Public Health Laboratory Surveillance of Tick-borne Diseases Causing Pathogens

Marieme Dembele

Masters in Health Science Candidate, JHSPH

PHASE Internship at the

Maryland Department of Health and Mental Hygiene

Laboratories Administration Division of Virology and Immunology

Preceptor: Division Chief Maria Paz Carlos, PhD, MBA

Lyme Disease

- *Borrelia burgdorferi*
- *Ixodes scapularis and Ixodes pacificus*
- *Erythema migrans*
- Late manifestations

http://www.ticktexas.org/ticks/afis_black_legged_tick.htm

http://borreliaburgdorferi.org/

Rocky Mountain Spotted Fever

- *Rickettsia rickettsii*
- *Dermacentor variabilis and D. andersoni*
- Rash
- Up to 80% fatality rate (untreated)

http://www.cdc.gov/tularemia/transmission/

http://www.cdc.gov/rmsf/symptoms/index.html#symptoms

Ehrlichiosis

- *Ehrlichia chaffensis* and *Anaplasma phagocytophilum* (HME and HGA)
- *Amblyomma americanum*
- *Ixodes scapularis*
- *Dermacentor variabilis*

http://www.cdc.gov/tularemia/transmission/

Babesiosis

- *Babesia microti*
- *Ixodes scapularis*
- Hemolytic anemia

Tularemia

- *Francisella tularensis*
- Deer tick and fly bite
- Aerosole transmission
- Handling of infected animals

Code of Maryland Regulations (COMAR)

http://www.dsd.state.md.us/comar/

COMAR

Problem Solver | Maryland.gov | Online Services | State Agencies | Phone Directory

Search

MARYLAND

OFFICE OF THE SECRETARY OF STATE

Email Friend

HOME | SOS | FAQ | DIRECTORY | FORMS | SITE MAP | CONTACT US

COMAR LINKS

- COMAR Order Form
- Cumulative Index
- Search tips

WHAT WE DO

- COMAR Online
- MD Register Online
- Subscriptions
- Useful Information
- Depository Libraries
- Cumulative Table
- Cumulative Index
- Regulation vs. Statute

John P. McDonough, Secretary of State
Brian Morris, Acting Administrator, Division of State Documents

Search Options for COMAR Online

Option 1. Search on a word or phrase, or enter the codification number
(search is word specific unless you add an asterisk *)

Option 2. Search a specific Title
(will search only that title for word or codification number)

Option 3. Access through Table of Contents Structure
(will display table of contents by Title, Subtitle & Chapter)

Important Information:

In August 2003, the **State Ethics Commission Advisory Opinions** were no longer printed in COMAR Title 19A, but are available **ONLY** as part of COMAR Online. They can be accessed or searched using all three search options.
Search Option 1: (ex. 79.01)
Search Option 2: select Advisory Opinions link under 19A (which limits the results returned).
Search Option 3: Advisory Opinion's listed by year. This option will return the opinions in that year.

Effective Dates:

- COMAR regulations are effective to date.
- COMAR is updated biweekly corresponding with the effective dates in the most current Maryland Register issue.

Order Forms:

- COMAR (by Title & Special Publications)
- Maryland Register in print
- Maryland Register E-Subscription

Please note:
- Regulations proposed but not yet adopted are published biweekly in the Maryland Register, available by print or email subscription from the Division of State Documents. Select the link above to go to the online version of the Maryland Register. Only the **8 most current** editions of the Maryland Register are available online for viewing.

Please note:
- Regulations appear individually and not as part of the larger chapter designation. You **MUST** open each regulation individually and hit the back button on your Browser to review the next regulation in that chapter. Excerpts of each regulation have been provided in the search results to better assist you.

Please note:
- Maryland State agency regulations are compiled in the Code of Maryland Regulations (COMAR). COMAR contains 35 Titles, with each Title usually corresponding to a department or agency. Each regulation is assigned a unique four-part codification

MARYLAND

OFFICE OF THE SECRETARY OF STATE

John P. McDonough, Secretary of State ~
Brian Morris, Acting Administrator, Division of State Documents

Search COMAR Online for: reportable diseases Search Reset

2 records match your search term.

File	Abstract
10.06.01.03.htm	10.06.01.03. 03 Reportable Diseases, Conditions, Outbreaks, and Unusual Manifestations; Submitting Clinical Materials.A. A person, as set forth in Regulation .04 of this chapter, shall report the diseases or conditions listed in §C of this regulation, or any other condition as requested by the Secretary.B. Within 1 working day of a positive laboratory finding for a disease or condition listed in §C of this regulation, or upon request of the Secretary, the director of a medical laboratory shall:
10.16.06.24.htm	10.16.06.24. 24 Health Log.. An operator shall ensure that:. A. A camp staff member records in the camp health log or a camper's personal health record, for all injuries, illnesses, and reportable diseases and conditions as delineated in COMAR 10.06.01, the:1) Date;. 2) Name of camper;. 3) Ailment;. 4) Treatment prescribed; and. 5) Name of person administering care;. B. The camp health log or camper's personal health record is:. 1) Written on lined paper;.

Enter the text or codification number you wish to locate in the box provided and click on the search button to locate all the occurrences of that text available in COMAR documents. For search tips and examples of other search techniques, click here.

Reminder, only put in the codification number. eg. 08.03.03*; or 08.03.03.02 ~ **DO NOT ADD THE SECTION** eg. 08.03.03.02(G) No results will be found if you add the section and subsections to the codification number.

Try Another Page | Return to Search Page

10.06.01.03

.03 Reportable Diseases, Conditions, Outbreaks, and Unusual Manifestations; Submitting Clinical Materials.

A. A person, as set forth in Regulation .04 of this chapter, shall report the diseases or conditions listed in §C of this regulation, or any other condition as requested by the Secretary.

B. Within 1 working day of a positive laboratory finding for a disease or condition listed in §C of this regulation, or upon request of the Secretary, the director of a medical laboratory shall:

(1) Submit clinical material to the Department's public health laboratory; and

(2) Include information about the clinical material on a form provided by the Secretary.

C. List of Reportable Diseases and Conditions.

HEALTH CARE PROVIDERS, INSTITUTIONS, AND OTHERS[1]
LABORATORIES
TIMEFRAME FOR REPORTING[2]

Diseases and Conditions	Laboratory Evidence of	Submit Clinical Materials to the Department[3]	Immediate	Within 1 Working Day
(1) An outbreak of a disease of known or unknown etiology that may be a danger to the public health[4]	Similar etiological agents from a grouping or clustering of patients		X	
(2) A single case of a disease or condition not otherwise included in this table of known or unknown etiology, that may be a danger to the public health	An etiologic agent suspected to cause that disease or condition			X
(3) An unusual manifestation of a communicable disease in an individual	An etiologic agent suspected to cause that disease			X
(4) Acquired immunodeficiency syndrome (AIDS)[5]	Refer to COMAR 10.18		Refer to COMAR 10.18	
(5) Amebiasis	Entamoeba histolytica			X
(6) Anaplasmosis	Anaplasma phagocytophilum			X
(7) Animal bites	Not Applicable		X	
(8) Anthrax	Bacillus anthracis	X	X	
(9) Arboviral infections including, but not limited to: (a) Dengue fever; (b) Eastern equine encephalitis; (c) LaCrosse virus infection; (d) St. Louis encephalitis; (e) Western equine encephalitis; (f) West Nile virus infection;	Any associated arbovirus including, but not limited to: (a) Dengue virus; (b) Eastern equine encephalitis virus; (c) LaCrosse virus; (d) St. Louis encephalitis virus; (e) Western equine encephalitis virus; (f) West Nile virus;	X	X	
(10) Babesiosis	Babesia species			X

10.06.01.03

www.dsd.state.md.us/comar/getfile.aspx?file=10.06.01.03.htm

(22) Ehrlichiosis	Ehrlichia species			X
(23) Encephalitis, infectious	Isolation from or demonstration in brain tissue, central nervous system tissue, or cerebrospinal fluid, of any pathogenic organism	X (Infectious agents as indicated elsewhere in §C of this regulation and viral agents except for HSV)		X
(24) Epsilon toxin of Clostridium perfringens	Clostridium perfringens, epsilon toxin		X	
(25) Escherichia coli O157:H7 infection	Escherichia coli O157:H7	X	X	
(26) Giardiasis	Giardia species			X
(27) Glanders	Burkholderia mallei	X	X	
(28) Gonococcal infection	Neisseria gonorrhoeae			X
(29) Haemophilus influenzae invasive disease	Haemophilus influenzae, isolated from a normally sterile site	X	X	
(30) Hantavirus infection	Hantavirus	X	X	
(31) Harmful algal bloom related illness	Not Applicable			X
(32) Hemolytic uremic syndrome, post-diarrheal	Not Applicable			X
(33) Hepatitis A acute infection	Hepatitis A virus IgM		X	
(34) Hepatitis, viral (B, C, D, E, G, all other types, and undetermined)	Hepatitis B, C, D, E, and G virus, other types			X
(35) Human immunodeficiency virus (HIV)[5]	Refer to COMAR 10.18		Refer to COMAR 10.18	
(36) Influenza- associated pediatric mortality	Influenza virus-associated pediatric mortality in persons younger than 18 years old (if known)			X
(37) Influenza: novel influenza A virus infection	Isolation of influenza virus from humans of a novel or pandemic strain	X	X	
(38) Isosporiasis	Cystoisospora belli (synonym Isospora belli)			X
(39) Kawasaki syndrome	Not Applicable			X
(40) Legionellosis	Legionella species	X (if isolate from human)	X	
(41) Leprosy	Mycobacterium leprae	X		X
(42) Leptospirosis	Leptospira interrogans	X		X
(43) Listeriosis	Listeria monocytogenes	X		X
(44) Lyme disease	Borrelia burgdorferi			X
(45) Malaria	Plasmodium species	X		X

www.dsd.state.md.us/comar/getfile.aspx?file=10.06.01.03.htm

(63) Rocky Mountain spotted fever	Rickettsia rickettsii			X
(64) Rubella (German measles) and congenital rubella syndrome	Rubella virus		X	
(65) Salmonellosis (nontyphoidal)	Salmonella species, including serogroup, if known	X		X
(66) Severe acute respiratory syndrome (SARS)	SARS-associated coronavirus (SARS-CoV)	X	X	
(67) Shiga-like toxin producing enteric bacterial infections	Shiga toxin, shiga-like toxin, or the toxin-producing bacterium	X	X	
(68) Shigellosis	Shigella species, including species or serogroup, if known	X		X
(69) Smallpox and other orthopoxvirus infections	Variola virus, vaccinia virus, and other orthopox viruses	X	X	
(70) Staphylococcal enterotoxin B poisoning	Staphylococcus enterotoxin B		X	
(71) Streptococcal invasive disease, Group A	Streptococcus pyogenes, Group A, isolated from a normally sterile site	X		X
(72) Streptococcal invasive disease, Group B	Streptococcus agalactiae, Group B, isolated from a normally sterile site	X		X
(73) Streptococcus pneumoniae invasive disease	Streptococcus pneumoniae, isolated from a normally sterile site	X		X
(74) Syphilis	Treponema pallidum			X
(75) Tetanus	Clostridium tetani			X
(76) Trichinosis	Trichinella spiralis			X
(77) Tuberculosis and suspected tuberculosis[6]	Mycobacterium tuberculosis complex	X	X	
(78) Tularemia	Francisella tularensis	X	X	
(79) Typhoid fever (case, carrier, or both, of	[illegible]	[illegible]	[illegible]	

AIM

To assess the importance of continued public health laboratory surveillance of tick-borne diseases in the State of Maryland.

Laboratory Surveillance of Tick-borne Disease Causing Agents Tested from 2008 to 2011 at the State of Maryland
DHMH Laboratories Administration Division of Virology and Immunology

OBJECTIVE

To analyze the immunological test results for Lyme disease (LD), Rocky Mountain Spotted Fever (RMSF), Ehrlichiosis (HGA and HME), Babesiosis and Tularemia.

METHODS

Lyme Disease

2 steps method

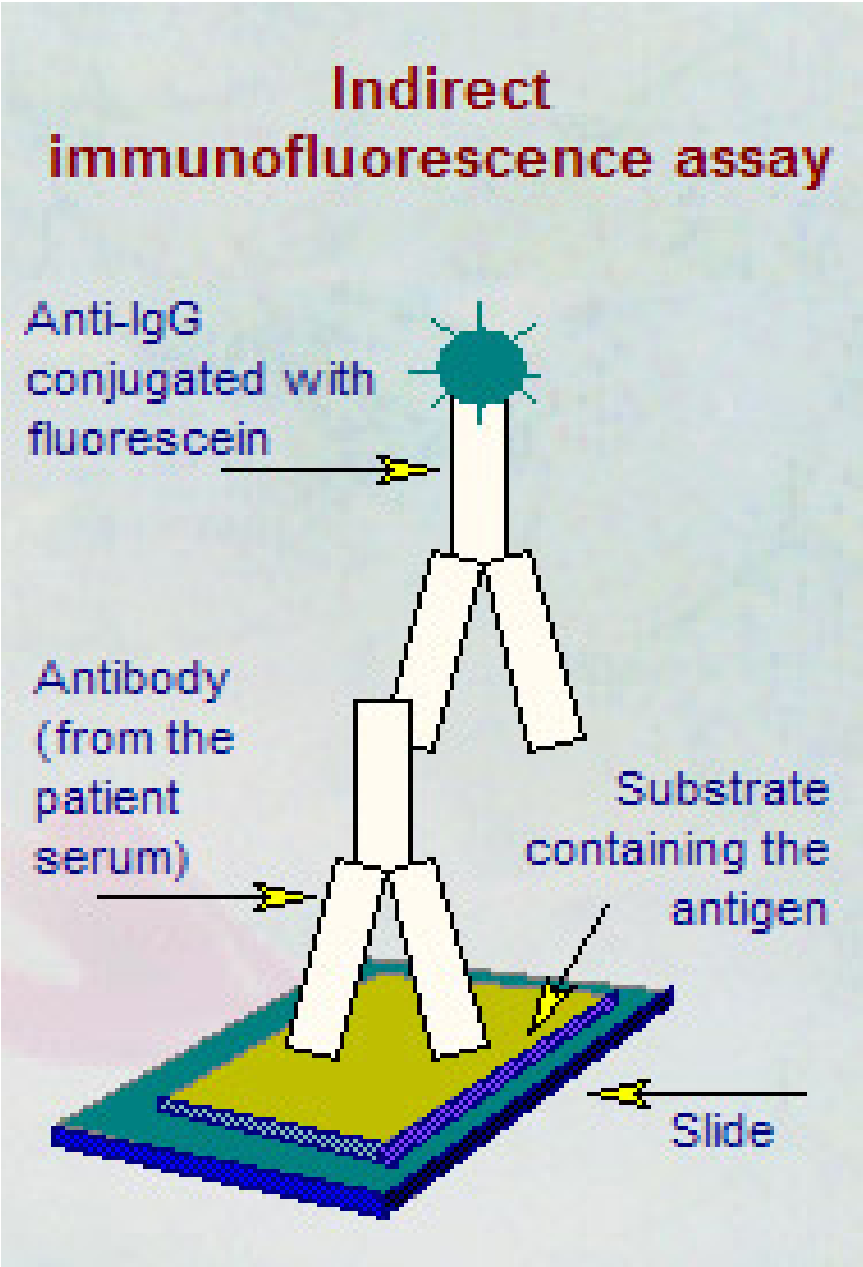
1st Step - Enzyme linked Immunoassay (ELFA) – VIDAS

2nd Step - Western Blot

RMSF and Ehrlichiosis (HME and HGA)

Titers = or >1:64 probable positive cases

Further testing is needed in order to obtain a definite diagnosis.



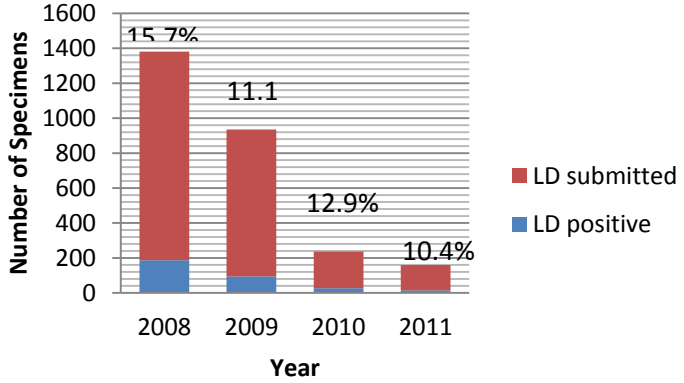
http://lymediseaseguide.org/test-accuracy-ifa

Tularemia and Babesia

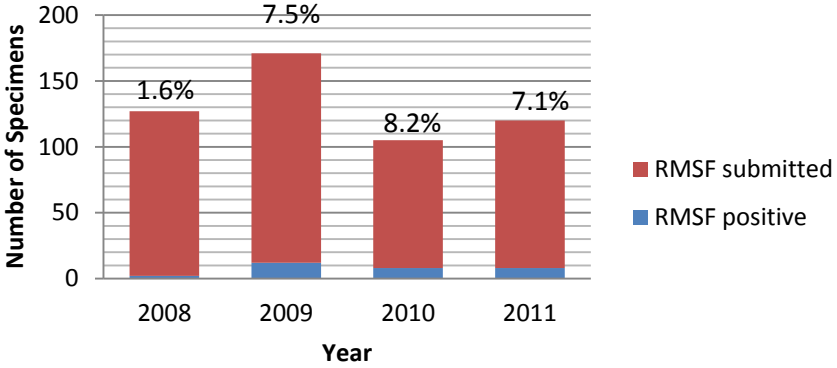
Submitted to Centers for Disease Control and Prevention (CDC)

Total No. of Specimens Tested at the Laboratories Administrations for Lyme Disease, Ehrlichiosis, Rocky Mountain Spotted Fever and Babesiosis from 2008 to 2011

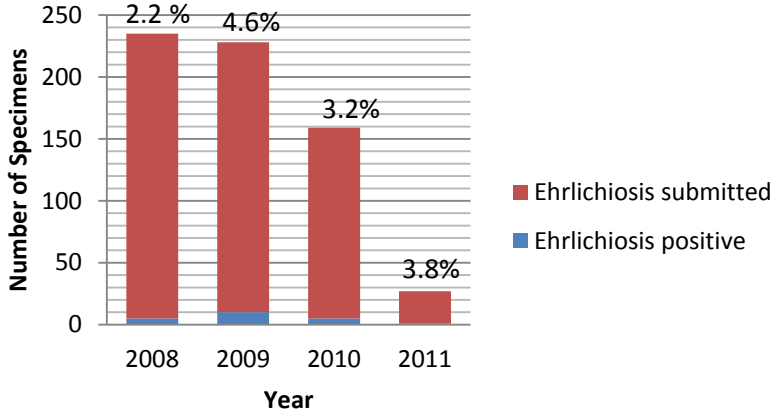
Lyme Disease



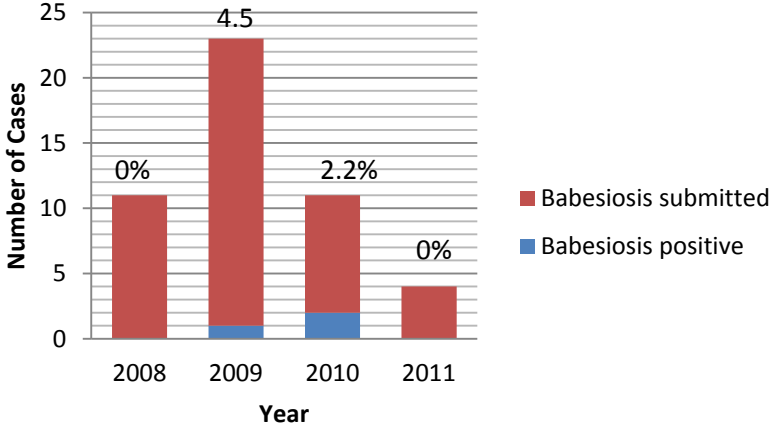
Rocky Mountain Spotted Fever



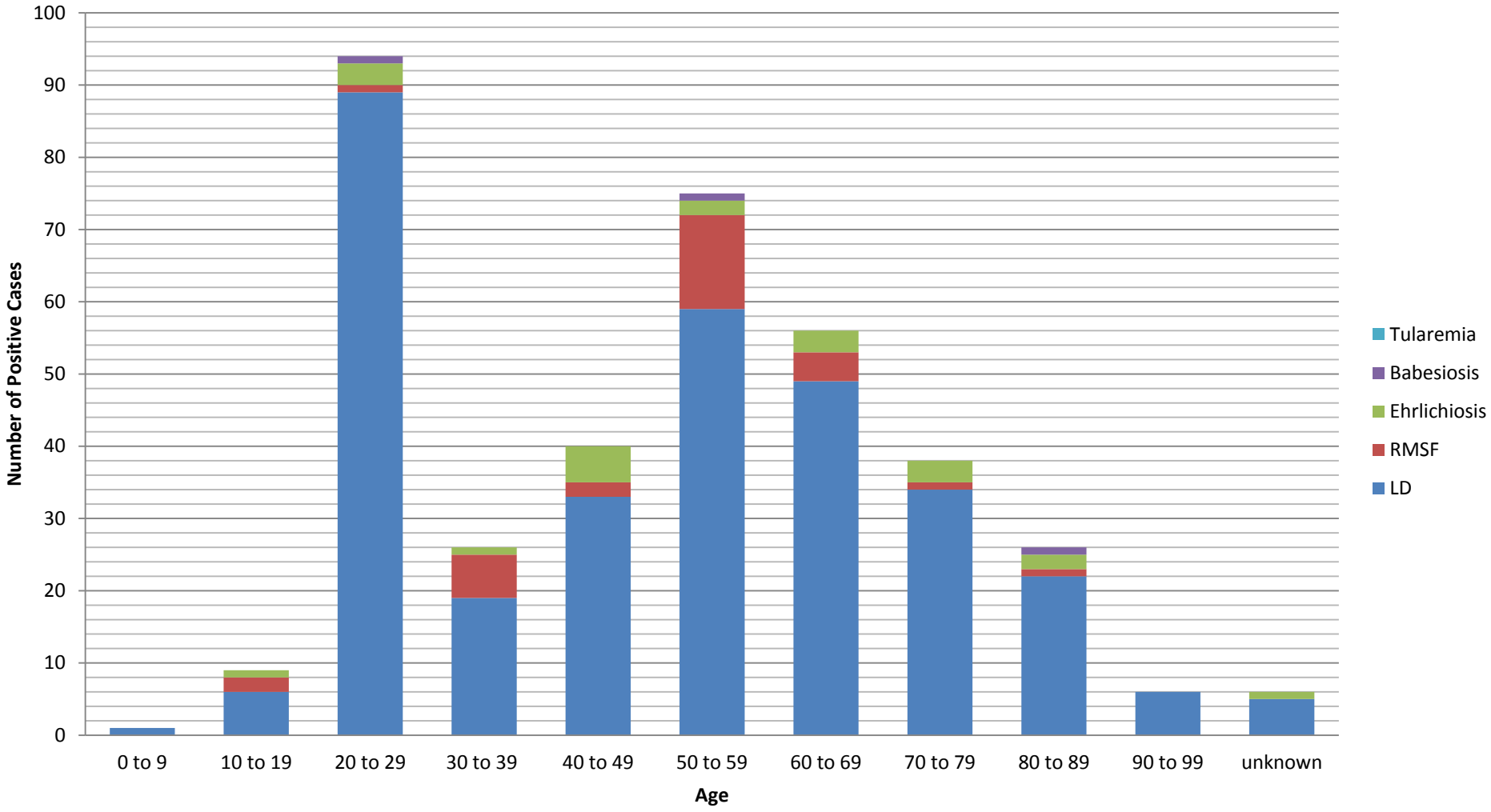
Ehrlichiosis



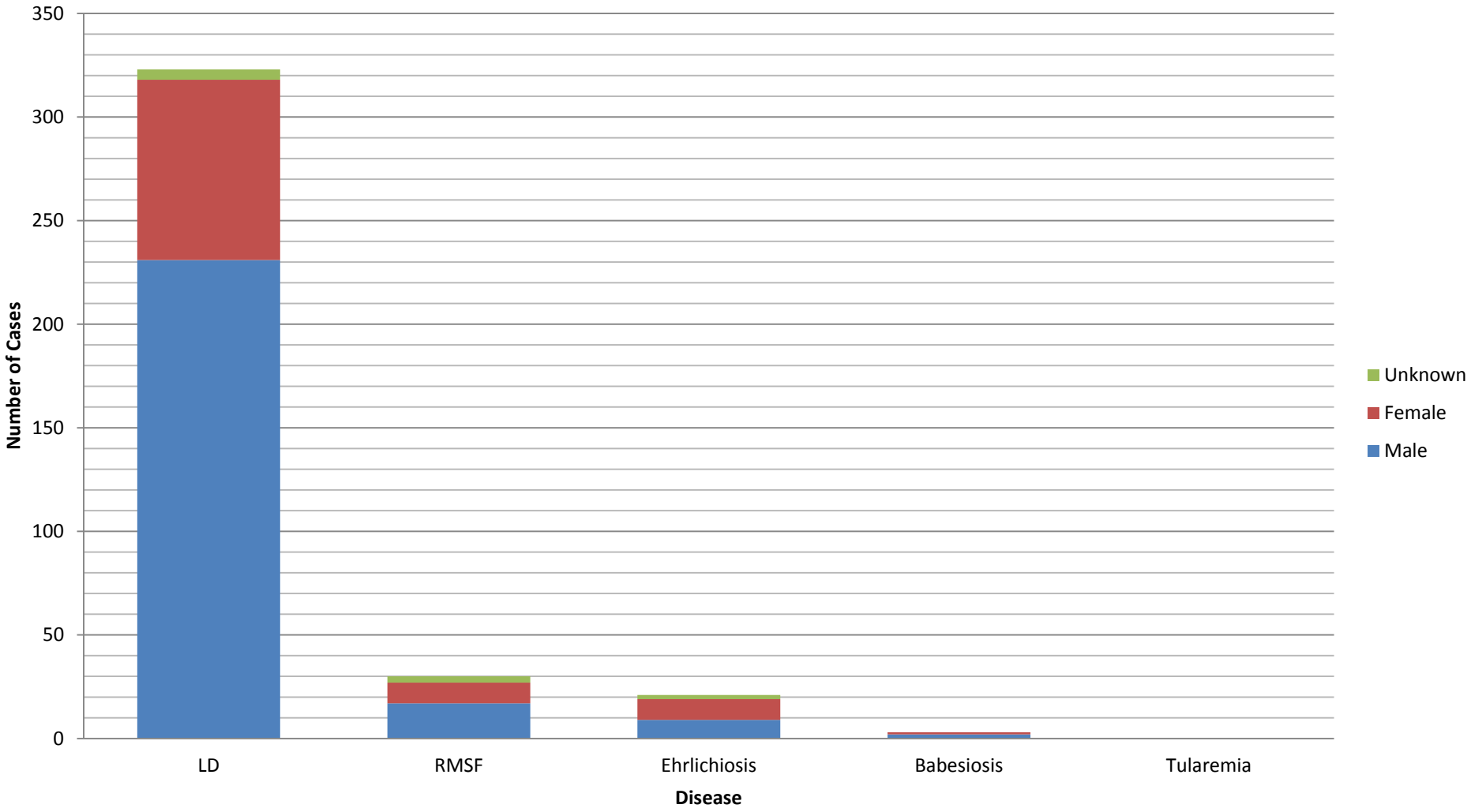
Babesiosis



Number of Positive Specimens Stratified by Age Tested at the Laboratories Administrations for Lyme Disease, Ehrlichiosis, Rocky Mountain Spotted Fever and Babesiosis from 2008 to 2011



Number of Positive Specimens Stratified by Sex Tested at the Laboratories Administrations for Lyme Disease, Ehrlichiosis, Rocky Mountain Spotted Fever and Babesiosis from 2008 to 2011



CONCLUSIONS

- Lyme Disease is the most (n=323) prevalent.
    - RMSF (n= 30) Ehrlichiosis (n=21)
- Most of the cases were found in males except for Ehrlichiosis
- Most LD cases were found in the 20 to 29 years old group
- Most RMSF cases were found in the 50 to 59 years old group
- Most Ehrlichiosis cases were found in the 40 to 49 years old group

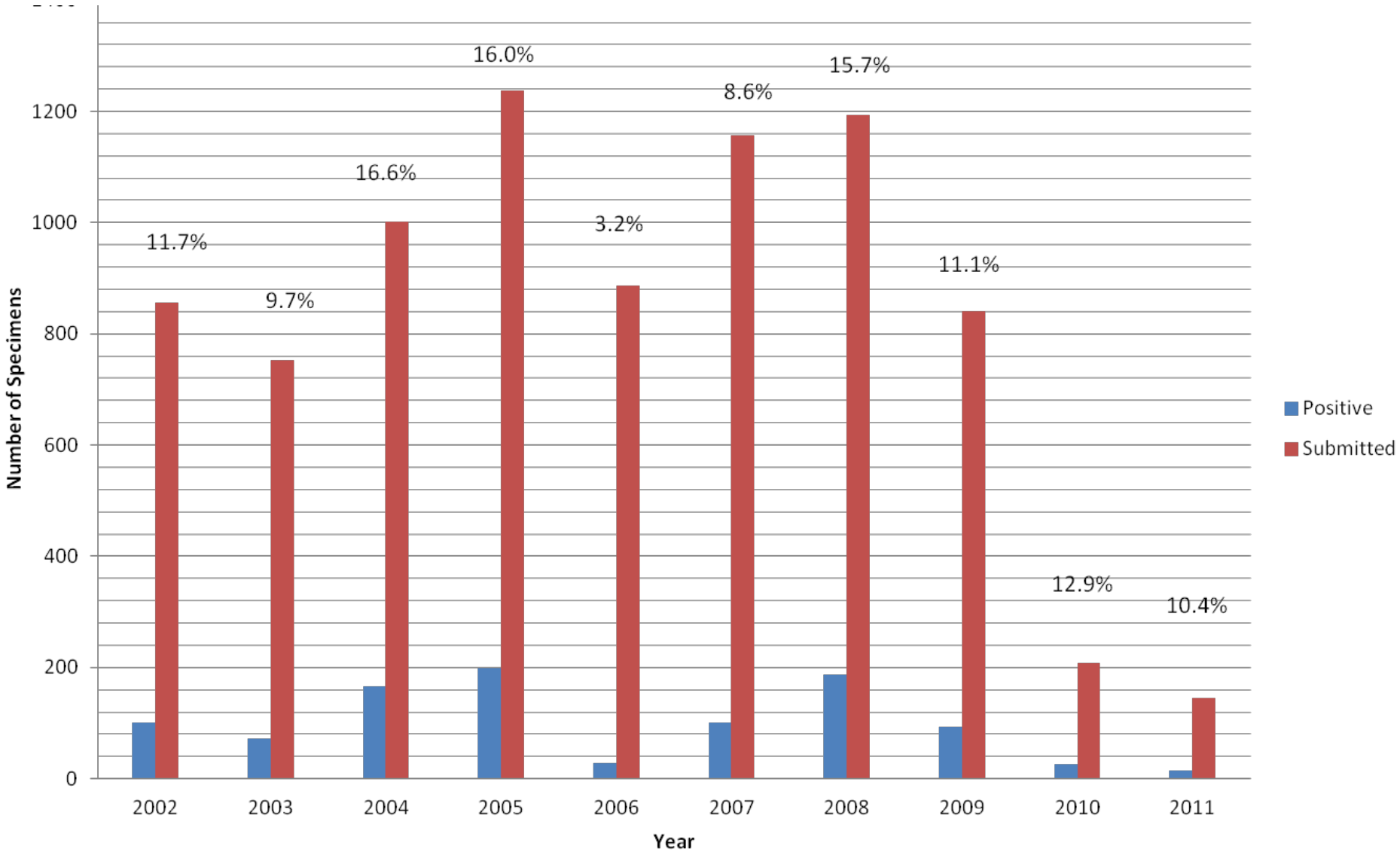
Public Health Laboratory Surveillance of Lyme Disease in the State of Maryland: A Ten Year Trend Analysis

OBJECTIVES

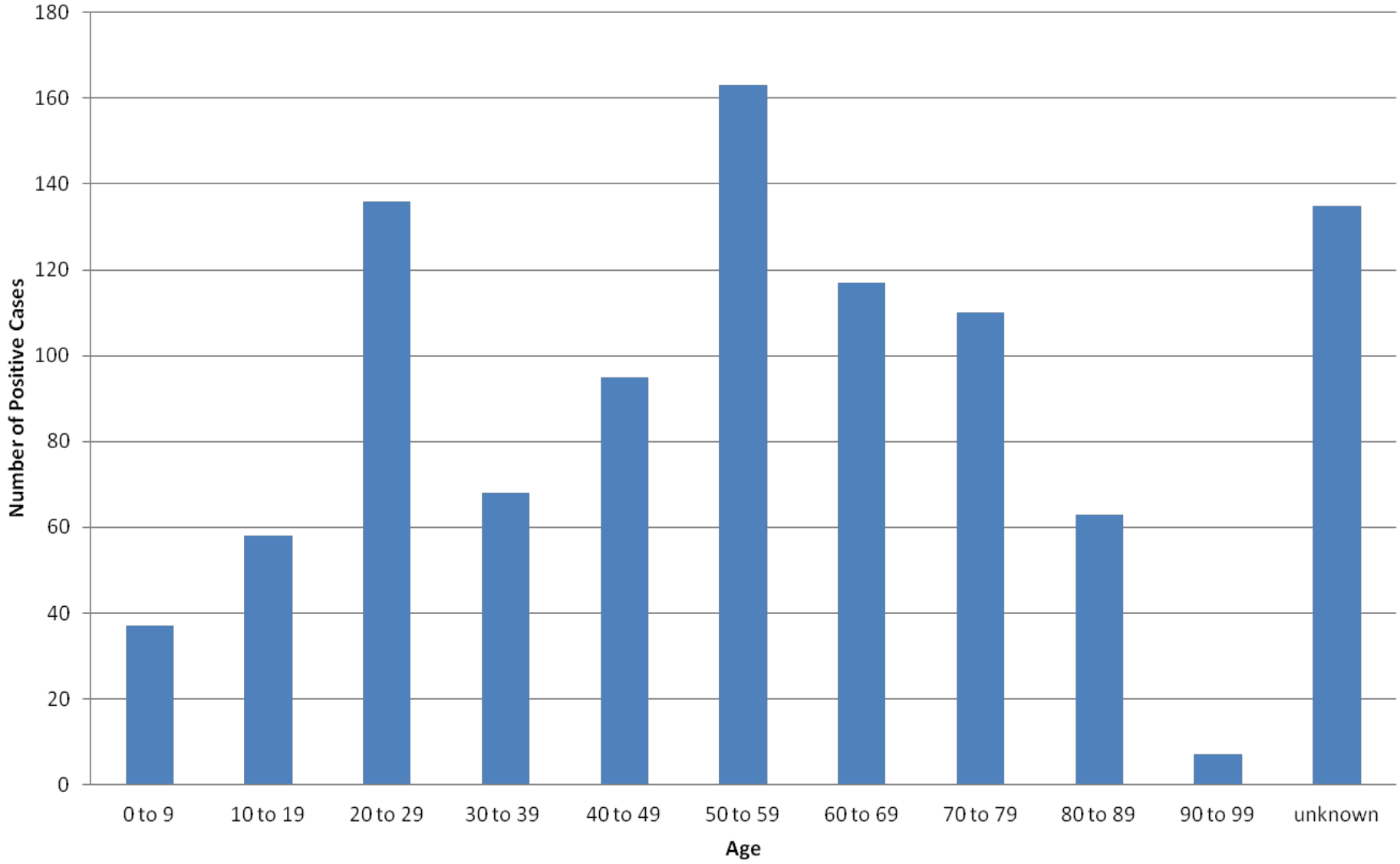
To analyze a decade (2002 to 2011) of Lyme Disease immunological test results.

To assess the importance of continuous Lyme disease surveillance at MD DHMH Laboratories Administration Division of Virology and Immunology.

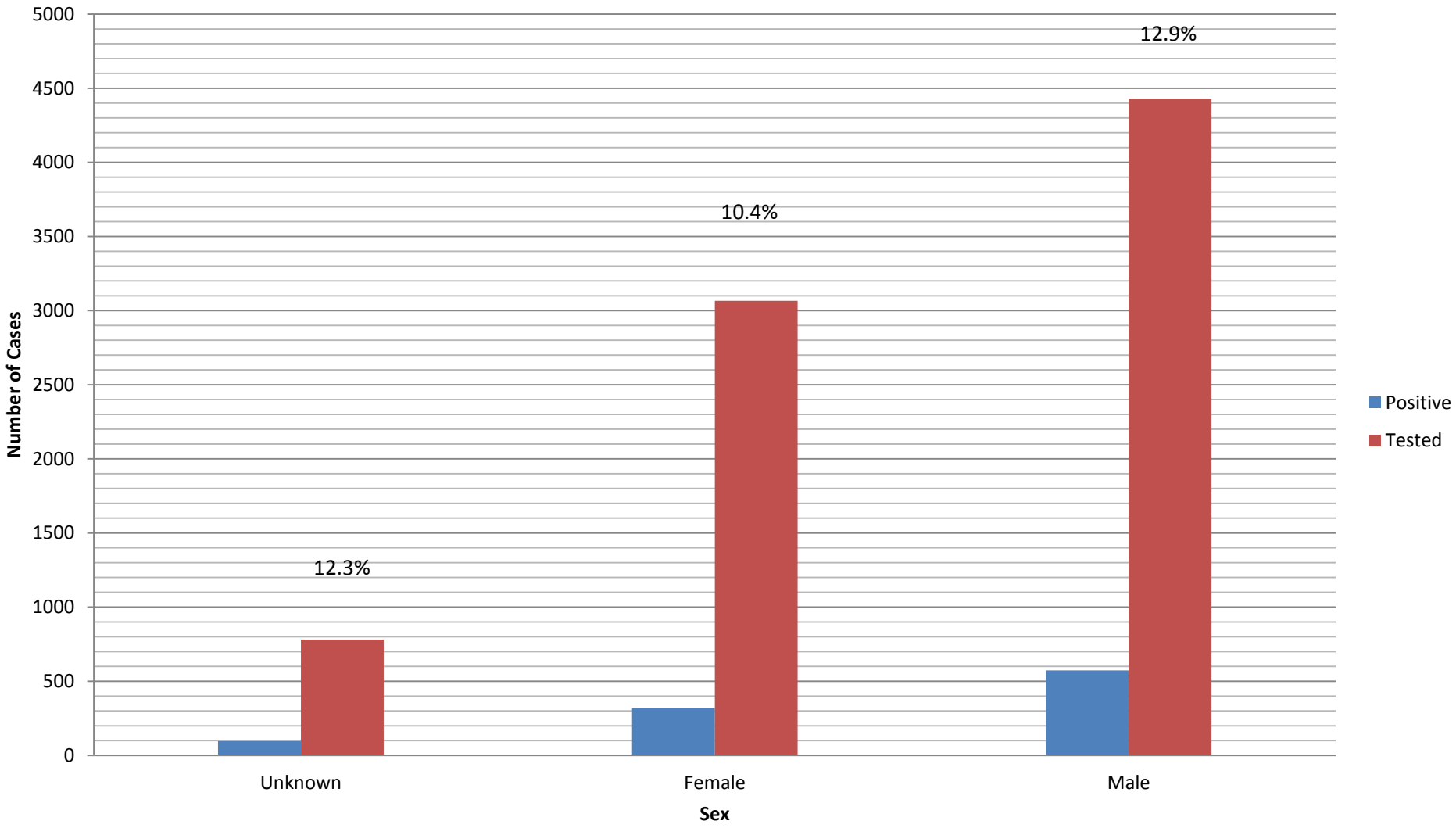
Total No. of Specimens Tested at the Laboratories Administrations for Lyme Disease from 2002 to 2012



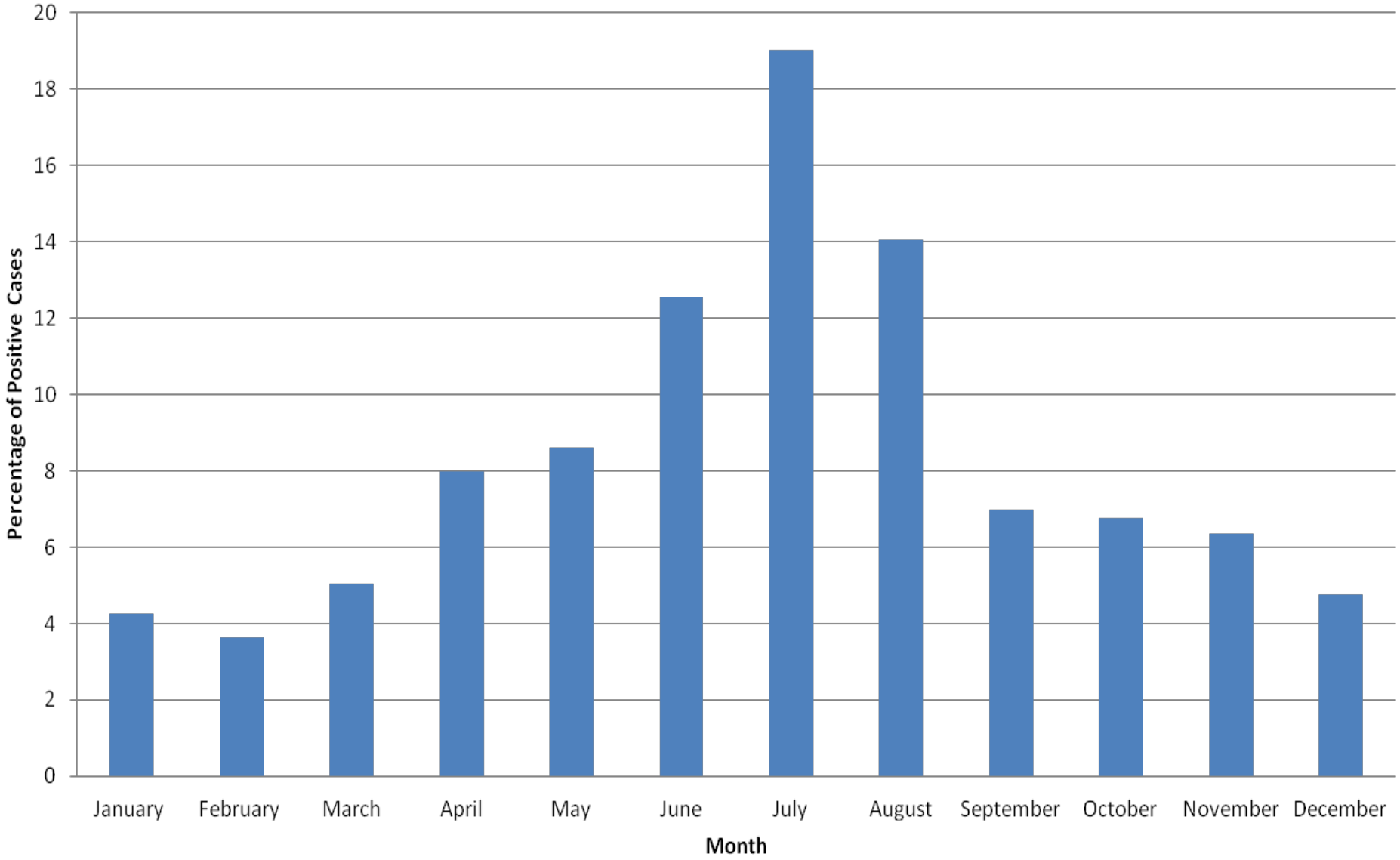
Number of Positive Specimens Stratified by Age Tested at the Laboratories Administrations for Lyme Disease, 2002 - 2012



Number of Positive Specimens Stratified by Sex Tested at the Laboratories Administrations for Lyme Disease, 2002 - 2012



Distribution of Lyme Disease Positive Cases by Month from 2002 to 2011 Tested at the Laboratories Administrations



CONCLUSIONS

- Number of tested specimens drastically decreased after 2009
- Most positive cases were found in:
  - 20 to 29 years
  - 50 to 59 years
  - unknown
- Most cases were found in Male
- Prevalence in June, July and August

LIMITATIONS AND CHALLENGES

- Surveillance
- Clinical diagnosis
- Testing
- Data interpretation
- Dynamics in pathogens
- Advances in technology

LESSONS LEARNED

- Reporting
- Importance of tick-borne diseases
- Collaboration between physicians and laboratories
- Collaboration between laboratories
- Innovations are crucial
- Education and awareness

POLICY AND PRACTICE IMPLICATIONS

- COMAR
- Case definition
- Continued support for laboratory surveillance
- Collaborations between multiple agencies
- Relationship between Departments of Health and Academia
- Susceptible Populations
- Biowarfare

REFERENCES

1) Andy, G., & Erika, R. (2001). Tick-borne Diseases. *American Family Physician* , 461-467.
2) Schlossberg, D. (2008). *Clinical Infectious Diseases.* New York: Cambridge University Press.
3) Filipe, D.-T. (2007). Rocky Mountain spotted fever. *Lancet Infectious Diseases*, 724-732.
4) Tamrakar, S. B., & Haas, C. N. (2011). Dose-Response Model of Rocky Mountain Spotted Fever (RMSF) for Human. *Risk Analysis*, 1620-1621
5) Nahed, I., Karen, C. B., & Jere, W. M. (2010). Human Ehrlichiosis and Anaplasmosis. *Clinical Laboratory Medicine*, 262-291.
6) Mayne, P. J. (2011). Emerging incidence of Lyme borreliosis, babesiosis, bartonellosis, and granulocytic ehrlichiosis in Australia. *International Journal of General Medecine*, 845-852.
7) Johnson, R. C., Schmid, G. P., Hyde, F. W., Steigerwalt, A., & Brenner, D. J. (1984). Borrelia burgdorferi sp. nov.: Etiologic Agent of Lyme Disease. *International Journal of Systematic Bacteriology*, 496-497.
8) Alfred, S. E., & Philip, S. B. (1998). *Bacterial Infections of Humans: Epidemiology and Control.*New York: Kluwer Academic/Plenum Publishers.
9) Gerald, L. M., John, E. B., & Raphael, D. (2000). *Mandell, Douglas, and Bennett's Principles & Practice of Infectious Diseases (2 Vol. Set).* Churchill Livingstone.
10) Ryan, K. J., Ray, C. G., & Sherris, J. C. (2003). *An Introduction to Infectious Diseases.* McGraw-Hill Prof Med/Tech.
11) Stanek, G., Wormser, G. P., & Strle, F. (2012). Lyme Disease Borreliosis. *Lancet*, 461-473.
12) Centers for Disease Control and Prevention. (15, November 2011). Retrieved April 2012, from Centers for Disease Control and Prevention: http://www.cdc.gov/.

ACKNOWLEDGEMENTS

I would like to thank Ms. Beth Resnick, Director of the Public Health Practice and Training Program at the Johns Hopkins University Bloomberg School of Public Health, as well as Ms. Dipti Shah and Ms. Patti Truant for supporting my professional training opportunities.

A special thank you to:
Dr. Leena Trivedi
Thomas Lawson
William Murtaugh

I am sincerely appreciative of Dr. Maria Paz Carlos, the Chief of the Division of Virology and Immunology at the State of Maryland Department of Health and Mental Hygiene Laboratories Administration and for her patience, understanding, and unending support of my personal and professional development.

ACTIVITIES (October 2011-June 2012)

Masters Thesis in partial requirement for the Masters of Health Sciences in Molecular Microbiology and Immunology, Johns Hopkins School of Public Health

Significance of Tick-borne Pathogens and Laboratory Surveillance

Manuscript Submitted

Public Health Laboratory Surveillance of Lyme Disease in the State of Maryland: A Ten Year Trend Analysis. M. Dembele, [1] L. Trivedi, [2*] T. Lawson, [2*] and M.P. Carlos [2, 3]

Manuscripts In-Preparation

Laboratory Surveillance of Tick-borne Diseases Causing Agents in the State of Maryland Public Health Laboratory (2008 to 2011). M. Dembele, [1] L. Trivedi, [2*] T. Lawson, [2*] and M.P. Carlos [2, 3]

Review of tick-borne Diseases Causing Pathogens

Poster Presentations

Laboratory Surveillance of Tick-borne Diseases Agents and other Relevant Pathogens in the State of Maryland, M. Dembele; L. Trivedi; T. Lawson; S. Montgomery, M. P. Carlos. ASM Biodefense and Emerging Infectious Diseases Research Meeting, Washington, 2012

Importance of Lyme Disease Laboratory Testing Surveillance in the State of Maryland Public Health Laboratory, M. Dembele; L. Trivedi; T. Lawson; S. Montgomery, M. P. Carlos. APHL annual meeting, Seattle, 2012 (Accepted)

Public Health Laboratory Surveillance of Lyme Disease, Ehrlichiosis and Rocky Mountain Spotted Fever in the State of Maryland from 2000 to 2011, M. Dembele; L. Trivedi; T. Lawson; S. Montgomery, M. P. Carlos. ASM Annual Meeting, San Francisco, 2012 (Accepted)

Laboratory Surveillance of Tick-borne Causing Agents and Other Relevant Pathogens in the State of Maryland

M. Dembele, L. Trivedi, T. Lawson, S. Montgomery and M. Carlos PhD, MBA.

Maryland Department of Health and Mental Hygiene, Laboratories Administration, Division of Virology and Immunology

*Corresponding Author: mdembele@jhsph.edu

BACKGROUND

The purpose of study is to analyze the immunological test results from suspected Lyme disease (LD), Ehrlichiosis (HME and HGE), Tularemia, Rocky Mountain Spotted Fever (RMSF), Babesiosis, Q fever, and plague specimens submitted to the Maryland Department of Health and Mental Hygiene (DHMH) Laboratories Administration Division of Virology and Immunology. The respective causative agents for the five tick borne disease are *Borrelia Burgdorferi*, *Ehrlichia chaffeensis* (HME), *Anaplasma phagocytophilum* (HGA), *Francisella tularensis*, *Rickettsia Rickettsii*, *Babesia genus Coxiella burnetii* and *Yersinia pestis*. This analysis will provide a better understanding of the occurrence of emerging and re-emerging tick and rodent born diseases in Maryland.

METHODS

From January 2008 to November 2011, de-identified data (N=3556) were obtained from DHMH Laboratories Administration State of Maryland Laboratories Information Management System. Indirect Immunofluoresence Assay (IFA) method was used for Ehrlichiosis and RMSF. Agglutination test was used for Tularemia serodiagnosis. A two step method consisting of an Enzyme Immunoassay (EIA) and Western Blot (WB) was used for LD. Babesiosis, *Coxiella Burnetii* and *Yersinia Pestis* specimens were forwarded to CDC for testing.

RESULTS

- Most cases of LD, RMSF and Babesia were detected in the 25- 49 years old age group. There were 146,19 and 2 positive cases respectively. In the instance of Ehrlichia, there were 8 positive cases in both the 25-45 and ≥60 years old age groups. The majority of *Coxiella* cases were of unknown age.
- Most cases of LD, RMSF and Babesia were detected in Males. They amounted to 230, 17 and 9 positive cases respectively. The majority of *Coxiella* cases were of unknown sex.
- The volume of positive LD cases decreased over time while Ehrlichia and RMSF experienced a peak in 2009 followed by a continuous reduction in number of positive cases. The occurrence of *Coxiella* cases decreased with 3 cases in 2008, 3 in 2009, none in 2010 and 1 in 2011.
- From 2008 to 2011, the positivity rate for LD was reduced by more than 50%. Ehrlichia's positivity rate was constant throughout the years, while RMSF experienced its lowest positivity rate in 2008 (1.6%) and its highest in 2010 (8.6%).
- There were 3 cases of Babesia and no case of Yersinia or Tularemia. All positive specimens except for LD represent probable cases. There were no submitted specimens for yersinia.

Table 1. Annual Positivity Rates for Each Pathogen

Year	Positivity Rate of Pathogens in %						
	Lyme	Babesia	Ehrlichia	RMSF	Tularemia	Coxiella	Yersinia
2008	15.6 % (187/1196)	0% (0/11)	2.2% (5/230)	1.6% (2/126)	0% (0/1)	33.3% (1/3)	0 % (0/0)
2009	11.1% (94/847)	4.3% (1/23)	4.6% (10/218)	7.5% (12/159)	0% (0/8)	33.3% (1/3)	0 % (0/0)
2010	13.7% (29/211)	22.2% (2/9)	3.2% (5/156)	8.1% (8/99)	0% (0/3)	0 (0/0)	0 % (0/0)
2011	7.2 % (10/138)	0% (0/4)	3.6% (1/28)	7.0% (7/100)	0% (0/0)	100% (1/1)	0 % (0/0)

Figure 1. Annual Distribution of the Total Number of Positive Cases for Each Pathogen

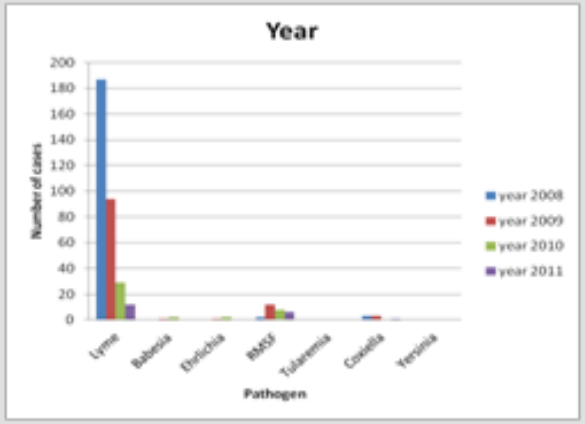


Figure 2. Total Number of Positive Cases per Pathogen Classified by Age Category

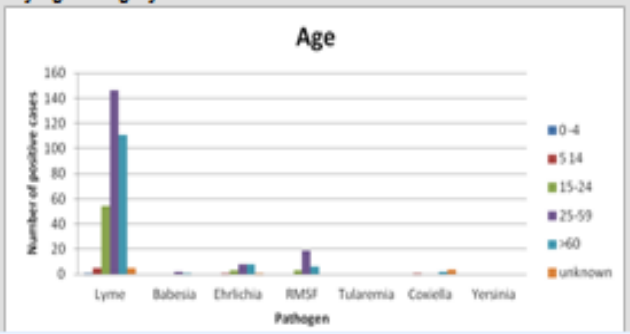
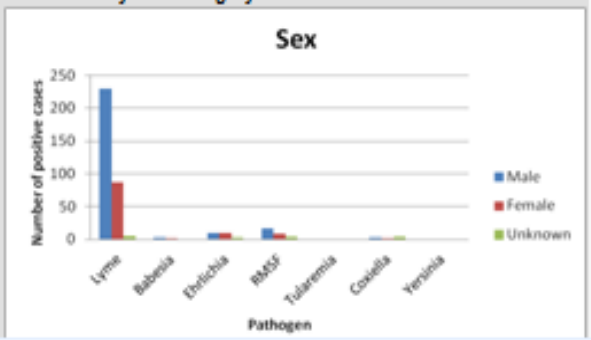


Figure 3. Total number of Positive Cases per Pathogen Classified by Sex Category



DISCUSSION

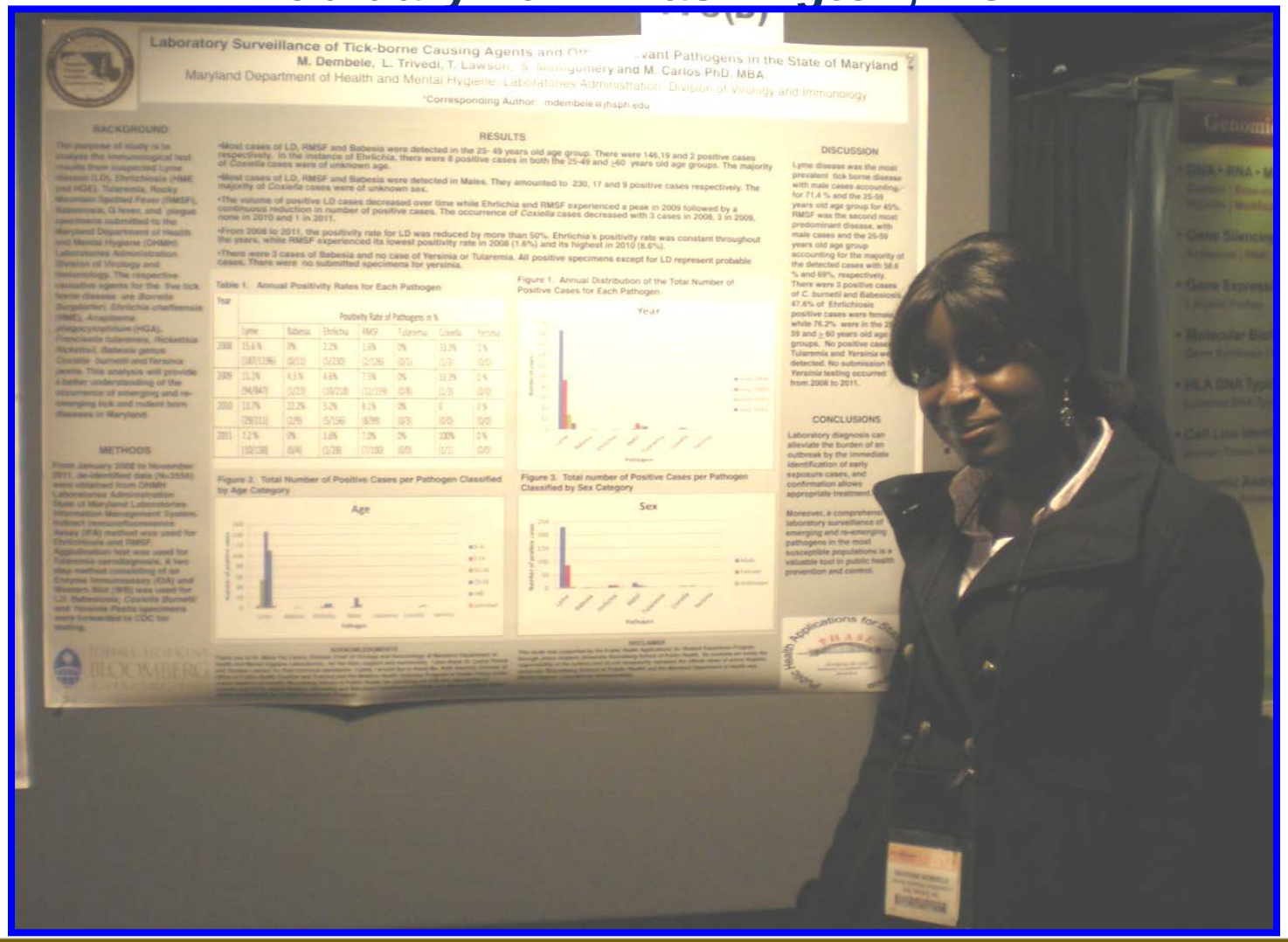
Lyme disease was the most prevalent tick borne disease with male cases accounting for 71.4 % and the 25-59 years old age group for 45%. RMSF was the second most predominant disease, with male cases and the 25-59 years old age group accounting for the majority of the detected cases with 58.6 % and 63%, respectively. There were 3 positive cases of *C. burnetii* and Babesiosis. 47.6% of Ehrlichiosis positive cases were female while 76.2% were in the 25 to 59 and ≥ 60 years old age groups. No positive cases of Tularemia and *Yersinia* were detected. No submission for *Yersinia* testing occurred from 2008 to 2011.

CONCLUSIONS

Laboratory diagnosis can alleviate the burden of an outbreak by the immediate identification of early exposure cases, and confirmation allows appropriate treatment.

Moreover, a comprehensive laboratory surveillance of emerging and re-emerging pathogens in the most susceptible populations is a valuable tool in public health prevention and control.

10th Annual American Society of Microbiology Biodefense and Emerging Infectious Diseases Meeting February 2012 Washington, DC



DISCLAIMER

This study was supported by the Public Health Applications for Student Experience Program through Johns Hopkins University Bloomberg School of Public Health. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of Johns Hopkins University Bloomberg School of Public Health and the Maryland Department of Health and Mental Hygiene Laboratories Administration.

QUESTIONS?