

CAREER OPPORTUNITIES FOR PHD TRAINEES IN LABORATORY MEDICINE *Christopher McCudden, PhD*

This presentation was given by Chris McCudden. I'm a clinical chemist and assistant professor at the University of North Carolina at Chapel Hill.

This presentation will briefly describe the many opportunities there are for Ph.D. graduates in laboratory medicine. It is supported by the American Association for Clinical Chemistry and the Society for Young Clinical Laboratorians.

The goals of this presentation are to define laboratory medicine and clinical chemistry, describe the job of a clinical chemist, and provide an overview of the training opportunities and requirements to become a professional clinical chemist.

Laboratory medicine is focused on the analysis of body fluid specimens and providing those results to physicians.

In the most common scenario, a patient visits their physician and a blood sample is drawn. The laboratory receives, processes, and analyzes the specimen. The results are then given to the treating physician who will combine this information with the patient's clinical signs and symptoms to make a diagnosis, treat the patient, or order additional laboratory tests.

Laboratory medicine is essential for patient care. Laboratory results are used to make most medical decisions. These decisions can range from making a diagnosis, determining the patient's prognosis, or guiding future therapy.

Clinical chemistry is one of many sub-specialties within Clinical Pathology. Clinical Chemistry includes analysis of electrolytes, enzymes, proteins, blood gases, hormones, drugs among many other analytes. It encompasses the majority of laboratory tests and I'll provide some specific examples of laboratory tests later on in the presentation.

Other sub-specialties within clinical pathology include microbiology, immunology, and genetics.

Clinical Microbiology involves detection of infectious diseases, and characterization of viruses, fungi, parasites, and bacteria. This area has played an essential role in the identification, medical management and epidemiology of the recent H1N1 or swine flu outbreak.

Immunology is focused on diseases of the immune system. This includes identifying autoimmune diseases, hypersensitivities or allergies, immune deficiency such as AIDS, and histocompatibility for transplants.

Molecular genetics is used to identify genetic diseases such as alpha-1-antitrypsin deficiency, and the assessment of risk factors for cancer such as the BRCA1 gene. Pharmacogenetics is used to determine drug sensitivity.

Cytogenetics focuses on the identification of aberrant chromosomes such as found in Down's syndrome or certain types of leukemia.

While many of these specialties are directed by PhD or MD trainees there are a few sub-specialties which are directed by MD professionals who may require patient care as well. This includes transfusion medicine and hematopathology among others.

Within clinical chemistry there are another whole host of sub-specialties, from critical care testing to lipid analysis to therapeutic drug monitoring. Each of these sub-specialties are represented by the various divisions within the American Association for Clinical Chemistry and can be found throughout the web site.

Collectively all of these subspecialties affect patient care. Clinical chemists directly help physicians make decisions, they provide guidelines for the best way to use laboratory tests, and they also provide a role in the discovery and development of new laboratory tests.

Clinical chemists ensure the quality and accuracy of existing laboratory tests and are at the leading edge of improvements in diagnostic medicine.

I'll show you a few examples of some of the most commonly encountered laboratory tests that you might be most familiar with. One example of a laboratory test is the use of cardiac markers to diagnose a heart attack. In the classical case, a patient with coronary artery disease has an acute onset of chest pain resulting from blockage of blood flow to the heart.

Along with an electrocardiogram, the patient will get a blood test for cardiac markers, such as troponin. Troponin is a key functional element of the myocardium. When the heart is damaged through ischemic injury, troponin is released into the blood stream. With cardiac damage, troponin levels in the blood follow a characteristic pattern as shown in the lower right hand figure. When this pattern is present with chest pain or an abnormal ECG the diagnosis is a heart attack or myocardial infarction.

The role of a clinical chemist depends on where they work. The three common areas where clinical chemists are employed are clinical laboratories such as hospitals, industry, including in vitro diagnostic companies, and federal or regulatory agencies such as the CDC.

The in vitro diagnostics industry is a multi-billion dollar global market, and there are numerous opportunities within this industry.

Some major players you may recognize are: Abbott, Beckman-Coulter, Ortho Clinical Diagnostics and Siemens. There are also numerous smaller companies and start-ups. In industry, clinical chemists may be involved in developing new tests and instruments, customer education, or clinical trials.

There are also opportunities within pharmaceutical companies to develop and test biomarkers to monitor drug efficacy and side effects.

There are also many opportunities within federal and regulatory agencies. Regulatory agencies such as the College of American Pathologists are involved in the oversight of laboratory accreditation and proficiency testing programs, as well as establishing and enforcing regulations. Federal agencies, such as the CDC, also serve as national reference laboratories for proficiency testing and performing analysis of extremely hazardous or dangerous materials.

Many clinical chemists who train at academic centers remain employed by university hospitals. This job involves oversight of the day-to-day operations of a hospital laboratory, physician consultations, and test evaluation. There are numerous research opportunities and most academically oriented clinical chemists are involved in education of medical students and residents. The percent time dedicated to each of these areas greatly depends on the individual and the medical center where one is employed.

A typical day for a clinical chemist in an academic medical center has a tremendous variety. Many of the responsibilities require the ability to communicate with staff performing the testing, management who administer hospital services, and physicians who ask questions. It requires analytical skills combined with strong initiative to learn and integrate new information in a fast paced environment. Clinical chemists also have periodic call responsibilities where they may be paged with questions or issues at any time of the day or week. This job requires organization, flexibility, and the ability to multi-task. It is certainly never dull!

Most biological, chemistry, and molecular diagnostics doctoral degrees will qualify you for training in clinical chemistry. The minimal requirements to enter training programs and be eligible to take Board exams are at least 30 hours of chemistry and/or biochemistry in undergraduate and graduate coursework. Training programs are 2-3 years long and provide real world experience in the technical, clinical, and research aspects of clinical chemistry.

After training in an accredited program individuals are eligible to take board exams which are required by federal legislation to be a laboratory director in a CLIA certified lab. There are different programs and exams for each of the sub-specialties shown here.

The most straightforward path to becoming a clinical chemist is to enter an accredited training program. The commission on accreditation in clinical chemistry or COMACC recognizes 20 programs in North America. Through these, there are a dozen or more people who complete training each year. Please visit the link shown at the bottom of the page to learn more about the COMACC training programs.

Consistent with the many opportunities, the most recent survey data demonstrate that new clinical chemists have entered a variety of jobs in different fields. The majority of trainees do tend towards academic medical centers and this is probably based on their familiarity of this type of job through their fellowship training.

Again based on survey data, starting PhD clinical chemists benefit from competitive salaries, where more than 65% started at more than \$95,000 a year. In addition, many of these individuals reported additional bonuses and the many realizes other benefits, such as health insurance and retirement savings programs.

In the future, there will be a continuing need for well-trained professionals in laboratory medicine.

The focus will be on laboratory consolidation, new technology, test utilization, and effective communication of the ever growing amount of information given to clinicians. There are myriad opportunities to impact patient care.

Clinical chemistry offers tremendous challenges and rewards.

I hope you have found this brief introduction to clinical chemistry informative. For more information follow the various links on throughout the AACC website or contact your local laboratory.