Seasonal Trends in Water Contamination and *Cryptosporidium* Infections in Households with On-site Wells and Septic Systems

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Presenter Disclosures

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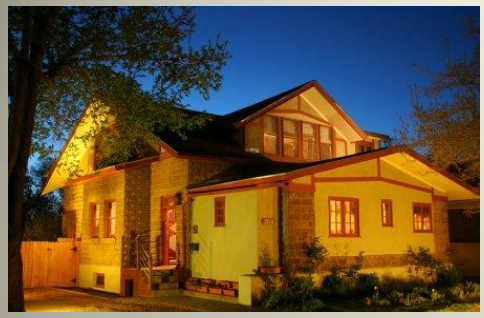
The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

No relationships to disclose



Introduction

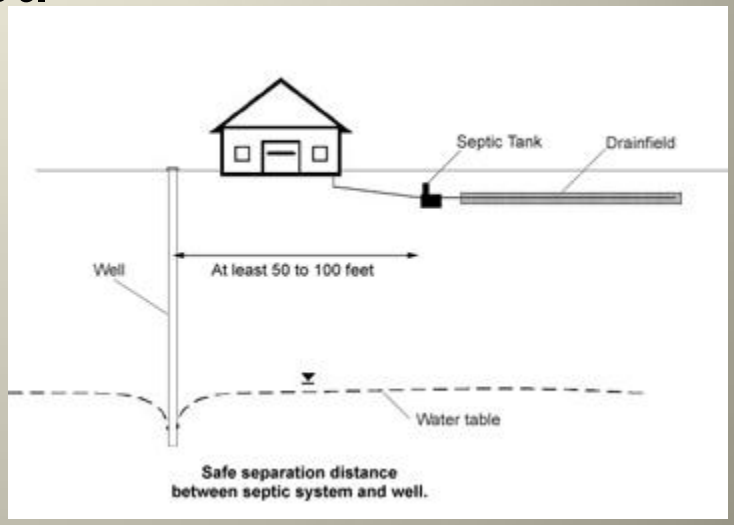
- Safe drinking water is a critical component of public health.
- In 2007, approximately 26 million homes use on-site wastewater systems for waste removal, about 20% of U.S. households (U.S. EPA 2008).
- What is the prevalence of the contamination of well water by septic tank contents?
- What are the public health impacts of these interacting systems?

Background

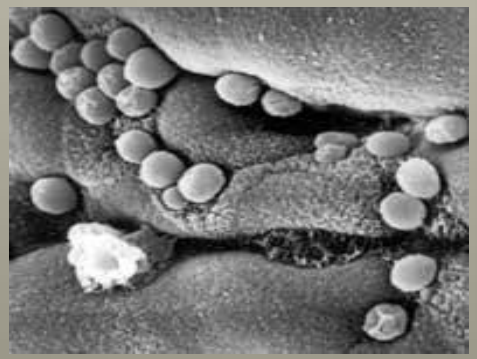
Regulation of wastewater systems and private wells are governed by NM State Engineering Dept.

and NM State Environment

Dept./Bernalillo County.



In this study, *Cryptosporidium* antibodies are used as an indicator of an immune response that may be caused by contaminated water.



Phase I: Cross-sectional Study

- Are people who reside in houses with private wells and septic systems at increased risk of enteric illness or infection from *Cryptosporidium*?

- Cross sectional study collected water samples, blood samples and questionnaires from exposed (septic and well) vs. unexposed (city water and sewer).

- Geological variation in the sites included riverbed, foothills, and mountain areas.

Phase I: Cross-sectional Study

Results

- Water samples testing positive: 15.8% riverbed, 27.6% foothills, and 28.2% mountain.

- People with on-site wastewater systems/private wells on the riverbed site had more intense serological response to *Cryptosporidium* antigen, after controlling for other risk factors, than the users of city water and sewer (other sites showed same trend).

- Having an on-site septic system and private well may increase risk of *Cryptosporidium* infection.

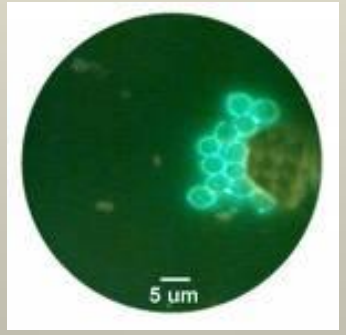
Phase II: Repeat Water Sample Study

- We wanted to examine the occurrence of groundwater contamination indicators and serological responses to *Cryptosporidium* antigens over time.

- Hypothesis: People with strong antigenic serological responses will be more likely to have water samples that have elevated indicators of contamination, suggesting that the water is the source of exposure.

Phase II: Repeat Water Sample Study

This analysis looks at individuals with high levels of *Cryptosporidium* antibodies in regards to:



- water contamination indicators,
- diarrheal and gastro-intestinal illness,
- risk factors for *Cryptosporidium* infection.

Methods: Participants

- Recruitment pool: Phase I participants who had an onsite wastewater system and private well, and who had a serological response ≥20% of the positive control.

- Participants lived in either the riverbed geological area, or the foothills geological area.

- 60 participants selected from exposed group of Phase I.

Methods: Data Collection

- Data collected Feb. 2008 to Feb. 2009.
- 7 water samples – once every other month.
- 5 blood samples – once every 3 months.
- 5 questionnaires – once every 3 months.

		Month Following Enrollment											
	Enrollment	2	3	4	5	6	7	8	9	10	11	12	13
Water	x		x		x		x		x		x		x
Blood	x			x			x			x			x
Questionnaire	x			x			x			x			x

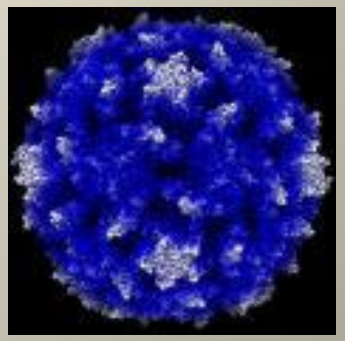
Methods: Water Samples

- Water tested for: total coliforms, *E. coli*, *Enterococcus*, and somatic coliphage.

coliform

E. coli

Enterococcus



somatic coliphage

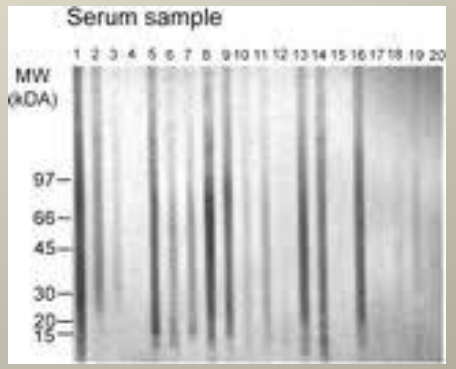
- Water samples sent to Dr. Marylynn Yates, UC Riverside. Results reported to participants after each test.

- Exposure: ever tested positive for any water test during the data collection period.

Methods: Blood Samples

- Serum was analyzed for the presence of *Cryptosporidium* antibodies by Western miniblot.

- Outcome for analysis:
  ≥75% of positive control for 27-kDa and 15/17-kDa antibody levels.



- The five antibody measures for each participant were averaged for one summary measure for each band site.

Methods: Questionnaire

- Information collected at the time of blood draw included:
  - Age, gender, marital status, education level.
  - Length of time at residence.
  - Information about well and wastewater system.
  - Children, pets, travel, and activity around water.
  - Amount of water consumed in past 24 hours.
  - Past diagnosis of cryptosporidiosis.

Methods: Questionnaire

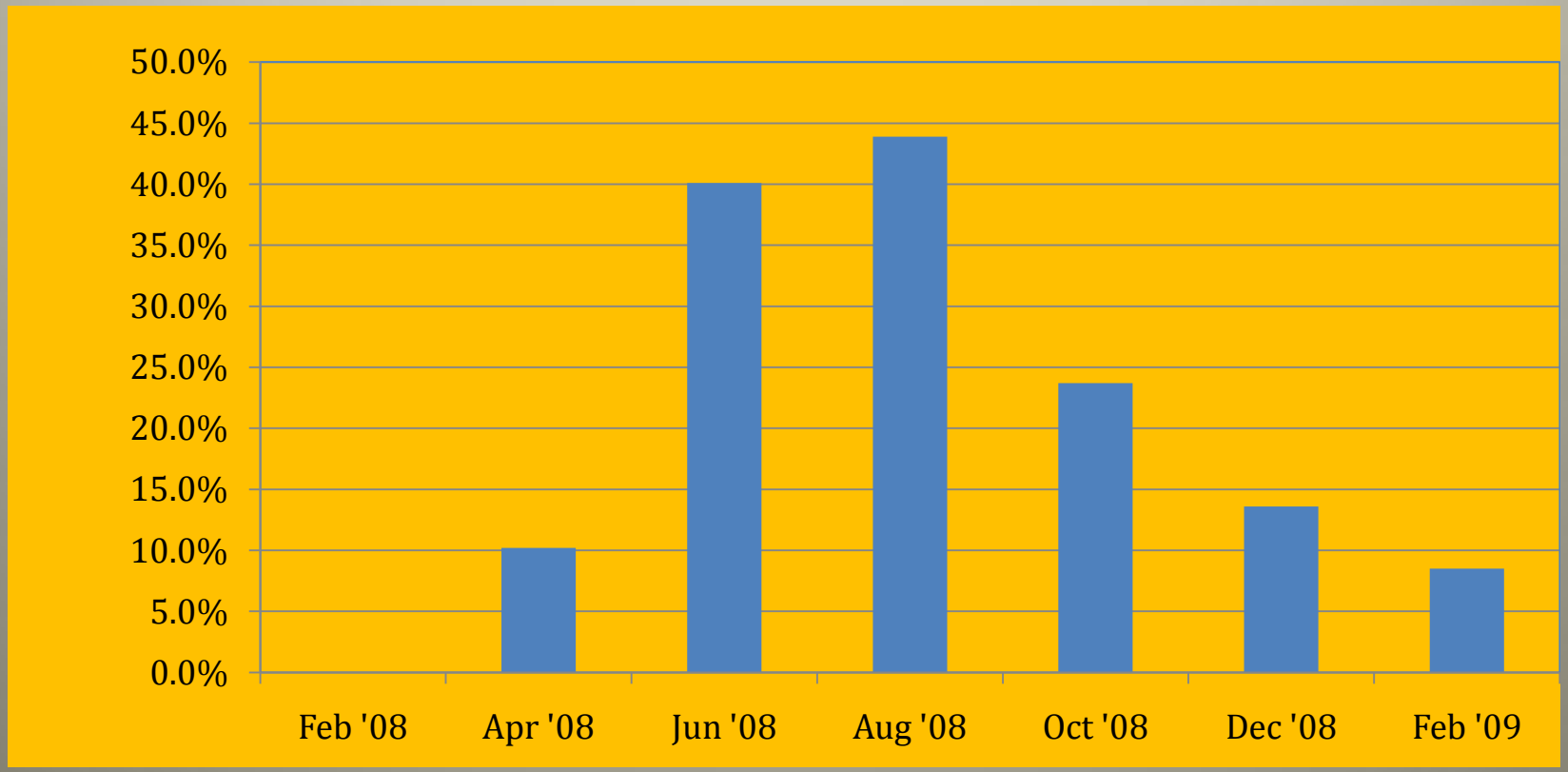
Answers to risk factor questions varied during the course of the study and were combined into two different summary variables.

- Most often positive: the five responses to the risk factor questions were most often positive.

- Ever positive: the five responses to the risk factor questions were ever positive.

Results

Total number of positive water tests by month



Results

Demographic characteristics of participants who have 27-kDa *Cryptosporidium* antibody levels at 75% or greater of a positive control, and participants with less than 75%

Variable		Percentage of people with high antibodies (N=21)	#	Percentage of people without high antibodies (N=38)	#	p-value
Gender	Male	47.6 %	10	39.5 %	15	0.54
	Female	52.4 %	11	60.5 %	23	
Age	< 50	19.0 %	4	23.7 %	9	0.65
	50-59	28.6 %	6	34.2 %	13	
	60-69	19.0 %	4	23.7 %	9	
	70-79	33.3 %	7	18.4 %	7	
Ethnicity	Non-Hispanic	71.4 %	15	84.2 %	32	0.02
	Hispanic	28.6 %	6	15.8 %	6	
Marital Status	Married	71.4 %	15	84.2 %	32	0.40
	Single/Divorced/ Widowed	28.6 %	6	15.8 %	6	
Education	High School	14.3 %	3	15.8 %	6	0.88
	Vocational/College	85.7 %	18	84.2 %	32	
Geographic Location	Riverbed	47.6 %	10	28.9 %	11	0.15
	Foothills	52.4 %	11	71.1 %	27	

Results

Water tests and reported illness of participants who have 27-kDa *Cryptosporidium* antibody levels at 75% or greater of a positive control, and participants with less than 75%

Variable		Percentage of people with high antibodies (N=21)	#	Percentage of people without high antibodies (N=38)	#	P-value
Positive water test: Total Coliform	Yes	71.4 %	15	42.1 %	16	0.03
Positive water test: Enterococcus	Yes	61.9 %	13	44.7 %	17	0.28
Positive water test: *E. coli*	Yes	57.1 %	12	31.6 %	12	0.06
Positive water test: Coliphage	Yes	9.5 %	2	18.4 %	7	0.36
Positive for any water test	Yes	90.5 %	19	73.7 %	28	0.17
Diarrhea lasting 4 days (over 1 yr)	Yes	9.5 %	2	15.8 %	6	0.68
Gastrointestinal illness (over 1 yr)	None	47.6 %	10	47.4 %	18	0.14
	1-5 episodes	42.9 %	9	52.6 %	20	
	6 or more episodes	9.5 %	2	0.0 %	0	

Variations in answers over 5 questionnaires in a 13 month period (N=59)

Risk Factor	Percentage giving variable answers out of 5 questionnaires
Diarrhea in the last 2 months	35.6 %
Episodes of GI illness in past year	40.7 %
Used daycare for child in home	8.5 %
Handled child in diapers	20.3 %
Cared for someone with diarrhea	25.4 %
Visited someone in the hospital	57.6 %
Handled pets	15.3 %
Handled young pets	35.6 %
Handled livestock or wild animals	13.6 %
Drank untreated water	1.7 %
Swam or waded in lake or stream	18.6 %
Used pool, hot tub or water park	35.6 %
Plumbing work done in home	39.0 %
Traveled outside United States	37.2 %
Have pets in home	8.5 %
Diagnosed with Hepatitis A	3.4 %
Vaccinated for Hepatitis A	15.3 %
Eat fresh food or vegetables	8.5 %
Eat organic vegetables	54.2 %
Wash produce before eating	35.6 %
Eat fruit and vegetable peels	79.7 %
Eat outer leaves	57.6 %

Risk factor: answer is most often positive

Relationship between 27-kDa antibody level ≥ 75% of positive control and a positive water test for total coliforms

Variable	N	Adjusted odds ratio and 95% confidence interval	p-value
Positive total coliform test	**59**	**3.4 (1.1-10.8)**	**0.04**

Relationship between 27-kDa antibody level ≥ 75% of positive control and a positive water test for *E. coli* (risk factor: most often positive)

Variable	N	Adjusted odds ratio and 95% confidence interval	p-value
Positive *E. coli* test	**59**	**2.9 (.96-8.7)**	**0.06**

Risk factor: answer is ever positive

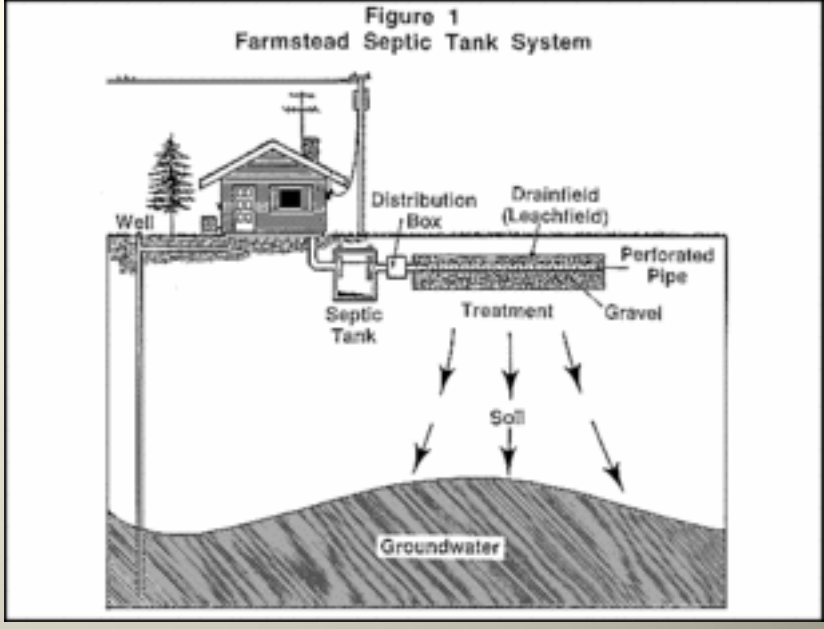
Relationship between 27-kDa antibody level ≥ 75% of positive control and a positive water test for total coliforms.

Variable	N	Adjusted odds ratio and 95% confidence interval	p-value
Positive total coliform test	**59**	**2.5 (0.7-8.5)**	**0.14**
Traveled outside the US	**59**	**.18 (0.0-0.8)**	**0.02**

Relationship between 27-kDa antibody level ≥ 75% of positive control and a positive water test for *E. coli.*

Variable	N	Adjusted odds ratio and 95% confidence interval	p-value
Positive *E. coli* test	**59**	**2.9 (.96-8.7)**	**0.06**

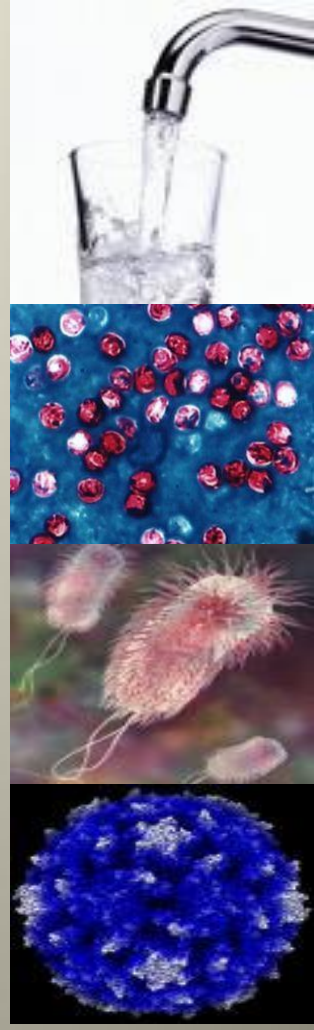
Implications



The results suggest an association between contaminated water and infection from *Cryptosporidium*.

- After controlling for other risk factors, the most likely source of exposure is an on-site underground wastewater system that exists in close proximity to the private wells.

Implications



- People with onsite wastewater systems and private wells are at risk for fecal contamination of their drinking water.
- In a 13 month cycle, 80% of the wells had fecal contamination at some point.
- It was common for a household to have more than one water test be positive in a sample, and for homes to test positive more than once.

Implications for Public Health Policy

- Despite the high number of contaminated samples, there were no associations between positive water tests and diarrhea or GI illness.

- Protective immunity may be occurring.

- Visitors may be susceptible to illness or deposit foreign bacteria, virus or parasite into the septic tank.

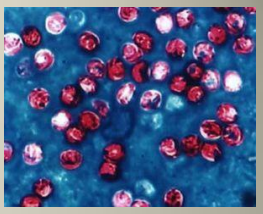
Implications for Public Health Policy

- People were not consistently reporting the same answers to risk factor exposures on the questionnaires.

- Cross-sectional study designs may be underestimating the prevalence of contamination and may also lead to risk factor misclassification.

- We rely on cross-sectional, point in time surveys for large national data sets.

Acknowledgements



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