Clinical Chemistry

# Evaluation of the Risk of Laboratory Microbial Contamination during Routine Testing in Automated Clinical Chemistry and Microbiology Laboratories

**Article:**
Christopher W Farnsworth, et al.
*Evaluation of the Risk of Laboratory Microbial Contamination during Routine Testing in Automated Clinical Chemistry and Microbiology Laboratories*
Clin Chem 2020; 66:1190-97 https://doi.org/10.1093/clinchem/hvaa128

**Guests:** Drs. Melanie Yarbrough and Christopher Farnsworth of the Department of Pathology & Immunology at Washington University in St. Louis, Missouri.

Bob Barrett: This is a podcast from *Clinical Chemistry,* sponsored by the Department of Laboratory Medicine at Boston Children's Hospital. I am Bob Barrett.

Every clinical specimen is potentially infectious, but data regarding risk for contamination of the laboratory environment during routine testing are surprisingly scarce. A paper appearing in the September 2020 issue of *Clinical Chemistry* examined contamination during routine sample processing and analysis in automated clinical chemistry and microbiology laboratories. We are pleased to have two authors of that paper as our guests in this podcast, Dr. Melanie Yarbrough and Dr. Christopher Farnsworth. They are both members of the Department of Pathology & Immunology at Washington University in St. Louis and Dr. Farnsworth, let's start with you. The issue of safety of healthcare workers has come to the forefront in recent months. What compelled you to assess risks of working with highly infectious clinical specimens in the laboratory?

Dr. Farnsworth: There are several reasons that we chose to perform a risk assessment of our clinical chemistry and microbiology laboratories. Perhaps the most notable among these is that the CDC actually recommends that all laboratories perform a risk assessment to determine the potential of exposure to pathogens, particularly blood-borne pathogens. During the Ebola virus disease epidemic in 2014, there was concern among laboratories that handle, process, and analyze these specimens that lab staff would be susceptible to transmission of the virus. More recently, the ongoing COVID-19 pandemic has brought this issue back to the forefront in labs. The problem with the recommendation of a risk assessment, though, is that there's no actual formal protocol or playbook as to how labs should assess risk.

Part of our study was creation of a protocol to assess laboratory risk of blood-borne pathogen exposure, that was robust, but also easy for others to replicate. We were also looking back into literature found very little regarding the risk points for laboratory acquired infection, but what we did find were studies that were completed 10 and, in some cases, as much as 20 years ago.

Bob Barrett: And how have things changed in contemporary clinical laboratories?

Dr. Farnsworth: So things have changed pretty dramatically in the last 20 years, but there have been relatively large magnitude changes even in the last five years. For example, compared to contemporary labs, there was very little automation in labs that were assessed in older studies. We are also very reliant on computers and other forms of technology that were relatively rare in previous studies.

This means that our study is one of the first to assess risk in an environment that is better reflective of what labs look like today. We've also changed practices to enhance safety in the last 10-15 years. For example, most older studies found that sharps and use of glass were a major risk point. But these materials aren't really used that frequently in most chemistry labs today.

Our automated equipment also has theoretically become safer through the implementation of engineering controls, which are essentially a safety barrier that protects workers from hazards. For example, the most recent study comparable to ours was completed a little over four years ago, and used automated chemistry instrumentation as an open track system. As a result, workers were potentially exposed to the track and aerosols generated by open tubes on the system. In contrast, newer systems such as the one we analyzed in our study are fully enclosed, protecting workers.

Finally, in the last few years, clinical microbiology laboratories have begun implementing total lab automation. This was entirely novel and to our knowledge, our study was the first to assess the risk of these instruments in the published literature.

Bob Barrett: What were the main findings from your study?

Dr. Farnsworth: We mimicked contaminated specimens by placing an invisible fluorescent powder on the outside of all tested specimens and also added a high titer of non-pathogenic virus called MS2 to each specimen. We then subjected a variety of specimens to routine testing in the chemistry and microbiology labs.

We found that it was highly likely for fluorescent contamination on the outside of the specimen tubes to transfer to workers' hands and the surrounding objects such as computers, specimen racks and other areas that are frequently touched in the lab. This was particularly the case in the processing areas prior to the specimens being placed

on instruments. In contrast, we did not observe any instances of contamination by the MS2 virus that was inside of the tube onto the automated instrumentation to the gloves of the lab workers or to the specimen racks.

In other words, the highest risk to laboratorians in our study was from handling tubes that were contaminated on the outside of the tube. So we're not supposed to actually handle and process grossly contaminated tubes in labs as part of our standard operating protocol, but we all know that it happens. It's also possible that small drops of blood or other specimens on the outside of containers are missed by the lab workers.

Bob Barrett: Dr. Yarbrough, let's go to you. Can you describe what safeguards are in place to protect laboratory workers and were these effective in your study?

Dr. Yarbrough: Well, as Dr. Farnsworth previously mentioned, there are several engineering controls used throughout our laboratory, most of which have been put into place by manufacturers of the equipment. For instance, caps have to be removed from the samples prior to analysis. On our instrumentation, the cap is discarded into an enclosed bin, then the sample travels along a covered track after the cap is removed.

These safeguards limit the frequency with which our technologists must handle the specimens after they have been opened and it reduces the likelihood of aerosolization into the laboratory. From our study, we know that handling contaminated tubes is one of our highest risk areas. Because it is impossible to know if a specimen tube is contaminated or if a sample contains an infectious agent, it is important that universal precautions are always followed in the laboratory.

Universal precautions are based on the principle that any human clinical specimen may be infectious. Hand hygiene and use of personal protective equipment, or PPE, as we call it, are major components of these precautions that limit potential exposure to blood-borne pathogens. In our lab, standard PPE includes a face mask or eye protection, disposable gloves, and a laboratory coat. We found that while fluorescence frequently transferred to the outside of the gloves of the technologists, and at times the lab coat cuffs from a grossly contaminated specimen, fluorescence did not further transfer to the lab workers' hands after they removed their gloves. In other words, appropriate use and removal of PPE prevented contamination of the lab worker from the contaminated sample.

Bob Barrett: Did you find that they were lapses in PPE use?

Dr. Yarbrough: Yes. We had two particular findings with regards to PPE used in our lab. The first is that lab workers in both the chemistry and microbiology sections frequently misused their PPE. Most egregious and common among these were the use of bare hands while working with non-sterile surfaces, and touching personal items such as their cell phones after working with clinical specimens while their gloves were still on. We observed use of computers with their hands and at times, even specimen tubes.

There were also numerous occasions of workers using gloves to touch specimens and then touching their face or using their personal cellphones while their gloves were still on. Interestingly, we did find that inappropriate PPE use was more likely to occur in the chemistry lab compared to the microbiology lab. While we did not fully test this hypothesis, we thought that it could be that people in the micro lab are more likely thinking about infectious organisms and are thus more likely to follow or adhere to their PPE protocols.

One thing we consistently noted in both areas of the lab was that proper hand hygiene was not always followed. Pretty shockingly, we found that less than half of the lab staff wash their hands when they were exiting the laboratory after working with clinical specimens. So, while we did show that the risk of contamination in a clinical lab may be relatively low, the potential for exposure may be increased considerably by inappropriate hand hygiene and PPE use.

Bob Barrett: Dr. Farnsworth, how easily can other laboratories replicate these studies for individualized risk assessment?

Dr. Farnsworth: We think that one of the greatest strengths of our study was the simplicity. The MS2 virus and fluorescent powder that we used to simulate pathogens inside and outside of the specimen tubes respectively are both commercially available products that may be used at minimum risk. The most difficult component was to determine the safety design that best fit into a high-volume complex lab without interrupting the flow of normal specimens. This was accomplished by considerable communication with laboratory supervisors and having a thorough understanding of laboratory operations prior to the start of the study.

Bob Barrett: Okay, well, finally Dr. Yarbrough, can I ask you to address where additional research in this field is needed?

Dr. Yarbrough: Well, certainly something that has been on our minds lately is the risk of handling respiratory specimens in the era of SARS-CoV-2. Specimen types such as sputum and other respiratory specimens were not one of the matrices that

 

were analyzed in our study. While this specimen type may be infrequently analyzed on automated chemistry equipment, it is a common specimen that's processed on total lab automation equipment in microbiology laboratories.

So further studies are needed to assess risk processing these specimen types on automated equipment particularly in the era of the COVID-19 pandemic. Additional areas of study should address specimen transport. As more and more labs consolidate and hospital systems continue to grow, specimens are often traveling a circuitous route from the patient to the lab. This often involves additional equipment such as a pneumatic tube system, which should be assessed for contamination risk as well, as there's really very little data on this topic.

Overall, we have come a long way in terms of laboratory safety in the past few decades, but as we have seen with COVID-19, new infectious diseases may emerge. Labs should keep on top of current threats and perform a risk assessment to assure the safety of our current practice, and don't forget to wear your PPE and wash your hands.

Bob Barrett: That was Dr. Melanie Yarbrough and she was joined by Dr. Christopher Farnsworth. They are both from the Department of Pathology & Immunology at Washington University in St. Louis. They are co-authors of the paper evaluating the risk of laboratory microbial contamination during routine testing in automated clinical chemistry and microbiology laboratories that appears in the September 2020 issue of *Clinical Chemistry*. I'm Bob Barrett, thanks for listening.