

Legionellosis Outbreak-Genesee County, June, 2014 – March, 2015

Full Analysis

Michigan Department of Health and Human Services
Genesee County Health Department

(This report was edited on January 15, 2016 to update case information, including Legionella infection associated deaths and illness onset dates.)



Legionellosis Outbreak — Genesee County, June 2014–March 2015

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Working Case Definitions

Confirmed Legionnaires' Disease (LD) – meets the CDC clinical and laboratory case definition for confirmed LD and illness occurred since June 1, 2014 in residents of Genesee County or those who had visited the Flint area in 2 weeks prior to their illness onset date.

Suspected LD – meets the CDC clinical and laboratory case definition for suspected LD and illness occurred since June 1, 2014 in residents of Genesee County or those who had visited the Flint area in 2 weeks prior to their illness onset date.

Confirmed Pontiac Fever (PF) – meets the CDC clinical and laboratory case definition for confirmed PF and illness occurred since June 1, 2014 in residents of Genesee County or those who had visited the Flint area in 2 weeks prior to their illness onset date.

Data Sources

1. Legionellosis Case Report Form in Michigan Disease Surveillance System (MDSS)
2. Medical record review from:
 - a. McLaren Medical Center; Flint, MI
 - b. Hurley Medical Center; Flint, MI
 - c. Genesys Regional Medical Center; Grand Blanc, MI
3. Patient interview using Genesee County-specific Legionellosis Questionnaire

Epidemiology

Number of lab-confirmed cases of Legionnaires' Disease: 45

Number of Pontiac fever cases: 1 with positive Ag test but asymptomatic (not included in analysis)

Geographic distribution:

45/46 Genesee Co (27 Flint, 6 Mt. Morris, 4 Burton, 2 Flint Twp, 1 Flushing, 1 Byron, 1 Davison, 1 Linden, 1 Otisville, 1 Vienna Twp)

1/46 Saginaw County (1 Chesaning)

Age range: 26-94 years

Average age (median): 62.1 years (63 years)

% Males: 51% (23/45)

Range of illness onset dates (n=45): 6/6/14- 3/9/2015

Number (%) of deaths*: 11.1% (5/45)

*Edited on 1/15/16: Death was defined as one that occurred during hospitalization, within 30 days of hospital discharge¹ or when *Legionella* was listed as a cause of death on the death certificate.

¹ Mykietiuk A et al. Clin Infect Dis. 2005 Mar 15;40(6):794-9.



Date outbreak-specific survey completed and approved for use: 2/23/15

Number of cases interviewed: 29 completed + one partial (63% complete; 95.7% in total attempted/completed)

MDHHS: 19 completed / 30 contacted Genesee: 10 completed / 15 (1 status unknown)

Number (%) of cases hospitalized: 45/46 (97.8%). Number in ICU: 22/45 (48.8%)

Number (%) of cases hospitalized at McLaren: 18/45 (40%)

Number (%) of cases hospitalized at Hurley: 14/45 (31%)

Number (%) of cases hospitalized at Genesys: 6/45 (13.3%)

Number (%) of cases hospitalized at other hospitals outside Flint: 7/45 (15.6%)

Number (%) of cases who had been hospitalized in 2-weeks prior to onset: 19/45 (37.8%)

Number (%) of cases who had only a short-term visit to a hospital/healthcare facility in 2-weeks prior to onset: 8/45 (17.8%)

Number (%) of cases who had been hospitalized or who had a short-term visit to a hospital/healthcare facility in 2-weeks prior to onset: 27/45 (60%)

Number (%) of cases who work outside the home: 8/46 (17.4%) [min of 72% were at home]

Number (%) of cases who are retired: 20 (43.5%)

Number (%) of cases who are unemployed: 7/46 (15.2%)

Number (%) of cases who are disabled: 6/46 (13%)

Number (%) of cases whose occupation status is unknown: 5/46 (10%)

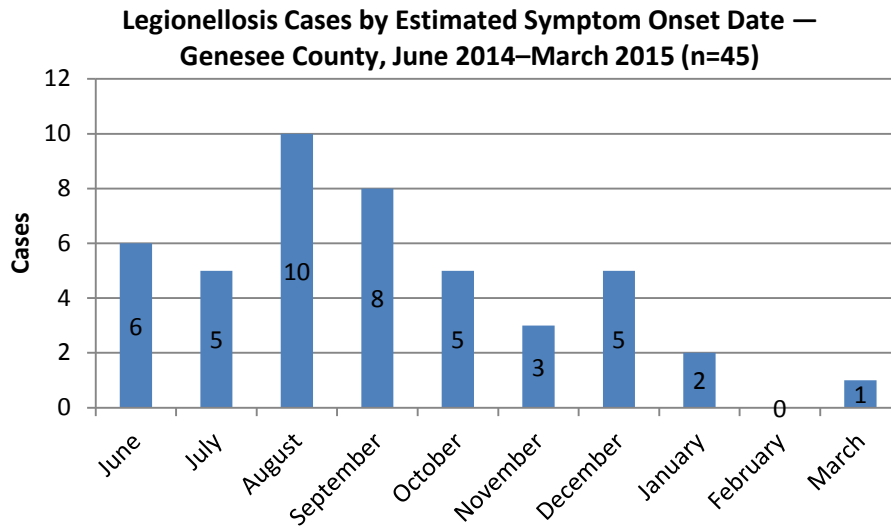
Number (%) of cases with ≥ 1 co-morbidity: 25/29 interviewed (86%)

Number (%) of cases who are current or former smokers: 24/29 interviewed (83%)



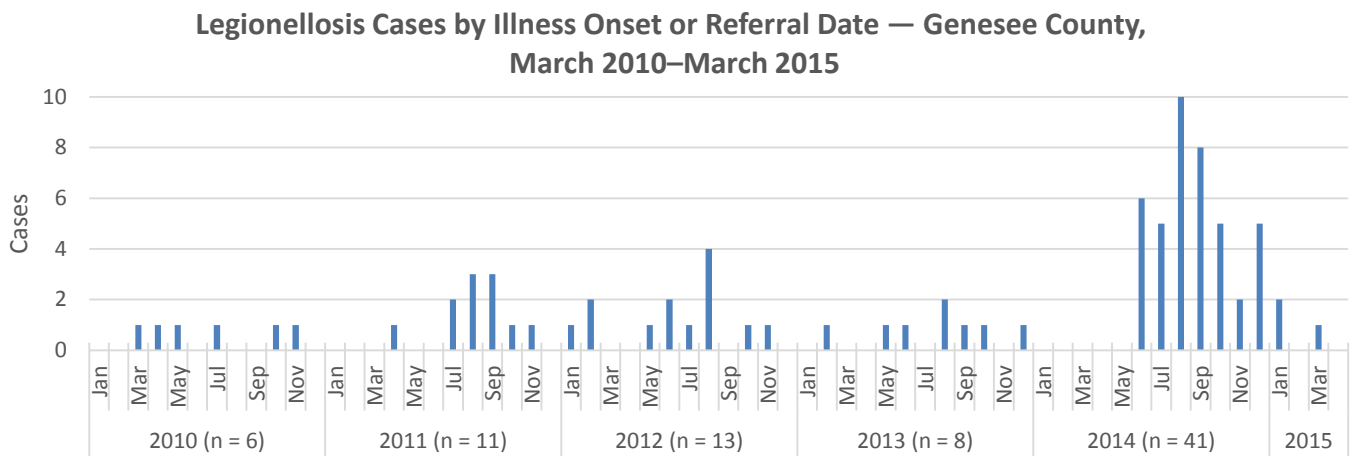
Epi Curves

Current Outbreak



This graph includes one Saginaw County resident who visited the Flint area within two weeks prior to their illness onset date. The graph was edited on 1/15/16 with an updated illness onset date.

Five-year History



In cases where an accurate onset date was unavailable, referral date was used.



Cases by Residence Water Source

Residence water source refers to the source of tap water at patient's home residence during the 14 days before symptom onset and was determined by patient interview and verified by City of Flint water distribution map.

Water Source at Residence	Total N=45	
	n	%
City of Flint water	21	47
City of Flint Township water	3	7
Other municipal water system	4	9
Private well	7	16
Unknown	10	22

For the remainder of the analysis, water source at home residence was stratified by:

- **Flint water at residence** (N=21)
- **Other water at residence**, which includes City of Flint Township, other municipal water, private well or unknown (N=24)

Healthcare Exposure

A person was defined as having a healthcare exposure if they visited a hospital or clinic in Flint, Michigan as an inpatient, outpatient, or visitor during the 14 days prior to their symptom onset date.

Healthcare Exposure by Residence Water Source

	Total N=45		Healthcare exposure N=27		No known healthcare exposure N=18	
	n	%	n	%	n	%
City of Flint Water	21	47	13	48	8	44
Other water at residence	24	53	14	52	10	56



Healthcare Exposures by Healthcare Location, Visit Type, and Residence Water Source (Table)

Healthcare exposure in 2 wks prior to onset	Residence on city water		Residence NOT on city water	
	Cases	Interviews missing	Cases	Interviews missing
Hospitalized at McLaren*	5	2	8	2
Hospitalized and Outpatient at McLaren	0		1	
Hospitalized and Visited McLaren; Outpatient at different Flint clinic	1		0	
Hospitalized at McLaren and Outpatient at different Flint clinic	1		0	
Outpatient at McLaren	3	1	1	1
Visited McLaren	0		1	
Hospitalized at McLaren and Hurley**	1		0	
Visited McLaren and Hurley	0		1	
Hospitalized at Hurley	1	1	1	1
Visited Hurley	1		1	
No known Flint healthcare exposure	8	4	11***	3
Total	21	8	24	7

* McLaren Flint Medical Center; Flint, MI. Hospital water is supplied by City of Flint.

** Hurley Medical Center; Flint, MI. Hospital water is supplied by City of Flint.

*** 3 of the 11 cases visited clinics outside of Flint as an outpatient.

Cases admitted (overnight) to a hospital during the 2 weeks prior to onset:

9/21 (43%) cases **on City of Flint water** with a hospital admission during the 2 weeks prior to onset.

8/21 (38%) admission to McLaren hospital

1/21 (5%) admission to Hurley

10/24 (42%) cases **NOT on City of Flint water** with a hospital admission during the 2 weeks prior to onset.

9/24 (38%) admission to McLaren hospital

1/25 (4%) admission to Hurley

Cases with any hospital exposure during the 2 weeks prior to onset:

13/21 (62%) cases **on City of Flint water** with any hospital exposure during the 2 weeks prior to onset.

11/21 (52%) admission, outpatient, or visit to McLaren*

3/21 (14%) admission or visit to Hurley*

* Percentages do not total due to cases with multiple exposures

14/24 (58%) cases **NOT on City of Flint water** with any hospital exposure during the 2 weeks prior to onset.

13/24 (54%) admission, outpatient, or visit to McLaren*

3/24 (13%) admission or visit to Hurley*

* Percentages do not total due to cases with multiple exposures

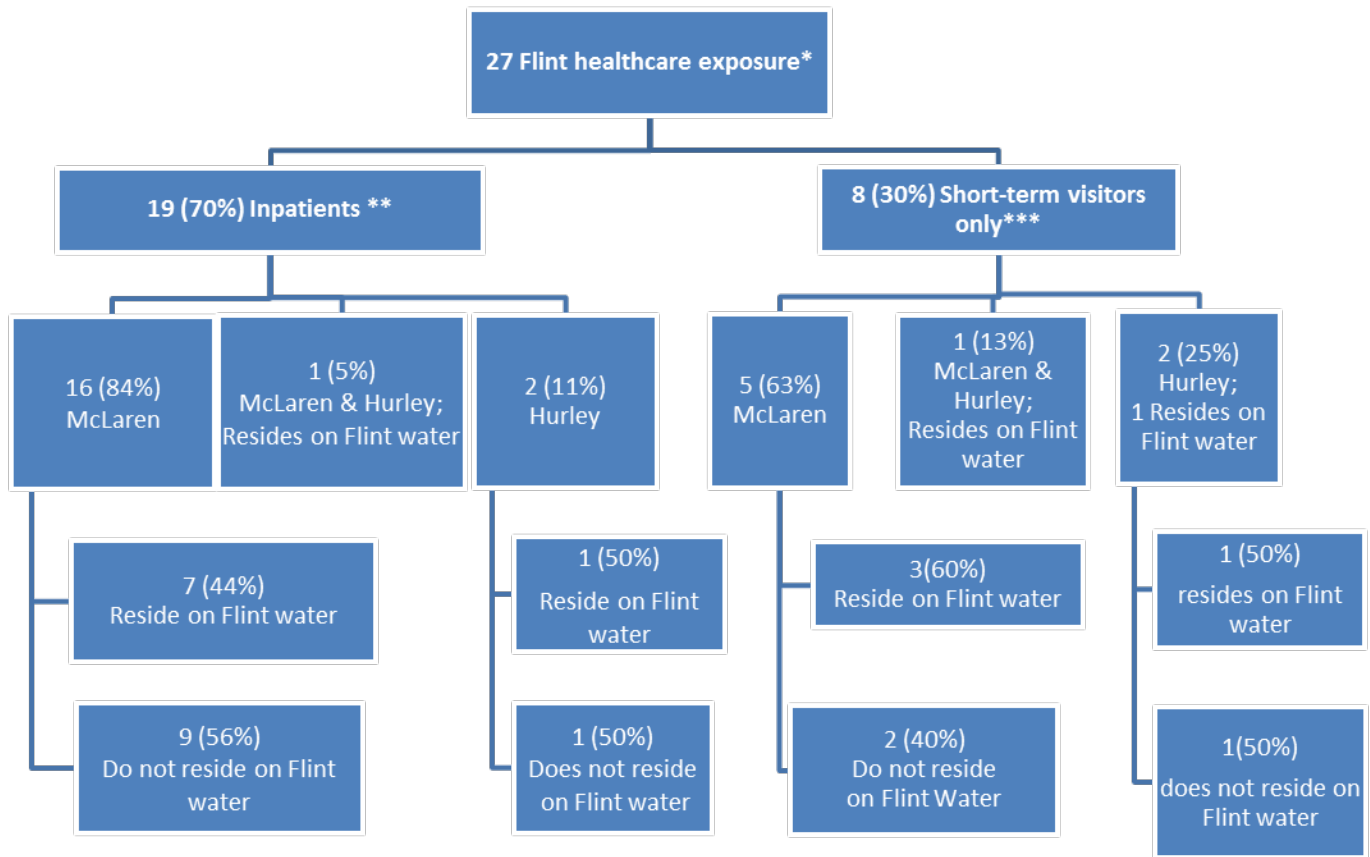
Overall:

17/45 (38%) Hospitalized at McLaren (overnight) during the 2 weeks prior to onset.

23/45 (51%) Any exposure to McLaren during the 2 weeks prior to onset.



Healthcare Exposures by Healthcare Location, Visit Type, and Residence Water Source (Graph)



*Flint healthcare exposure = Inpatient, outpatient or visitor to McLaren Flint Hospital or Hurley Medical Center during 14 days prior to symptom onset date.

**Inpatient = overnight stay at McLaren Flint Hospital or Hurley Medical Center during 14 days prior to symptom onset date.

***Short-term visitors = outpatient or visitor to McLaren Flint Hospital or Hurley Medical Center during 14 days prior to symptom onset date.



Hospitalized Cases By Length of Stay and Residence Water Source

Location	Length of Stay*		
	N	Median (days)	Range
McLaren	16	2	0.5–14
City of Flint water at patient residence	7	2	0.5–7
Other water at patient residence	9	5	1–14
Hurley	2	1.5	1–2
City of Flint water at patient residence	1	1	
Other water at patient residence	1	2	
McLaren and Hurley; Residence on Flint water	1	5	
McLaren		3	
Hurley		2	
Total	19	3	0.5–14

* Length of stay = Number of days hospitalized during 14 days prior to symptom onset date.



Legionellosis Questionnaire Results

Data were obtained from patient interviews using the Legionellosis Questionnaire.

Column percentages are displayed. The denominators are based on the number of patients interviewed.

Interview Status by Healthcare Exposure

Interview status (as of May 21, 2015)	Total (N=45)		Healthcare Exposure (N=27)		No Known Healthcare Exposure (N=18)	
	N	%	N	%	N	%
Complete interview	29	64	19	70	10	56
Partial interview	1	2	0	0	1	6
Refused	1	2	1	4	0	0
Unable to contact	14	31	7	26	7	39

Interview Status by Residence Water Supply

Interview status (as of May 21, 2015)	Total (N=45)		Flint water at residence (N=21)		Other water at residence (N=24)	
	N	%	N	%	N	%
Complete interview	29	64	12	57	17	71
Partial interview	1	2	1	5	0	0
Refused	1	2	0	0	1	4
Unable to contact	14	31	8	38	6	25



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?

	Flint Water at Residence (N=13)		Other Water Source at Residence (N=17)		Total (N=30)	
	n	%	n	%	n	%
Q4. Noticed changes in water pressure	2	15	1	6	3	10
Healthcare exposure	2		1		3	
No known healthcare exposure	0		0		0	
Q5. Noticed changes in water quality	10	77	0	0	10	33
Healthcare exposure	7		0		7	
No known healthcare exposure	3		0		3	
Q6. Made recent plumbing changes or repairs at residence	1	8	2	12	3	10
Healthcare exposure	1		2		3	
No known healthcare exposure	0		0		0	
Q7. Experienced water main breaks or water line issues that affected residence	6	46	0	0	6	20
Healthcare exposure	5		0		5	
No known healthcare exposure	1		0		1	



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)?

	Healthcare Exposure		No Reported Healthcare Exposure		TOTAL N=30
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=4	Other water at residence N=7	
Q8. Work outside of the home, n (%)	1 (11)	0 (0)	1 (25)	3 (43)	5 (17)
Contractor/painter	1	0	0	0	
Construction	0	1	0	0	
HR technician	0	0	0	1	
Industrial painter	0	0	0	1	
Welder	0	0	0	1	
Q8. Volunteer outside of the home, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Q10. Reside or visit an assisted living facility or rehab facility, n (%)	0 (0)	3 (30)*	0 (0)	0 (0)	3 (10)
Q11. Spend nights away from home, n (%)	0 (0)	0 (0)	0 (0)	2 (29)**	2 (7)

* Patients visited three different locations; none on City of Flint Water

1. Three night stay in rehab facility; Flushing, MI
2. Visited assisted living facility; Flint, MI
3. Visited rehab facility; Grand Blanc, MI

**Patients stayed in two different hotels outside of Flint and stayed ≤2 nights each.



Community Exposures

Question prompt:

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

n (%)	Healthcare Exposure		No Reported Healthcare Exposure		Total N=30
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=4	Other water at residence N=7	
Hotel but did not stay overnight	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Auditorium	0 (0)	1 (10)	0 (0)	0 (0)	1 (3)
Barbershop or Hair salon (different locations)	2 (22)	2 (20)	1 (25)	2 (29)	7 (23)
Salon on Flint water supply	0	1	0	0	
Salon not on Flint water supply	1	1	0	2	
Unknown location	1	0	1	0	
Car Wash (different locations)	1 (11)	1 (10)	1 (25)	2 (29)	5 (17)
Car wash on Flint water supply	0	0	1	0	
Car wash not on Flint water supply	0	1	0	2	
Unknown location	1	0	0	0	
Casino (different locations, outside Flint)	1 (11)	1 (10)	0 (0)	1 (14)	3 (10)
Place of worship	3	2	1	2 (29)	8 (27)
St. John Vianney; on Flint water supply	2	0	0	0	
Places not on Flint water supply	0	1	1	2	
Unknown location	1	0	0	0	
Gym or Work-out facility	1 (11)	0 (0)	0 (0)	0 (0)	1 (3)
Grocery Store	6 (67)	6 (60)	2 (50)	6 (86)	20 (67)*
<i>Stores on Flint water supply:</i>					
Save-a-Lot (Dort Hwy, Flint)	1	0	0	0	1
Aldi (Center St, Burton)	0	0	0	2	2
Kroger (Richfield Rd, Flint)	0	0	0	1	1
Kroger (Davison Rd, Flint)	1	0	0	0	1
<i>Stores not on Flint water:</i>					
Aldi (Pierson Rd, Flushing)	1	1	0	0	1
Aldi (Corunna Rd, Flint)	0	1	0	0	1
Kroger (Saginaw Rd, Mount Morris)	0	2	0	0	2



	Healthcare Exposure		No Reported Healthcare Exposure		Total N=30
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=4	Other water at residence N=7	
<i>Grocery stores, not on Flint water (continued)</i>					
Kroger (State Rd, Davison)	1	0	0	1	2
Kroger (Pierson Rd, Flushing)	1	0	0	0	1
Kroger (Corunna Rd, Flint)	1	0	1	0	2
Meijer (Center Rd, Flint)	1	0	0	4	5
Meijer (Birch Run Rd, Birch Run)	0	0	0	1	1
Meijer (M21, Corunna)	0	1	0	0	1
Meijer (Swartz Creek, MI)	0	1	0	0	1
Meijer (Pierson Rd, Flint)	2	0	0	0	1
Walmart (Linden Rd, Clio)	0	1	0	1	2
Walmart (Court St, Burton)	0	0	0	1	1
Walmart (Corunna Rd, Flint)	0	0	1	0	1
Other	1	2	0	0	3
Home improvement store; none on Flint water supply	3 (33)	0 (0)	2 (50)	3 (43)	8 (27)**
Lowes (Mansour Blvd, Flint)	1	0	0	0	1
Lowes (Court St, Burton)	1	0	0	0	1
Home Depot (Corunna Rd, Flint)	1	0	0	0	1
Home Depot (Pierson Rd, Flushing)	1	0	0	0	1
Home Depot (Court St, Burton)	0	0	1	1	2
Menards (Linden Rd, Clio)	0	0	0	1	1
Menards (Court St, Davison)	0	0	0	1	1
Unknown	0		1	0	1
Spa or nail salon	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mall or Department store	0 (0)	1 (10)	0 (0)	0 (0)	1 (3)
Movie Theater	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

* Do not sum to 20 because people visited multiple locations.

** Do not sum to 8 because people visited multiple locations.



Community Exposures by Location of Healthcare Exposure

	Healthcare Exposure (N=17)								No known healthcare exposure (N=12)		TOTAL	
	Hurley		McLaren		McLaren & Hurley		Total					
	n	%	n	%	n	%	n	%	n	%	n	%
Auditorium	0	0.00	1	5.88	0	0.00	0	0.00	0	0.00	1	3.45
Barbershop	1	5.88	2	11.76	1	5.88	4	23.53	3	25.00	7	24.14
Car Wash	1	5.88	0	0.00	1	5.88	2	11.76	3	25.00	5	17.24
Casino	1	5.88	0	0.00	0	0.00	1	5.88	2	16.67	3	10.34
Church	0	0.00	4	23.53	1	5.88	5	29.41	3	25.00	8	27.59
Gym	1	5.88	0	0.00	0	0.00	1	5.88	0	0.00	1	3.45
Grocery	1	5.88	9	52.94	1	5.88	11	64.71	9	75.00	20	68.97
Home Improvement Store	0	0.00	3	17.65	0	0.00	3	17.65	4	33.33	7	24.14
Spa/Nail Salon	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Mall	0	0.00	0	0.00	1	5.88	1	5.88	1	8.33	2	6.90
Movie Theater	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00



Water Exposures in the Home

Question prompt:

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

	Healthcare Exposure		No Reported Healthcare Exposure		TOTAL N=29*
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=3*	Other water at residence N=7	
Shower	8 (89)	10 (100)	2 (75)	7 (100)	27 (93)
Use a detachable shower head or hose	2 (22)	2 (20)	1 (33)	3 (43)	8 (28)
Hot tub, whirlpool spa, Jacuzzi tub	0 (0)	0 (0)	1 (33)	1 (14)	2 (7)
Sat NEAR hot tub or whirlpool spa	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steam room or wet sauna	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Humidifier	2 (22)	2 (20)	0 (0)	2 (29)	8 (28)
Respiratory therapy machine	4 (44)	2 (20)	0 (0)	0 (0)	6 (21)
CPAP	1	0	0	0	
Nebulizer	3	2	0	0	

* Number decreased compared to previous tables because of the one partial interview.

Water Exposures Outside of the Home

	Healthcare Exposure		No Reported Healthcare Exposure		TOTAL N=29
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=3	Other water at residence N=7	
Use a detachable shower head or hose	1 (11)	0 (0)	0 (0)	0 (0)	1 (3)
Hot tub, whirlpool spa, Jacuzzi tub	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Sat NEAR hot tub or whirlpool spa	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Humidifier	0 (0)	0 (0)	1 (33)	0 (0)	1 (3)
Pool/splash pad/waterpark (different locations)	1 (11)	1 (10)	0 (0)	1 (14)	3 (10)
Recreational or cooling misters	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Steam room or wet sauna	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Decorative fountain	1 (11)	0 (0)	0 (0)	0 (0)	1 (3)
Outdoor watering hose or sprinkler	2 (22)	0 (0)	1 (33)	2 (29)	5 (17)
Beach, lake, pond, river, creek, etc.	1 (11)	0 (0)	0 (0)	1 (14)	2 (7)



Self-reported Comorbidities by Healthcare Exposure and Residential Water Supply

	Healthcare Exposure		No Reported Healthcare Exposure		TOTAL N=29
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=3	Other water at residence N=7	
≥1 comorbidity	8 (89)	10 (100)	2 (67)	5 (71)	25 (86)
Chronic kidney disease	3 (33)	6 (60)	1 (33)	1 (14)	11 (38)
Immunocompromised	1 (11)	4 (40)	2 (67)	2 (29)	9 (31)
Diabetes	4 (44)	4 (40)	1 (33)	3 (43)	12 (41)
Chronic lung disease	3 (33)	6 (60)	1 (33)	2 (29)	12 (41)
Asthma or chronic bronchitis	3 (33)	2 (20)	1 (33)	1 (14)	7 (24)
Heart disease or congestive heart failure	4 (44)	5 (50)	1 (33)	2 (29)	12 (41)
Liver disease	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Number of Self-reported Comorbidities by Healthcare Exposure and Healthcare Location

Comorbidities are self-report from interviews, hospital exposure from medical records

	Healthcare Exposure (N=19)						No known healthcare exposure (N=10)		TOTAL N=29			
	Hurley N=1		McLaren N=15		McLaren & Hurley N=3		Total					
	n	%	n	%	n	%	n	%	n	%		
≥1 comorbidity	1	5.88	14	82.35	3	5.88	18	94.12	7	75.00	25	86.21
0 comorbid conditions	0	0.00	1	5.88	0	0.00	1	5.88	3	25.00	4	13.79
1 comorbid conditions	1	5.88	6	35.29	0	0.00	7	41.18	3	25.00	10	34.48
2 comorbid conditions	0	0.00	2	11.76	0	0.00	2	11.76	1	8.33	3	10.34
3 comorbid conditions	0	0.00	2	5.88	1	0.00	3	5.88	1	25.00	4	13.79
4 comorbid conditions	0	0.00	3	23.53	2	5.88	5	29.41	1	8.33	6	20.69
5 comorbid conditions	0	0.00	1	5.88	0	0.00	1	5.88	0	0.00	1	3.45
6 comorbid conditions	0	0.00	0	0.00	0	0.00	0	0.00	1	8.33	1	3.45



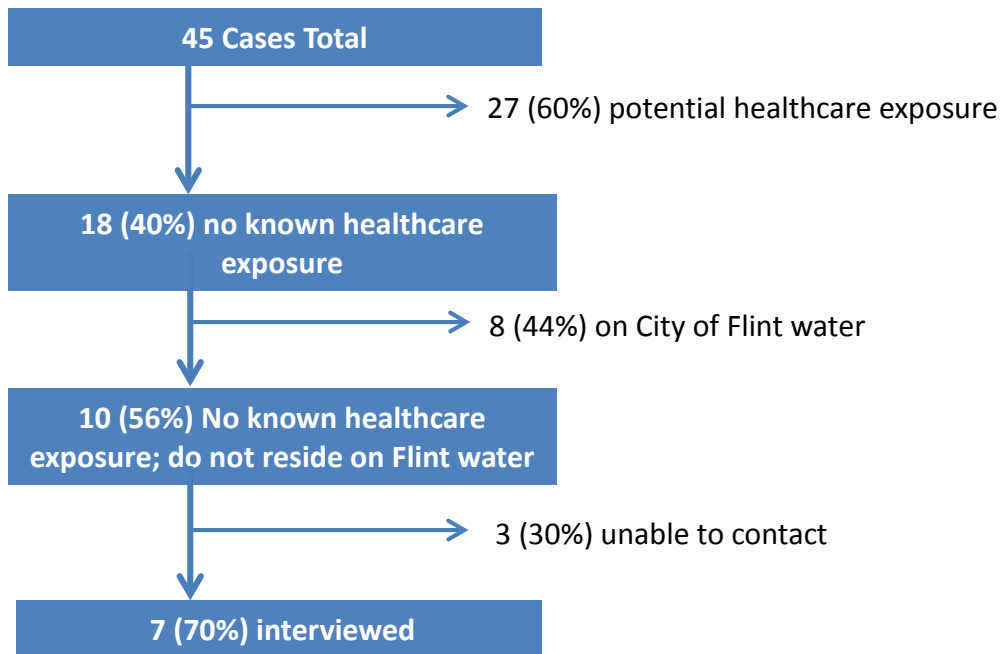
Patient-reported Health Behaviors by Healthcare Exposure and Residential Water Supply

	Healthcare Exposure		No Reported Healthcare Exposure		TOTAL N=29
	Flint water at residence N=9	Other water at residence N=10	Flint water at residence N=3	Other water at residence N=7	
Former or current smoker, n (%)	8 (89)	6 (60)	3 (100)	7 (100)	24 (83)
Median packs per day (range)	1 (0.15–2)	1 (0.5–2)	1 (0.14–3.5)	1 (0.21–3.5)	1 (0.14–3.5)
Median years (range)	35 (25–45)	32.5(20–48)	30	30 (15–35)	30 (15–48)
Drinks alcohol, n (%)	4	2	0	3	9 (31)
Median drinks per day (range)	2	0.15 (0.1–0.2)	n/a	1 (0.2–2)	1 (0.1–2)
Median years (range)	1	51 (45–57)	n/a	UNK	45 (1–57)

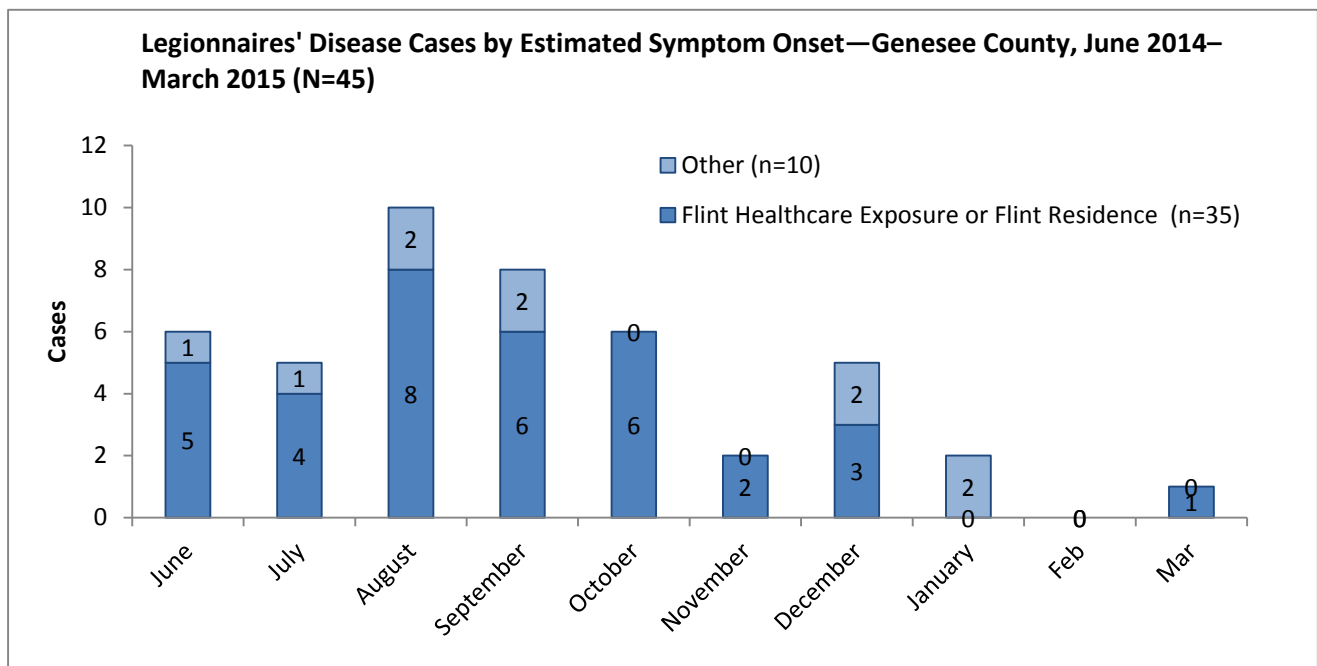


Cases with No Known Healthcare Exposure and Residence not on Flint Water Supply

Case Flow-chart

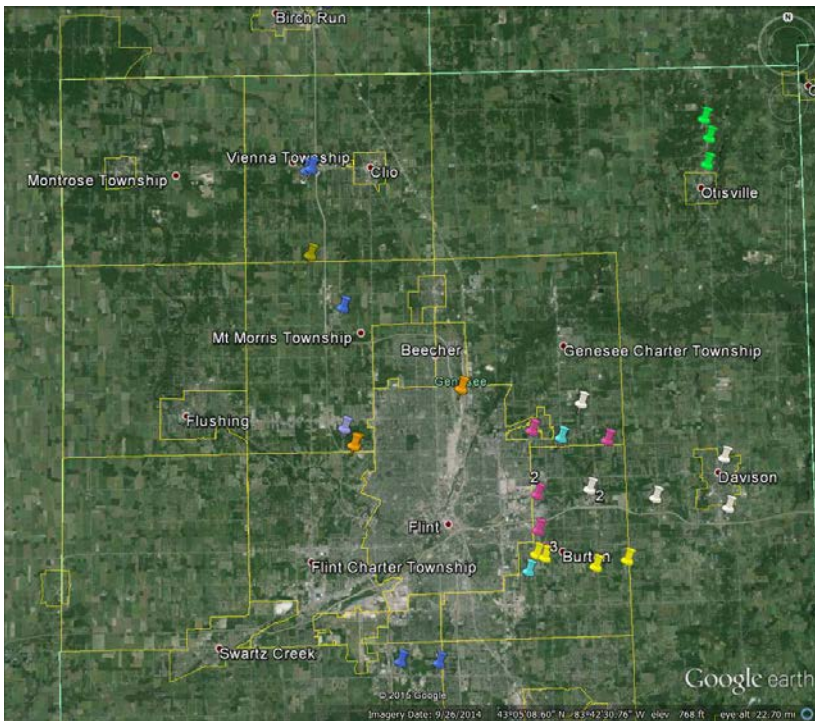


Epi Curve



Map of Community Exposures

We mapped the community locations visited by the 10 cases with unknown exposures (no known healthcare exposure and do not reside on Flint water supply) during the 14 days prior to symptom onset. Pins are color-coded by case. With exception of 2 grocery stores, none of the cases reported visiting the same locations. The majority of community locations were located outside of Flint or in Flint but were not supplied by City of Flint water.



Same map, zoomed in

