BACKGROUND

• Legionnaires' Disease (LD): bacter negative bacteria genus Legionella.

- Spread through aerosolization of wa
- Incubation period 2-14 days after expo
- Legionella is estimated to cause 8,000 United States annually¹.
- Colorado yearly median: 31 cases; monthly med s (2007-2011).

• Colorado typically has increases in late summer and early fall (Figure 1), consistent with seasonal trends in LD found nationwide².



• After a week of record temperature highs³, heavy rainfall occurred along Colorado's Front Range during September 9-15, 2013 ("1000 year rain event"⁴).

• Caused extensive flooding and damage, particularly in Larimer and Boulder counties.

• In the two weeks following the floods, routine disease surveillance through the Colorado Electronic Disease Reporting System (CEDRS)by CDPHE staff identified 10 confirmed cases of LD, prompting a public health investigation.

METHODS

CASE INVESTIGATION

• A case was defined as a Colorado resident with positive culture or urine ntigen test, with onset or specimen collection between September 9th and November 1st, 2013.

• Cases were interviewed by local public health agency staff with the standard CDC case investigation form and a hypothesis-generating questionnaire. Cases were asked about recreational water use, floodwater exposure, travel and other common exposures.

• A Health Alert Network (HAN) was sent to health care providers to inform them of the increase in cases, and to ask that respiratory specimens be collected from urine antigen positive cases for isolation and genetic sequencing at the state public health laboratory and CDC.

• We consulted with the Water Quality Control Division to ensure that no breaches or abnormalities in municipal water supplies had occurred that could be a potential risk for Legionella exposure.

LITERATURE SEARCH

• We conducted a literature review to identify past instances of increases in LD following periods of heavy rainfall.

SPATIAL AND STATISTICAL ANALYSIS

• Statewide rainfall data for September 9th – 15th was obtained through the Community Collaborative Rain, Hail and Snow Network (COCORAH) and mapped in ArcGIS

•A continuous surface of rainfall levels for Colorado was created via Kriging using ESRI's Geospatial Analyst and variance analyzed for model accuracy. Cases were geocoded and overlayed atop rainfall data for interpretation (Figure 2).

• Confirmed LD cases from the 2013 flood period were modeled against previous years (Aug. 1st – Nov. 1st, 2007-2011) in SAS 9.3 using logistic regression. Rainfall data (tenths/mm) obtained from NOAA was incorporated and incubation period was accounted for using the LAG procedure. Crude odds ratios were calculated. Greater than 0.1 inches (90% percentile) of rainfall was deemed a significant precipitation event. (Figure 4).

Increase of Sporadic Legionnaires' Disease in Colorado Following the 2013 Floods Benjamin White MPH, Lisa Miller MD MSPH Colorado Department of Public Health and Environment





Figure 4. Odds Ratio (OR) Calculations				Figure 5. Poisson [
Effect	Point Estimate	9 Confi	5% Wald idence Limits	of LD Cases, 2007-	
Rainfall Oto7dayLAG	6.628	2.346	18.721		
Rainfall 7to14dayLAG	7.500	2.324	24.207	0	5 10 15

Colorado Department of Public Health and Environment

Distribution (95%CI) -2011, 2013 (Aug-Nov)



RESULTS

CASE INVESTIGATION • 26 cases of LD (20 confirmed, 5 suspect, 1 probable) were identified (Figure 3), six times the expected number.

• The median age was 62 years (range of 29-75 years). 19 (73%) were males.

• 13 (50%) reported having pre-existing Legionella infection risk factors (smoking, COPD, immunosupression, etc.).

• No common exposures among cases were identified. Two cases recalled being near separate construction projects, however no cases reported any significant exposure to flood waters. Of interest, the Pitkin County case was actually in Boulder during the floods/their exposure period.

• Water Quality Control Division Staff ruled out municipal drinking water as a likely source of exposure.

• As a result of our HAN, four cases had clinical specimens collected and sent for genetic sequencing. Typing yielded three distinct and unrelated Legionella species: L.pneumophila serogroup 1, L. pneumophila serogroup 7, and L.longbeachae.

LITERATURE SEARCH

• We found peer-reviewed articles documenting the association of Legionella cases with basement flooding⁵, increased precipitation and temperatures⁶, and the successful isolated of legionella spp. from pluvial floodwaters after intense rainfall⁷.

• Additionally, increases in sporadic cases of LD were reported following flood events in Shelby County, TN (2010)⁸, Northeastern PA (2011)⁹, and Delaware following Hurricane Irene (2011)¹⁰.

• Consultation with CDC staff indicated that substantial rainfall episodes as well as warm temperatures such as those experienced the week prior to the floods have been associated with increases in sporadic cases of LD. Unfortunately, the exact mechanics behind this are still widely unknown, and more research is needed.

SPATIAL AND STATISTICAL ANALYSIS • Poisson Distribution: for 2007-2011 (months Aug-Nov) the expected number of LD cases was 11.4 (95% CI 6.2 -19.7). In 2013, for the same months, 31 cases were observed (Figure 5).

• The odds of being exposed to a substantial rainfall event (>0.1 inches) within 0-7 days of being clinically tested for LD were 6.6 times higher and between 7-14 days were 7.5 times higher among Aug-Nov. 2013 LD cases than for Aug.- Nov. baseline cases (2007-2011).

CONCLUSIONS

• A statistically significant increase in cases of LD was documented in the months after the 2013 Floods when compared to baseline data (Figure 3).

• Genetic sequencing of clinical specimens showed no common "outbreak strain" of Legionella, ruling out a common point-source for our cluster.

• Other reported past instances of flooding and scholarly research have indicated that increased temperatures and rainfall are associated with higher incidence of Legionnaires' Disease, though the exact mechanism remains unexplained. Water exposures and increased water ubiquity following flooding events should be considered by public health nursing staff when investigating clusters of Legionnaires' Disease in their jurisdictions.

• PPE and other precautions documented by CDC, OSHA, and WHO should be followed when dealing with floodwaters in order to prevent LD^{11} .

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4) Brennan, Charlie & Aguilar, John. "Eight days, 1000 -year rain, 100-year flood". Daily Camera [Boulder] 09/21/2013

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