Capsule
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What’s new, what’s hot, what’s timely? If you don’t have time to search the Internet for the latest developments that might impact your work environment, you just might find some of this information in this “Capsule” column. Please e-mail any comments or suggestions to felix.gmuender@bh.com.sg or to Co-Editor Barbara Johnson at barbara_johnson@verizon.net or Co-Editor Karen B. Byers at karen_byers@dfci.harvard.edu.

Viral Infections in Workers in Hospital and Research Laboratory Settings, Maintenance of Influenza Virus Infectivity on the Surfaces of Personal Protective Equipment, and Transocular Entry of Seasonal Influenza-Attenuated Virus Aerosols and the Efficacy of PPE

Pedrosa & Cardoso (2011) present one of the most comprehensive reviews of means of occupational laboratory and hospital infections with viruses. Based on strict selection criteria, the authors selected 66 out of 141 papers published between 1935 and 2006 for detailed analysis. Thirty-six papers with a total of 211 cases deal with laboratory-acquired (or associated) infections (LAI). The time period was divided into three 24-year periods. For the first period from 1935-1958, 28 LAI were analyzed; for the second period from 1959-1982, 68 cases were analyzed; and for the final period from 1983-2006, 157 LAI were analyzed. The author of this Capsule noticed that only 6 cases of LAI came from the time period after 2000. Notwithstanding, the general trend for LAIs is up, not down, despite increasing efforts to improve biosafety at the bench and biosafety management. Perdrosa & Cardoso (2011) comment that “the volume of virological research and the number of patients with viral diseases in hospitals have both grown over time.”

Many of the case studies reviewed by Pedrosa & Cardoso (2011) deal with viruses that infect via the mucosa, in particular the eye. While most of these occurred in hospital settings, the lessons learned are highly relevant for biomedical and microbiological laboratories. In many BSL-2 laboratories, staff are not wearing eye protection, probably unaware of the mucosal route of transmission and/or claiming that they would conduct work that creates droplets and aerosols in a biosafety cabinet. They forget that in BSL-2 laboratories, many tasks are carried out on the open bench, outside of primary containment systems, and that while the BSC very efficiently captures aerosols, higher velocity large droplets may escape the BSC. Furthermore, BSCs do not prevent contact infections via mucocutaneous membranes or infections via ingestion. Flasks, vials, and tubes are frequently manipulated outside primary containment systems, including their transport from the incubator to the BSC. Spill and leak accidents, and splashes to the face and eye do occur. In many biological and microbiological laboratories, workers wearing gloves walk around the lab, and even outside of one lab into another lab or support area, and touch common items. Lack of a glove policy can spread contamination into laboratory areas perceived by laboratory staff as “clean.” Thus, we should keep an eye (sic!) on contact infections (i.e., How many times per day do we touch the face near or at the eye?). Using safety glasses in the laboratory will prevent the potential risk of transmission in addition to protecting against splashes. An adequate glove policy, hand washing, and strict adherence to the rules would eliminate or at least reduce the likelihood of fomite and finger transmission.

This review article (Pedrosa & Cardoso, 2011) helps us to better reason with staff who are reluctant to wear eye protection at all times in BSL-2 laboratories and provides evidence-based examples to laboratory managers that enforcing an appropriate glove and hand-hygiene policy is important in reducing the risk of LAI.

The LAI quoted in this review occurred predominantly when workers were processing risk groups 3 and 4 viral agents, which are known to be transmitted through aerosols. In a laboratory situation, the infectious dose for the aerosol route may be generated during certain procedures (nebulizers, resuspension of centrifuge pellets, etc.), when a spill occurs outside primary containment equipment, or when primary containment systems fail. For example, the authors quote the following accident, published in 1995:

“A second laboratory infection with Sabia virus [Ed.: Today this is a risk group 4 virus] and aerosol inhalation as the mode of infection occurred in a biosafety level 3 (BSL-3) facility. Despite that, the researcher only wore a disposable gown, two pairs of gloves, and a surgical mask (droplet protection only), which constitute BSL-2 personal protective equipment. The researcher had no positive pressure high efficiency particulate air (HEPA) filtered respirator, and after performing a centrifugation of 200 ml of viral suspension in a bottle with Vero cell culture (high
titer viral suspension with high volume), viral suspension was found in the bottom of the rotor and the outside of the bottle was wet when the lid of the rotor was opened by the virologist.” (Pedrosa & Cardoso, 2011)

With hindsight we can identify the chain of events that caused the above-mentioned LAI and what should have been done to prevent it and break the links in the chain of infection. The biosafety community benefits when information from such accidents is published so lessons are learned and knowledge about the root causes and appropriate precautionary safety measures can be adopted worldwide. Accidents still do happen, but fortunately we continue to learn from them. The above-quoted case was totally preventable. Most exposures occur because lab workers are not aware of the risks when, for example, a sealed biosafety rotor or cup is not used, rotors are opened inappropriately, or inappropriate PPE such as surgical masks are worn. One single safety measure might have prevented this LAI. With the tools of microbiological risk assessment and management as described in current biosafety guidance documents, the risks in the biosafety laboratory can be minimized to a negligible or acceptable level.

To the uninitiated reader of this review article the conclusion might be that the risk situation in a biosafety laboratory has not changed since the last century, because numbers of LAI are going up. However, to quote the authors: “The measures and protocols of biosafety generated to minimize the number of these accidental infections involving specific modes of infection were less effective than commonly supposed.” The analyzed case studies show that non-compliance with biosafety protocols for aerosol containment and personal protective equipment results in LAI; thus, the point could be made that the problem is in the adoption and adherence to biosafety protocols.

For those who are new to the field of biosafety, the article helps to better understand the risks and shows that biohazards do not pose a phantom risk. The two authors have provided a meticulous and valuable review.


**Maintenance of Influenza Virus Infectivity on the Surfaces of Personal Protective Equipment and Clothing Used in Healthcare Settings**

In healthcare settings (and biosafety laboratories as well), the tenacity and viability of infectious agents on surfaces are of high relevance. In healthcare settings, surfaces typically get contaminated by secretions and droplets spread by patients and in laboratories by droplets and aerosol particles large enough to settle quickly. Personal protective equipment (PPE), including clothing and respirators, can prevent direct contact and inhalation, but at the same time the PPE may become fomites that can cross-infect other surfaces and eventually even people. Inappropriate usage and disposal of PPE may result in an inadvertent direct exposure or contamination of surfaces. Sakaguchi et al. (2011) studied whether and for how long influenza A viruses (H1N1) maintain infectivity on PPE worn in healthcare institutions; these include rubber gloves, N95 respirators, surgical masks, and Tyvek® suits. 1280 hemagglutination (HA) units of the ATCC VR-95 influenza A strain were applied to the surfaces and left for 1, 8, and 24 hours. Samples were collected to determine the 50% tissue culture infective dose TCID_{50}/ml. Sakaguchi et al. (2011) report that the HA titer did not decrease in any of the materials even after 24 hours, which served as a control (virus particles did not detach). The infectivity (TCID_{50}/ml) was maintained on all materials for 8 hours and on rubber gloves for 24 hours. The authors conclude that periodic replacement and correct removal of PPE are necessary to prevent cross infections.


**Transocular Entry of Seasonal Influenza—Attenuated Virus Aerosols and the Efficacy of N95 Respirators, Surgical Masks, and Eye Protection in Humans**

Bischoff et al. (2011) investigated to what extent the airborne transmission route for a live attenuated influenza vaccine strain can be barred by N95 respirators, surgical masks, and/or eye protection (non-vented goggles). Twenty-eight test subjects were assigned to 6 groups: (1) no protection; (2) eye protection only; (3) surgical mask without eye protection; (4) surgical mask with eye protection; (5) fit-tested N95 respirator without eye protection; and (6) fit-tested N95 respirator with eye protection. The test subjects were exposed to monodispersed viral aerosols with a particle size of 4.9 µm. All 4 participants in the control group (no protection) exhibited successful transmission. Successful transmission was confirmed in: 3 of 4 subjects with eye protection only; all of 5 subjects wearing surgical masks only; all of 5 subjects wearing surgical masks and goggles; 2 of 5 subjects wearing a fit-tested N95 respirator; and 1 of 5 subjects wearing a fit-tested respirator and goggles. Despite the small sample size, the authors concluded that the eyes play a relevant entry route for influenza viruses.