1
Visited Hospital A and Hospital B	0	1	1
No known Genesee hospital healthcare exposure	3	16	19
Total	10	36	46

*Hospitals Y and Z are located outside of Genesee County.

Healthcare exposure to a Genesee County hospital during the 2 weeks prior to onset:

7/10 (70%) case-patients with **City of Flint water** at their residence had a healthcare exposure to a Genesee County hospital during the 2 weeks prior to onset

5/7 (71.4%) had a hospitalization at Hospital A only

1/7 (14.3%) had a hospitalization at Hospital A and Hospital C

1/7 (14.3%) had a hospitalization at Hospital A and Hospital Y (non-Genesee County)

20/36 (55.6%) case-patients **NOT on City of Flint water** at their residence had a healthcare exposure to a Genesee County hospital during the 2 weeks prior to onset

18/20 (90.0%) had a hospitalization at Hospital A only

1/20 (5.0%) had a hospitalization at Hospital A and Hospital Z (non-Genesee County) during the entire 2 weeks prior to onset

1/20 (5.0%) visited both Hospital A and Hospital B

26/46 (56.5%) case-patients were hospitalized (overnight) at Hospital A during the 2 weeks prior to onset

27/46 (58.7%) case-patients had an exposure (inpatient, outpatient, visitor) to Hospital A during the 2 weeks prior to onset

19/46 (41.3%) case-patients had no known hospital exposure during the 2 weeks prior to onset

16/46 (34.8%) case-patients had no known hospital exposure and did not have City of Flint water at their residence

Healthcare-associated Legionellosis Cases by Hospital Location

Consistent with the working case definition used for this outbreak, a case was defined as definitely healthcare-associated if the case-patient was hospitalized continuously for at least the 14 days prior to legionellosis symptom onset. A case was defined as possibly healthcare-associated if they had exposure to a hospital for a portion of the 2-14 days prior to legionellosis symptom onset. (Ref. Demirjian A et al. *Clin Infect Dis*. 2015 June 1;60(11): 1596-1602.)

Healthcare exposure in 2 weeks prior to legionellosis symptom onset	Definitely healthcare-associated	Possibly healthcare-associated	Not healthcare-associated
Hospitalized at Hospital A	1	22	0
Hospitalized at Hospital A and Hospital C	0	1	0
Hospitalized at Hospital A and Hospital Y*	0	1	0
Hospitalized at Hospital A and Hospital Z*	1	0	0
Visited Hospital A and Hospital B	0	1	0
No known Genesee hospital healthcare exposure	0	0	19
Total	2	25	19

*Hospitals Y and Z are located outside of Genesee County.

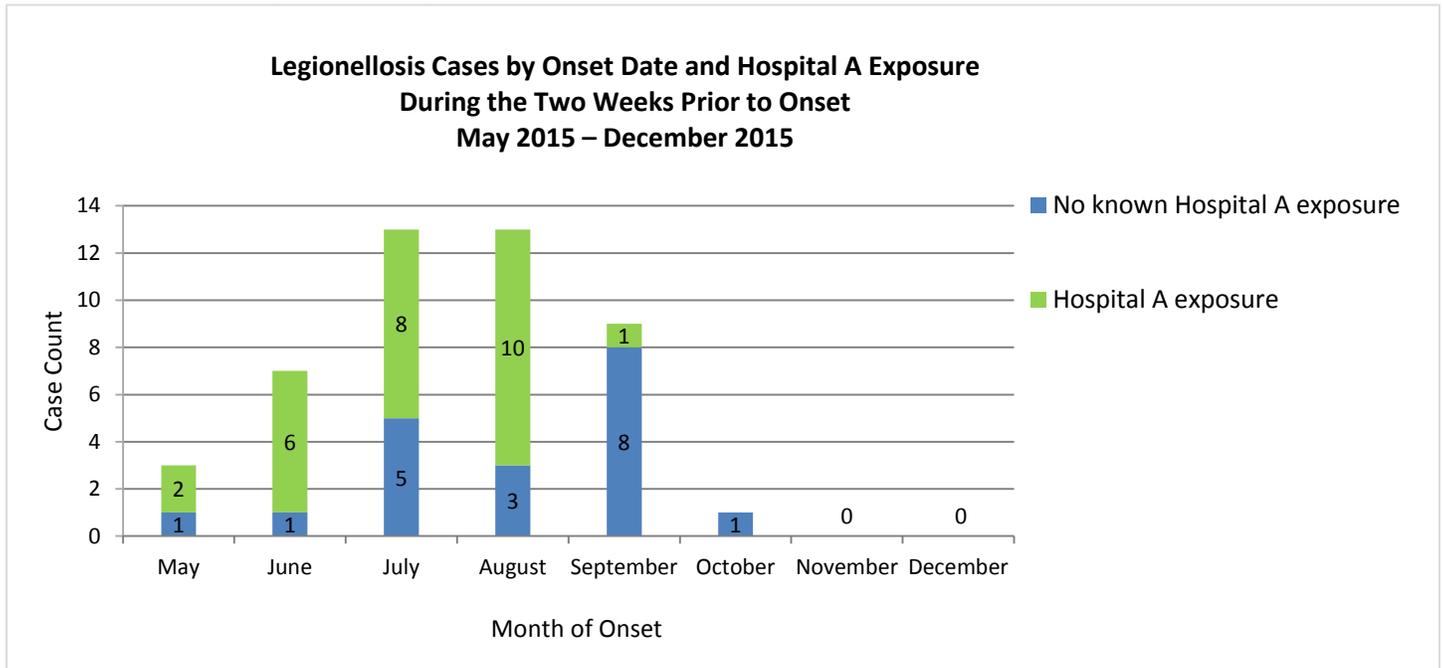
Prior Inpatient Hospitalization Cases by Length of Stay and Residence Water Source

Prior inpatient hospitalization was defined as a person who was an inpatient (overnight) at a hospital in Genesee County within the 2 weeks prior to legionellosis symptom onset. Length of stay was defined as the number of nights hospitalized at a hospital in Genesee County during the 2 weeks prior to legionellosis symptom onset.

Location	Length of Stay		
	N	Median (days)	Range
Hospital A*	25	5	1–14
Individuals with City of Flint water at residence	6	8.5	1–9
Individuals with other water at residence	19	5	1–14
Hospital A and Hospital C	1		
Individual's residence on City of Flint water			
Hospital A		1	
Hospital C		6	
Total	26	5	1–14

*Two people hospitalized at Hospital A also had additional inpatient stays at hospitals outside of Genesee County during the 2 weeks prior to onset; one case-patient for 5 days (Hospital Y) and another for 10 days (Hospital Z). One patient visited Hospital A and B and is not included in the length of stay calculation.

Epi Curve by Hospital A Exposure



Legionellosis Questionnaire Results

Data were obtained from case-patient or proxy interviews using the enhanced legionellosis questionnaire. Column percentages are displayed. The denominators are based on the number of case-patients interviewed.

Interview Status by Healthcare Exposure

A person was defined as having a healthcare exposure if they visited a hospital in Genesee County as an inpatient, outpatient, or visitor during the 2 weeks prior to their legionellosis symptom onset date.

Interview status	Healthcare Exposure n=27		No Known Healthcare Exposure n=19		Total N=46	
	n	%	n	%	N	%
Complete interview	23	85.2	17	89.5	40	87.0
Partial interview	1	3.7	1	5.3	2	4.3
Refused	0	0.0	0	0.0	0	0.0
Unable to contact	3	11.1	1	5.3	4	8.7

Interview Status by Residence Water Supply

Interview status	Flint water at residence n=10		Other water at residence n=36		Total N=46	
	n	%	n	%	N	%
Complete interview	9	90.0	31	86.1	40	87.0
Partial interview	0	0.0	2	5.5	2	4.3
Refused	0	0.0	0	0.0	0	0.0
Unable to contact	1	10.0	3	8.3	4	8.7

Water Changes at Residence

Question Prompts:

Q4. During the last year, has the water pressure at your residence changed?

Q5. During the last year, has the water quality (appearance, taste, smell) at your residence changed?

Q6. Prior to your illness, did you make any recent plumbing changes or repairs at your residence?

Q7. Prior to your illness, were there any water main breaks or other water line issues that affected the water at your residence, including boil water advisories?

	City of Flint water at Residence n=9		Other Water Source at Residence n=32		Total N=41*	
	n	%	n	%	N	%
Q4. Noticed changes in water pressure	2	22.2	6	18.8	8	19.5
Healthcare exposure	1		1		2	
No known healthcare exposure	1		5		6	
Q5. Noticed changes in water quality	7	77.8	5	15.6	12	29.3
Healthcare exposure	3		2		5	
No known healthcare exposure	4		3		7	
Q6. Made recent plumbing changes or repairs at residence	0	0.0	1	3.1	1	2.4
Healthcare exposure	0		1		1	
No known healthcare exposure	0		0		0	
Q7. Experienced water main breaks or water line issues that affected residence	1	11.1	2	6.3	3	7.3
Healthcare exposure	0		0		0	
No known healthcare exposure	1		2		3	

* Does not include one person who was interviewed but did not answer these questions.

Work and Travel

Question Prompts:

- Q8. During this 2 week period (exposure period), did you work or volunteer, either full or part time?
- Q10. Visit, reside, or work in a long term care facility, nursing home, assisted living facility, or senior living facility?
- Q11. In the 2 weeks before you before you got sick, did you spend any nights away from home (excluding healthcare settings)?

Work and Travel, n (%)	City of Flint Water At Residence n=7	Other Water Source At Residence n=30	Total N=37*
Q8. Work/volunteer outside of home (all different locations outside of Flint)	0 (0.0)	7 (23.3)	7 (18.9)
Q10. Reside or visit an assisted living facility or rehab facility (all different facilities outside of Flint)	0 (0.0)	4 (13.3)	4 (10.8)
Q11. Spend nights away from home (all different locations outside of Flint)	0 (0.0)	5 (16.7)	5 (13.5)

* Does not include data from 5 interviewees. 4 individuals were interviewed based on an incorrect exposure time period and one person did not answer these questions.

Community Exposures

Question prompt:

Q12. In the 2 weeks before you got sick, did you visit any of the following community venues?

Community Venue, n (%)	Healthcare Exposure		No Known Healthcare Exposure		Total N=37*
	City of Flint Water At Residence n=5	Other Water At Residence n=17	City of Flint Water At Residence n=2	Other Water At Residence n=13	
Hotel without staying overnight (unknown location)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.7)
Auditorium (outside of Flint)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.7)
Barbershop or hair salon (all different locations)	0 (0.0)	6 (35.3)	1 (50.0)	2 (15.4)	9 (24.3)
On City of Flint water supply	0	0	1	0	1
Not on City of Flint water supply	0	3	0	2	5
Unknown location	0	3	0	0	3
Car wash (all different locations)	0 (0.0)	1 (5.9)	0 (0.0)	1 (7.7)	2 (5.4)
On City of Flint water supply	0	1	0	0	1
Not on City of Flint water supply	0	0	0	1	1
Casino	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Doctor's office or clinic** (all different locations)	1 (20.0)	5 (29.4)	1 (50.0)	8 (61.5)	15 (40.5)
On City of Flint water supply	0	1	0	1	2
Not on City of Flint water supply	0	3	1	9	13
Unknown location	1	1	0	0	2
Place of worship (all different locations)	1 (20.0)	3 (17.6)	0 (0.0)	6 (46.2)	10 (27.0)
On City of Flint water supply	0	0	0	1	1
Not on City of Flint water supply	1	3	0	4	8
Unknown	0	0	0	1	1
Gym or work-out facility (outside of Flint)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.7)
Grocery store**	1 (20.0)	8 (47.1)	2 (100.0)	11 (84.6)	22 (59.5)
On City of Flint water supply:					
Store A	0	0	0	1	1
Store B	0	0	1	0	1
Not on City of Flint water supply:					
Store C	0	0	1	1	2
Store D	0	0	0	1	1
Store E	0	2	0	1	3

Not on City of Flint water (continued):					
Store F	0	0	0	3	3
Store G	0	0	0	2	2
Store H	0	0	0	4	4
Store I	0	1	0	1	2
Store J	0	2	0	0	2
Store K	0	0	0	1	1
Store L	0	1	0	1	2
Store M	1	0	0	1	2
Store N	0	2	0	2	4
Store O	0	1	0	1	2
Store P	0	0	0	1	1
Store Q	0	3	0	1	4
Store R	0	1	0	0	1
Store S	0	1	0	0	1
Home improvement store**; None on City of Flint water supply	0 (0.0)	4 (23.5)	0 (0.0)	4 (30.8)	8 (21.6)
Store T	0	0	0	1	1
Store U	0	0	0	2	2
Store V	0	0	0	1	1
Store W	0	1	0	0	1
Store X	0	1	0	3	4
Store Y	0	1	0	0	1
Unknown	0	1	0	0	1
Spa or nail salon (unknown location)	0 (0.0)	1 (5.9)	0 (0.0)	0 (0.0)	1 (2.7)
Mall or department store	0 (0.0)	1 (5.9)	0 (0.0)	1 (7.7)	2 (5.4)
Not on City of Flint water supply	0	0	0	1	1
Unknown	0	1	0	0	1
Movie theater (unknown locations)	0 (0.0)	2 (11.8)	0 (0.0)	0 (0.0)	2 (5.4)
Other locations (all different locations: bank, pharmacy, convenience store)	0 (0.0)	1 (5.9)	1 (50.0)	1 (7.7)	3 (8.1)
On City of Flint water supply	0	0	1	0	1
Not on City of Flint Water supply	0	1	0	1	2

* Does not include data from 5 interviewees. 4 individuals were interviewed based on an incorrect exposure time period and one individual did not answer these questions.

** The individual locations do not equal the total because some individuals visited more than one location.

Question prompt:

Q13. In the 2 weeks before you got sick, did you have exposure to any of the following water sources, either **at home** or while **away from home**?

Water Exposures in the Home

Water exposure, n (%)	Healthcare Exposure		No Known Healthcare Exposure		Total N=36*
	City of Flint Water At Residence n=5	Other Water At Residence n=16	City of Flint Water At Residence n=2	Other Water At Residence n=13	
Shower	5 (100.0)	13 (81.3)	2 (100.0)	13 (100.0)	33 (91.7)
Use a detachable shower head or hose	2 (40.0)	7 (43.8)	1 (50.0)	6 (46.2)	16 (44.4)
Hot tub, whirlpool spa, Jacuzzi tub	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)
Sat NEAR hot tub or whirlpool spa	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)
Steam room or wet sauna	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Humidifier	1 (20.0)	2 (12.5)	0 (0.0)	3 (23.1)	6 (16.7)
Respiratory therapy machine	0 (0.0)	2 (12.5)	0 (0.0)	1 (7.7)	3 (8.3)
CPAP	0	1	0	1	
Nebulizer	0	1	0	0	

* Does not include data from 6 interviewees. Four individuals were interviewed based on an incorrect exposure time period and two individuals did not answer these questions.

Water Exposures Outside of the Home

Water Exposure, n (%)	Healthcare Exposure		No Known Healthcare Exposure		Total N=36*
	City of Flint Water At Residence n=5	Other Water At Residence n=16	City of Flint Water At Residence n=2	Other Water At Residence n=13	
Showered outside the home	1 (20.0)	2 (12.5)	0 (0.0)	4 (30.8)	7 (19.4)
Use a detachable shower head or hose	1 (20.0)	2 (12.5)	0 (0.0)	2 (15.4)	5 (13.9)
Hot tub, whirlpool spa, Jacuzzi tub	0 (0.0)	0 (0.0)	0 (0.0)	2 (15.4)	2 (5.6)
Sat NEAR hot tub or whirlpool spa	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Humidifier	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)
Pool/splash pad/waterpark	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)
Recreational or cooling misters	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)
Steam room or wet sauna	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Decorative fountain	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Outdoor watering hose or sprinkler	0 (0.0)	1 (6.3)	0 (0.0)	5 (38.5)	6 (16.7)
Beach, lake, pond, river, creek, etc.	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (2.8)

* Does not include data from 6 interviewees. Four individuals were interviewed based on an incorrect exposure time period and two individuals did not answer these questions.

Comorbidities by Healthcare Exposure and Residence Water Supply

n (%)	Healthcare Exposure		No Known Healthcare Exposure		TOTAL N=46*
	City of Flint water at residence N=7	Other water at residence N=20	City of Flint water at residence N=3	Other water at residence N=16	
≥1 comorbidity	7 (100.0)	19 (95.0)	2 (66.7)	10 (62.5)	38 (82.6)
Chronic kidney disease	3(42.9)	5 (25.0)	0 (0.0)	2 (12.5)	10 (21.7)
Immunocompromised	1 (14.3)	10 (50.0)	0 (0.0)	3 (18.8)	14 (30.4)
Diabetes	2 (28.6)	7 (35.0)	2 (66.7)	5 (31.3)	16 (34.8)
Chronic lung disease	2 (28.6)	5 (25.0)	0 (0.0)	3 (18.8)	10 (21.7)
Asthma or chronic bronchitis	2 (28.6)	3 (15.0)	1 (33.3)	1 (6.3)	7 (15.2)
Heart disease or congestive heart failure	5 (71.4)	13 (65.0)	1 (33.3)	7 (43.8)	26 (56.5)
Liver disease	0 (0.0)	1 (5.0)	0 (0.0)	1 (6.3)	2 (4.3)

* Number increased compared to previous tables because of data from medical records and self-reported comorbidities.

Health Behaviors by Healthcare Exposure and Residence Water Supply

Smoking and Drinking Status, n (%)	Healthcare Exposure		No Known Healthcare Exposure		TOTAL N=46*
	City of Flint water at residence N=7	Other water at residence N=20	City of Flint water at residence N=3	Other water at residence N=16	
Current smoker	1 (14.3)	5 (25.0)	2 (66.7)	5 (31.3)	13 (28.3)
Former smoker	4 (57.1)	11 (55.0)	1 (33.3)	4 (25.0)	20 (43.5)
Lives with Smoker	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.3)	1 (2.2)
Never Smoker	1 (14.3)	4 (20.0)	0 (0.0)	6 (37.5)	11 (23.9)
Unknown	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.2)
Drinks alcohol	0 (0.0)	6 (30.0)	2 (66.7)	6 (37.5)	14 (30.4)
Does not drink alcohol	3 (42.9)	12 (60.0)	1 (33.3)	7 (43.8)	23 (50.0)
Unknown	4 (57.1)	2 (10.0)	0 (0.0)	3 (18.8)	9 (19.6)

* Number increased compared to previous tables because of data from medical records and self-reported health behaviors.

Epi Summary of Cases with No Known Healthcare Exposure

Number of cases in individuals with no known healthcare exposure to a Genesee County Hospital: 19/46 (41.3%)

Geographic residence distribution: 19 Genesee County (7 Flint, 12 non-Flint)

Residence on City of Flint water system: 3/19 (15.8%)

Age range: 45–89 years

Average age (median): 66.4 years (63 years)

Sex: males, 9/19 (47.4%)

Legionellosis symptom onset dates from May 27, 2015 – October 29, 2015

L. pneumophila clinical isolates obtained: 6/19 (31.6%); among the 6 isolates, none had matching PFGE patterns to each other.

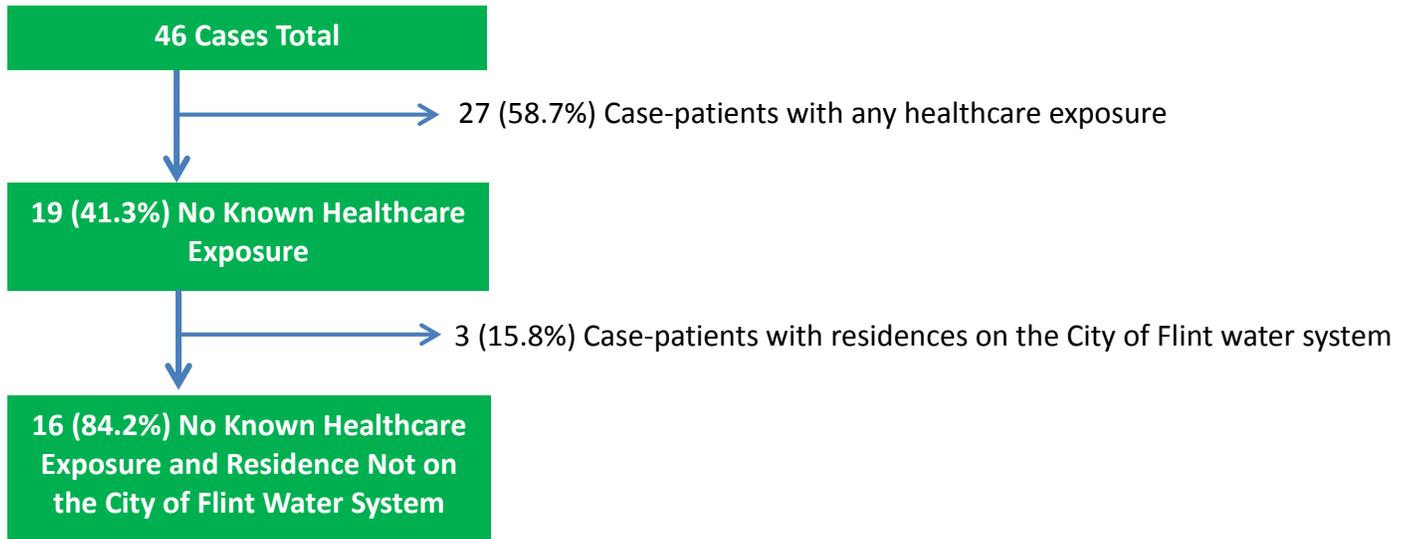
Cases with no known health care exposure and community exposure data available: 15/19 (78.9%)

During their two week exposure period:

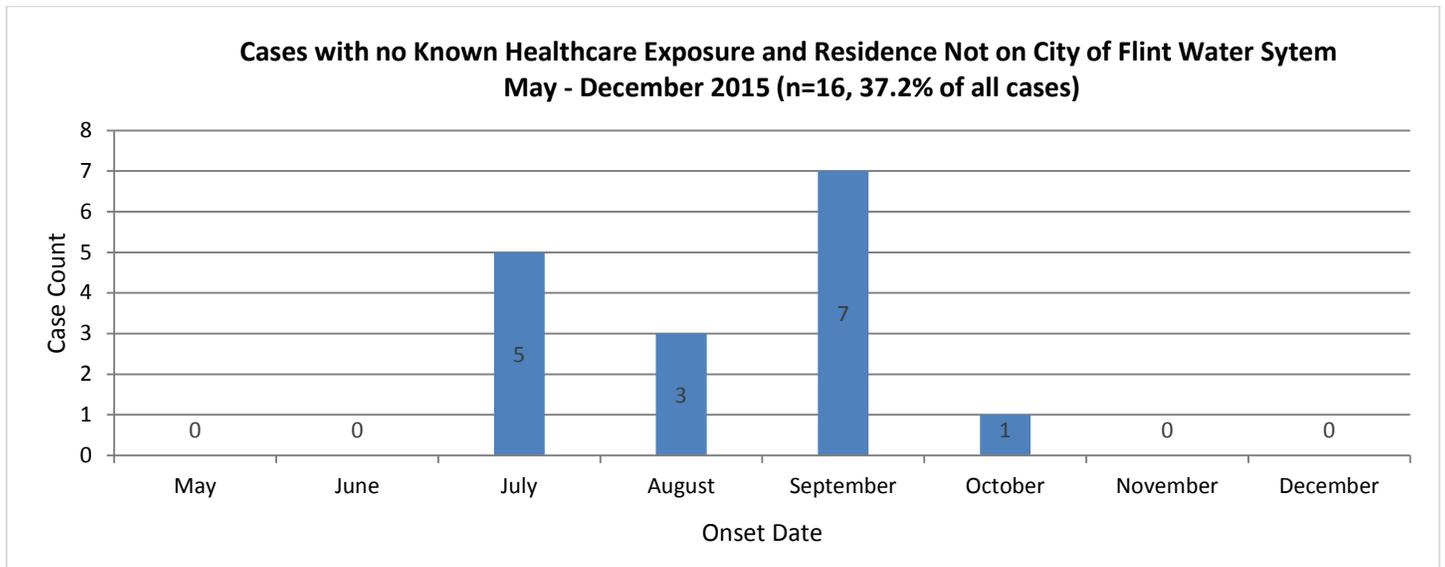
- 5/15 (33.3%) case-patients reported visiting a community location on the City of Flint water system
 - 2/5 (40.0%) individuals also had City of Flint water at their residence
 - All different locations; no location on the City of Flint water system was reported by more than one individual
- 13/15 (86.6%) case-patients visited a grocery store
 - 2 individuals visited two different grocery stores on the City of Flint water system (1 visited Store A, 1 visited Store B)
 - At most, 4 people reported visiting the same grocery store, which is not on the City of Flint water system
- 9/15 (60%) case-patients visited a doctor's office or clinic
 - 10 different locations (1 on City of Flint water system; 1 not on City of Flint water; 8 non-Flint locations)
- 6/15 (40%) case-patients visited a place of worship
 - 5 different locations (1 on City of Flint water system; 4 non-Flint locations) and 1 unknown location
- 4/15 (26.7%) case-patients visited home improvement stores
 - At most, 3 people reported visiting the same home improvement store, which is not on the City of Flint water system
- 4/15 (26.7%) case-patients had an overnight stay away from home
 - 4 different locations; all non-Flint locations
- 3/15 (20%) case-patients visited a barbershop or salon
 - 3 different locations (1 on City of Flint water system; 2 non-Flint locations)

Cases with No Known Healthcare Exposure and Residence not on City of Flint Water Supply

Case Flow-chart



Epi Curve



Laboratory Testing

Out of 46 cases, 12 sputum specimens were received at the MDHHS BoL for additional testing. Three specimens were culture negative; one specimen was received contaminated and unable to be tested. *L. pneumophila* was cultured from 8 of the 12 specimens; all 8 isolates were typed by PFGE. Two of these case-patients had inpatient hospitalizations in the 2 weeks prior to the onset of illness; one of the two hospitalized case-patients also had a residence on the City of Flint water system. While the number of samples available for additional testing increased relative to the previous year (cases from June, 2014–March, 2015), the isolates represent only 17% of the current cases (May–Nov, 2015). The collection of respiratory culture specimens remains a priority for the continued surveillance in 2016.

	Total N = 46	
	n	%
Urinary Antigen Positive	46	100
Sputum Culture Positive		
Yes (<i>Legionella pneumophila</i> serogroup 1)	8	17.4
No (Specimen culture negative or specimen received contaminated)	4	8.7
Specimen culture not collected by hospital or not received at MDHHS Lab	34	73.9

Pulsed-field gel electrophoresis (PFGE) Testing Summary

Number of legionellosis cases with PFGE performed: 8

Geographic residence distribution: 8 Genesee County (3 Flint, 5 non-Flint)

Residence on City of Flint water system: 1/8 (12.5%)

Age range: 45-85 years

Average age (median): 60.3 years (56 years)

Sex: Males, 4/8 (50%)

Number of cases interviewed: 7/8 (87.5%); 6 completed plus one partial interview

PFGE results: 6/8 isolates had unique (non-matching) PFGE patterns:

Onset	Healthcare exposure during the 2 weeks prior to onset?	Residence on City of Flint water system?	Enhanced questionnaire interview able to be completed?
July, 2015	No	No	Yes
July, 2015	No	No	Yes
July, 2015	No	No	Yes
August, 2015	No	No	Yes
Sept, 2015	Yes- Hospital A & Hospital C	Yes	Yes
Sept, 2015	No	No	Partial interview

2/8 isolates had matching PFGE patterns:

Onset	Healthcare exposure during the 2 weeks prior to onset?	Residence on City of Flint water system?	Enhanced questionnaire interview able to be completed?
May, 2015	Yes- Hospital A	No	Yes
August, 2015	No (Hospital visitor status unknown)	No	No