# Nebraska Public Health Laboratory Newsletter

A publication of the Nebraska Public Health Laboratory (NPHL) at the University of Nebraska Medical Center.

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## NPHL Updates

*By Steven Hinrichs, M.D., Director, NPHL*

This issue of the NPHL newsletter contains articles on topics that are common to public health as well as issues new to the laboratory community. Since laboratorians have been familiar with the importance of *Staphylococcus* for many years, the recent attention focused on methicillin resistant *S. aureus* (MRSA) was long overdue. The revelation that disease from *Staphylococcus* infections caused more deaths than AIDS in 2005 put the significance of this problem into terms that are understandable by all Americans. It's important that laboratory scientists keep up to date on new developments associated with MRSA. Nebraska is fortunate to have the expertise of nationally recognized researchers at both Creighton and UNMC to provide us with their insights. Dr. Paul Fey has investigated the molecular basis for antibiotic resistance for the type of *Staphylococcus* originally called community acquired MRSA and his article describes important changes to our understanding of this disease.

Although culturing and identification of *Salmonella* has been a long-standing topic, the development of new patterns of antimicrobial resistance in *Salmonella* species represents a continually changing challenge. Peter Iwen, PhD. contributes his special expertise with an update of current trends and approaches for antimicrobial susceptibility testing of *Salmonella*.

We also continue the discussion of laboratory preparedness with a story focused on the National Incident Management System or NIMS. NIMS training is recommend for a number of reasons best summarized by the Admiral in charge of the medical response to the tsunami that struck the Philippines. His team practiced addressing what they expected to encounter during the entire boat trip from the west coast but when they arrived nothing happened according to plan. The Admiral said that without their NIMS training they would have been totally ineffective. In other words, although you can never correctly anticipate all the challenges of a crisis, you can prepare yourself to address an ever changing environment.

The article on laboratory informatics expands on an earlier introduction to this topic, one that will continue to develop as the capability of laboratory and hospital information systems expands. There are many factors contributing to the emphasis on electronic data exchange and the opportunities for improving laboratory efficiency and accuracy are only beginning. While most laboratory scientists did not grow up with this technology, it is essential that we learn to adapt and use it to our advantage, just as we do to prepare ourselves for emergencies of all types.

We also want to call your attention to an article on the risk of laboratory acquired infections, the summary by Beth Schweitzer reminds us to pay attention to the details.

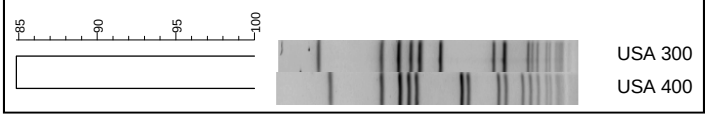
All the staff at the NPHL wish you all a happy and safe holiday season.

## Community-Acquired MRSA (CA-MRSA)

*By Paul Fey, PhD, Associate Director, NPHL*

Since we last discussed this topic in the NPHL newsletter (Spring of 2002), there have been many significant developments in the epidemiology, genetic background, and prevalence of CA-MRSA. At that time, CA-MRSA was mainly detected in select populations in the United States and was generally susceptible to non-b-lactam antibiotics. In addition, the main CA-MRSA genetic background or "strain" in 2002 was called USA400. However, since that time, many changes have occurred. First, the prevalence of USA400 has decreased significantly and a new CA-MRSA clone has emerged, which is called USA300. The USA300 and USA400 clones are named according to their pulsed-field gel electrophoresis pattern (**Figure 1**). The

**Figure 1.**




genome of USA300 has been recently sequenced and it was found to be highly related to some common laboratory strains (e.g. COL -one of the first MRSA isolated in 1961 in London). However, USA300 also carries a gene that codes for Panton-Valentine Leukocidin (PVL; encoded by a bacteriophage) and a pathogenicity island (called the ACME island) that encodes several unique genes. It is currently unclear what role some of these proteins may have in virulence of CA-MRSA, however, PVL has recently been postulated to have a significant role in necrotizing pneumonia caused by USA300. In addition, USA300 is not only detected in the community but also is commonly isolated in hospital environments and is no longer universally susceptible to erythromycin and the fluoroquinolones.

Secondly, the prevalence of USA300 and CA-MRSA has increased significantly over the last few years. In a recent study from the New England Journal of Medicine (NEJM, 2006, 355:666-674. G. J. Moran et al.), 57% of all skin and soft tissue infections presenting to 11 university-affiliated emergency departments were CA-MRSA USA300. These data suggest that Emergency Room physicians should treat empirically for CA-MRSA with all skin and soft tissue infections. Concerns have been raised that this recent "emergence" of USA300 is an epidemic.

Lastly, based on the data reflecting the increased prevalence of USA300 and other MRSA, many hospitals are screening all new patients for colonization with MRSA. This decision directly impacts the clinical microbiology laboratories as new methodologies (DNA based) may need to be implemented to process the number of specimens that are received. In addition to the

*(CA-MRSA continued on page 3)*

## Meet the Laboratorian – Gregory Post, Ph.D.

*Compiled by Josh Rowland, State Training Coordinator, NPHL*

**What got you interested in pursuing a career in clinical laboratory medicine?**

My interests have always revolved around science and I gravitated towards biochemistry. In my second year of graduate school, a visiting clinical chemist gave a lecture on pheochromocytoma, which is an adenoma of the adrenal gland that causes hypertension. I knew from that moment that Clinical Chemistry was where my career path was going to follow. Clinical Chemistry applied everything I found to be of interest with the application toward living systems.

**Where did you receive your formal training?**

I received a BA in chemistry/biology from Jamestown College (Jamestown, ND) and Ph.D. from North Dakota State University located in Fargo ND. I was fortunate to be selected for the post-doctoral program in Clinical Chemistry at the Mayo Graduate School of Medicine in Rochester, MN where I spent two years of training. The first year was primarily classroom and hands on experience in each area of laboratory medicine, while the second year was research in a particular area. My research project was in the area of therapeutic drug monitoring/toxicology where I developed assays for immunosuppressant drugs and pesticides/ insecticides.

**How long have you worked in the clinical laboratory field?**

In 1986, my first job was in Lincoln, NE and have worked here ever since. My initial plans were to stay a few years and get some experience, however, something about Nebraska gets into your system which makes it hard to leave.

**Are there specific areas of clinical laboratory medicine in which you have special interest or expertise**?

I am Board Certified in both Clinical Chemistry and Toxicology. Since there are limited numbers of clinical chemists in these areas, I had to develop a general knowledge in most every area. My interests have varied over time with requirements of the job, but forensic toxicology currently has a strong interest for me. I also enjoy research and development in the areas of nutritional assessment and newborn screening. My latest venture is in the area of molecular diagnostics, which has endless possibilities in applications to laboratory medicine.

**What do you see as the greatest future challenges for clinical laboratories?**

The workforce in the laboratory is aging and not enough young people choose clinical laboratory science as a career path. Thus, attracting and retaining qualified individuals is one of the bigger challenges for the laboratory today. Another area where challenges exist is in the delivery of results. Electronic medical records are the way of the future and laboratories must position themselves to have the tools and the right people in place to accomplish these tasks necessary in today's environment.

**What is the greatest challenge you face in your job today?**

Trying to keep up with the incredible amount of new information. The development of new technology and tests is accelerating which allows many tests traditionally considered reference tests to be brought in-house.

**What advice would you give to a first year medical technologist?**

Find an area of interest and develop your knowledge base in the area. Do not be afraid to ask questions and never think your education is complete. Embrace change because that is the nature of the job market today.

**What do you think is the single biggest change in the laboratory since you started?**

Automation in the laboratory and the positive and negative impact this change has had on personnel.

**What do you think will be the biggest change in the laboratory over the next ten years?**

Embracing new technologies and developing new skill sets in order to provide testing deemed critical in the medical decision process. Since tests performed by the clinical laboratory in the past are now done in physicians' offices, laboratorians must adapt and provide services that are perceived as beneficial to our clientele.

**What do you like most about your job?**

What I like most about my job is the people I work with and the fact that every day brings on a new challenge.

## New Strategies for Achieving Uniformity for Test Orders and Results

*By Curt Safranek, IT Specialist, and Steven Hinrichs, M.D., Director*

Secretary of Health and Human Services, Michael Leavitt has made health informatics one of the most important agenda items for his administration. That emphasis is being seen in many ways including the creation of a national organization focused on creating electronic medical health records called the American Health Informatics Community. Many people have criticized the United States health care system for not taking advantage of the technology available today. While most people carry credit cards that can be used around the world, our medical records are largely kept on inaccessible paper forms in many different offices. While some people argue this is necessary for security reasons the most relevant comparison is in the banking industry, where high value transactions are taking place every second, every day throughout the country. The new concept is that if a laboratory test result is not available to the physician or medical provider in a timely fashion, and if that data cannot be appropriately shared with those authorized people who make decisions about health care, it should not have been performed in the first place.

The epidemiology section of the Nebraska Department of Health and Human Services under the Direction of Dr. Tom Safranek has led the country in many respects with its early participation in the National Electronic Disease Surveillance System or NEDSS. The Nebraska Public Health Laboratory has been a partner in that effort with the creation of electronic systems for moving data into a secure data mart that allows authorized individuals to receive reports electronically. The impact of this system has been significant as regional public health officials in the state are now able to see the information the same

*(New Strategies, continued on page 3)*

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day it is generated rather than when the mail or fax system delivers the result.

As a result of these successes, the NPHL was invited to join a national effort to accelerate the use of electronic data exchange. The effort is called the Public Health Interoperability Project (PHLIP) and is a joint partnership between the Association of Public Health laboratories (APHL) and the Centers for Disease Control and Prevention (CDC). The goal of the project is to address a very significant problem in the laboratory system and medical informatics in that different terms or vocabulary are being used for the same concept or test type. While coding systems have been created to address this problem, the coding system itself has is complex so that differences arise even when the same test is being coded. The problem is obvious to most laboratorians who have grown accustomed to using either EIA or ELISA for a microtitre based test for antibodies or antigens depending on the situation. In addition we know that some people call the confirmatory test for antibodies to HIV the Western blot test and another group calls it the Immunoblot confirmatory test. Terminology varies widely even in public health, where a recent survey showed that 10 of 12 public health laboratories used different words or codes for the same test type. The issue is less obvious but even more complex for the new molecular tests such as PCR or rapid antibody detection tests using lateral transfer or antibody concentration methodologies. One group has advocated for a negative HIV quantitative RNA assay to be reported as "less than 50 copies detected" (the level of detection for the assay), while others recommend reporting as "negative" or "no RNA detected".

To address this problem, the PHLIP effort brought representatives from six state public health laboratories and the CDC together to reach consensus on the most important tests being performed. At one level, the project is an experiment because the traditional way to address these types of problems has been either to generate high level rulings from one over arching administrative entity or create a drawn out process where participants discuss the various alternatives without a defined endpoint. It was generally accepted that if these alternative approaches were effective for this type of task, the problem would have been addressed many years ago after it first became apparent. It was recognized that the effort must remained focused and not attempt to extend to case reporting or epidemiology investigations.

A sense of urgency was added to the activity based on the need to close the gaps in capability for mounting an effective response to a possible influenza outbreak. At the same time the team began working on harmonizing elements critical for electronic exchange of laboratory data including message structure and process.

The validity of the strategy has been realized through the achievement of the first set of goals for the project, that being the creation of a common set of vocabulary for achieving test ordering and reporting for all of the different tests that are used for influenza detection. The data package is undergoing peer review by external experts in preparation of posting the recommended terms for laboratory tests and results for public comment.
There are several benefits that this project will bring to Nebraska. Most importantly, as more laboratory information systems become capable of transferring data electronically, there will be an increasing demand for uniformity in data elements. When a laboratory information specialist establishes the code and process for entering test orders and results into their system, they will be able to go to the look up tables provided by the CDC and APHL and select the recommended codes and vocabulary for each test type. This will not only result in considerable time savings on the part of the laboratory but will also facilitate the reporting into local and state programs. It is expected that achieving uniformity in laboratory data standards will eventually allow the patient greater access to their own health information.

## Recent Article on Laboratory Acquired Infections

*By Beth Schweitzer, MS, MT(ASCP)SM,*
*Assistant Bioterrorism Coordinator, NPHL*

The incidence of laboratory-acquired infections (LAI) is not known because no federal guidelines exist for reporting. Baron and Miller attempted to shed some light on this subject in a recently published article in *Diagnostic Microbiology and Infectious Diseases* [1]. This article highlights many areas that are important for the clinical laboratorian to consider as a means to protect against LAI. These include safety practices, the proper use of biosafety cabinets, review of the latest edition of the *Biosafety in Microbiological and Biomedical Laboratories* Manual [2], and understanding the capabilities and limitations of automated identification instrumentation.

Additionally, the article outlined other important recommendations that benefit microbiology laboratories. These recommendations included:

- Adequate job specific training
- The ability to recognize growth characteristics of special pathogens
- Proper immunization of laboratory employees
- Facility design and work flow that limits possible exposure
- Proper use of personal protective equipment
- Limitations/cautions of using automated instrumentation for special pathogen identification

We will continue to emphasize these during various training events throughout the state including our special pathogens wet workshops. Further questions concerning the work place and safety practices and/or for a copy of the Baron and Miller article, contact Josh Rowland at jrowland@unmc.edu.

**References**

1. Baron, E. J., & Miller, J. M. 2007. Bacterial and fungal infections among diagnostic laboratory workers: evaluating the risks. *Diagnostic Microbiology and Infectious Diseases*. epub.
2. The 5th Edition of the BMBL can be accessed via the NPHL website at www.nphl.org/news.html#BMBL.

*(Continued from page 1, CA-MRSA)*
increased workload, some hospitals may ask their laboratories to decrease the turn around time on MRSA detection to less than a day (which rules out culture methodologies). Next year (summer of 2008), educational programs by the NPHL and the Nebraska Department of Health and Human Services will focus on issues surrounding MRSA; including those issues involving the clinical microbiology laboratory and infection control. For more information about CA-MRSA, please contact Dr. Fey at 402-559-2122 or pfey@unmc.edu.

## Antimicrobial Susceptibility Testing of *Salmonella* Isolates from Nebraska, 2006

*By Peter C. Iwen, PhD, Associate Director, NPHL*

The Spring 2007 newsletter gave an overview of the *Salmonella* serotypes identified in Nebraska during 2006. The top 5 serotypes detected in Nebraska during this time were serotype Typhimurium (Group B, 15.5%), Enteritidis (Group D, 13.2%), Typhimurium 5 null (Group B, 12.3%), Newport (Group C2, 7.3%), and Heidelberg (Group B, 4.6%). All *Salmonella* submitted to the NPHL also underwent antimicrobial susceptibility testing (AST) for the 12 antimicrobial agents listed in **Table 1**. This article compares AST results from Nebraska isolates with the CDC national testing program[1].

A comparison of the percentage and number of non-Typhi *Salmonella* isolates resistant to antimicrobial agents between Nebraska and historical data from the CDC is shown in **Table 1**. A consistent yearly percentage increase in resistance for the Nebraska

**Table 1.** Comparison of the percentage and number of non-Typhi *Salmonella* isolates resistant to antimicrobial agents between Nebraska and historical data from the CDC.[a]

| Antimicrobial Agent | % of isolates resistant (Number of isolates tested) | | | | |
|---|---|---|---|---|---|
| | Nebraska[b] | | | NARMS[c] | |
| | 2004 (120) | 2005 (221) | 2006 (219) | 2003 (1864) | 2004[d] (1793) |
| Ampicillin | 6.7 | 14.7 | 15.1 | 13.7 | 12.4 |
| Cefoxitin | 2.5 | 5.9 | 4.1 | 4.3 | 3.5 |
| Chloramphenicol | 7.5 | 12.7 | 11.9 | 10.0 | 7.6 |
| Ciprofloxacin | 0.0 | 0.5 | 0.0 | 0.2 | 0.2 |
| Ceftriaxone[e] | 1.7 | 1.8 | 3.2 | 0.4 | 0.6 |
| Gentamicin | 0.0 | 3.6 | 2.7 | 1.4 | 1.3 |
| Kanamycin | 1.7 | 5.0 | 3.7 | 3.4 | 2.8 |
| Naladixic acid | 1.7 | 1.8 | 4.1 | 2.3 | 2.6 |
| Sulfamethoxazole | 12.5 | 18.1 | 15.5 | 15.1 | 13.2 |
| Streptomycin | 19.2 | 24.4 | 21.9 | 15.0 | 11.8 |
| Trimethoprim/Sulfa | 1.7 | 2.3 | 0.5 | 1.9 | 1.8 |
| Tetracycline | 15.0 | 21.3 | 17.8 | 16.3 | 13.5 |

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]The Kirby Bauer disk diffusion method, set up and interpreted using the CLSI recommendations, was used for antimicrobial susceptibility testing. Reduced susceptibility results (intermediate) were categorized as "sensitive".
[c]The Sensititre TREK Diagnostic System was used for antimicrobial susceptibility testing. MIC results were reported as sensitive or resistant and isolates with reduced susceptibility (intermediate) were categorized as "sensitive".
[d]Data for 2005-06 not available (11/07).
[e]Resistant ceftriaxone results by Sensititre and disk diffusion methods were confirmed using the MIC method (CDC) or E-test method (NPHL), respectively.

strains from 2004, 2005, and 2006 was noted for ampicillin (6.7 to 14.7 to 15.1), ceftriaxone (1.7 to 1.8 to 3.2), and naladixic acid (1.7 to 1.8 to 4.1). The percentage of the 2006 isolates resistant in Nebraska were higher for all the antimicrobials tested when compared with the 2004 CDC National Antimicrobial Resistance Monitoring System (NARMS) data, with the exception of ciprofloxacin (Nebraska 0% to NARMS 0.2%). Ciprofloxacin had the lowest percent resistance in both the local and national data while streptomycin had the highest resistance in Nebraska (21.9% compared with NARMS for 2004 at 11.8%) and tetracycline had the highest resistance in the NARMS data (13.5%).

Among the 219 non-Typhi *Salmonella* serotypes isolated in Nebraska in 2006, 72.6% had no detectable resistance to all agents tested (**Table 2**). This increase in sensitivity (68.3% and 72.6% showed no resistance in 2005 and 2006, respectively) has also been seen

**Table 2.** Resistance patterns of non-Typhi *Salmonella* isolated from humans in Nebraska compared with historical data from the CDC.[a]

| Pattern | % of isolates per time period (Number tested) | | | | |
|---|---|---|---|---|---|
| | Nebraska | | | NARMS | |
| | 2004 (120) | 2005 (221) | 2006 (219) | 2003 (1864) | 2004[b] (1793) |
| No resistance | 74.1 | 68.3 | 72.6 | 77.7 | 79.6 |
| Resistance to ≥ 1 agent | 25.9 | 31.7 | 27.4 | 22.3 | 20.4 |
| Resistance to ≥ 2 agents | 15.0 | 22.6 | 20.1 | 17.7 | 15.0 |
| Resistance to ≥3 agents | 12.5 | 19.0 | 17.8 | 14.3 | 11.7 |
| Resistance to ≥4 agents | 12.5 | 15.8 | 15.5 | 11.6 | 9.4 |
| Resistance to ≥5 agents | 6.7 | 13.6 | 12.3 | 9.9 | 8.1 |
| At least ACSSuT resistant[c] | 5.8 | 10.4 | 11.4 | 9.3 | 7.1 |
| At least ACSuTm resistant[d] | 0.8 | 0.9 | 0.5 | 1.2 | 0.6 |

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]Data for 2005-06 not available. (11/07)
[c]ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline
[d]ACSuTm: ampicillin, chloramphenicol, sulfamethoxazole, and trimethoprim-sulfa

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in the national data (77.7% in 2003 to 79.6% in 2004). The resistance to multiple agents was similar among 2004, 2005 and 2006 in both groups; however, the number of isolates with resistance to ≥ 5 agents continued to be higher in Nebraska (12.3%) than in the NARMS data (8.1%).

In 2006, serotypes Typhimurium and Typhimurium 5 null accounted for 34 and 27, respectively of the isolates submitted for susceptibility testing. The percentage of these serotypes showing no detectable resistance decreased from 64.8% sensitive in 2005 to 54% sensitive in 2006 while nationally, there was an increase in sensitivity from 55.3% in 2003 to 60.7% in 2004 (**Table 3**). The resistance to multiple agents showed a general increase with the most notable increase observed with 34.4% of the isolates showing resistance to ≥ 5 agents tested, a substantial increase from 2004 (18.1%) and 2005 (22.0%). Overall, the pattern of resistance was higher in Nebraska isolates than that observed with the NARMS data.

The most common multiple resistance pattern for 2006 Nebraska isolates of *Salmonella* serotype Typhimurium and Typhimurium 5 null was resistant to ACSSuT with 32.3% of the isolates showing at least this pattern (an increase from both 2004 and 2005) (**Table 3)**. This pattern is commonly associated with the Definitive Phage Type 104 (DT104) strain, that historically has been circulating in Nebraska [2]. Fifteen of the 27 serotype Typhimurium 5 null isolates from Nebraska showed this resistance pattern. Resistance to trimethoprim-sulfamethoxazole has only been seen in one Nebraska isolate, thus the pattern of resistance to at least ACSuTm, has been rarely observed. The isolate associated with this pattern showed resistance to 8 of the 9 antimicrobial subclasses tested. This isolate, which was determined by the CDC to be a "rough" isolate and thus the O antigen could not be determined, was identified as a unnamed subspecies I with the antigenic formula of "I Rough:-:1,5".

**Table 3.** Resistance patterns of *Salmonella* serotype Typhimurium and Typhimurium 5 null isolated from humans in Nebraska compared with historical data from the CDC.[a,b]

| Pattern | % of isolates per time period (Number tested) | | | | |
|---|---|---|---|---|---|
| | Nebraska | | | NARMS | |
| | 2004 (55) | 2005 (90) | 2006 (61) | 2003 (403) | 2004[c] (382) |
| No resistance | 58.2 | 64.8 | 54.0 | 55.3 | 60.7 |
| Resistance to ≥ 1 agent | 41.8 | 35.2 | 46.0 | 44.7 | 39.3 |
| Resistance to ≥ 2 agents | 23.6 | 29.7 | 37.7 | 40.9 | 37.2 |
| Resistance to ≥3 agents | 20.0 | 26.4 | 34.4 | 36.5 | 31.4 |
| Resistance to ≥4 agents | 20.0 | 25.3 | 34.4 | 31.8 | 28.0 |
| Resistance to ≥5 agents | 18.1 | 22.0 | 34.4 | 27.5 | 24.3 |
| At least ACSSuT resistant[d] | 12.7 | 19.8 | 32.3 | 25.8 | 23.3 |
| At least ACSuTm resistant[e] | 1.8 | 3.3 | 1.6 | 3.2 | 1.6 |

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]Includes both serotype Typhimurium and serotype Typhimurium 5 null formerly called var Copenhagen.
[c]Data for 2005-06 not available. (11/07)
[d]ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline
[e]ACSuTm: ampicillin, chloramphenicol, sulfamethoxazole, and trimethoprim-sulfa

*Salmonella* serotype Enteritidis, which was the 2nd most common serotype detected in Nebraska in 2006 (29 isolates), only had 5 isolates resistant each to one agent (data not shown). All 5 of these isolates showed resistance to naladixic acid. Nationally, resistance to naladixic acid has been on the increase (2). This resistance is troublesome since naladixic acid is related to the fluoroquinolones and may indicate resistance problems for this class of agents in the future.

For additional information concerning the *Salmonella* Serotyping/Susceptibility Testing Programs at NPHL, contact Beth Schweitzer at 402-559-6098 or Dr. Iwen at 402-559-7774.

**References**

1. CDC. *Salmonella* Surveillance Annual Summary, 2004. Atlanta, Georgia; U.S. Department of Health and Human Services, CDC, 2005.
2. CDC. Multidrug-resistant *Salmonella* serotype Typhimurium, United States, 1996. MMWR, Morbidity and Mortality Weekly Report. 1997, 46: 308-10.

## Dr. Iwen Earns Important National Certification

Peter Iwen, PhD, MS, D(ABMM), Associate Director, NPHL, has recently been certified as a Diplomate of the American Board of Medical Microbiology (ABMM). Dr. Iwen is also an Associate Professor in Pathology/Microbiology at the University of Nebraska Medical Center (UNMC) and only the second person in Nebraska after Dr. Steve Cavalieri, Director of Microbiology, at Creighton University Medical Center to obtain this certification. Certification indicates acceptance of a code of professional ethics, as well as a sense of responsibility toward maintaining the high standards of the profession and practice of clinical microbiology. ABMM certification is recognized by federal and state governmental agencies as a significant component toward meeting licensure requirements to direct laboratories engaged in the microbiological diagnosis of human disease. *Taken from UNMC Today, 8-7-07*

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