Overview of a few Laboratory Acquired Infections (LAIs)

Benjamin Fontes, CBSP, MPH – Yale University EHS

Pathogen	Exposure Route	Notable Impact	Factors	Risk Assessment or Risk Management Failures
Salmonella typhimurium	U ING	SO	NASS, IBOA, PWP	1, 2, 3, 4, 5, 6
Salmonella typhimurium	U ING	SO, F	NASS, IBOA, PWP	1, 2, 3, 4, 5, 6
Salmonella typhimurium	U ING	SO	NASS, IBOA, PWP	1, 2, 3, 4, 5, 6
Lassa Fever virus	U AER-L	SI, F	NASS, IBOA, PWP	1, 2, 3, 4, 5, 6
Rabies virus	U AER-L AER-MM	F	PWP	1, 2, 3, 4, 5, 6
Rabies virus	U AER-L AER-MM	F	PWP	1, 2, 3, 4, 5, 6
Neisseria meningitidis	U AER-L	F	NASS, PWP, NIMM	1, 2, 3, 4, 5, 6
Yersinia pestis (attenuated)	U AER-L	F	NASS, PWP	1, 2, 3, 4, 5, 6
Sabia virus	U AER-L	SI	NASS, PWP	1, 2, 3, 4, 5, 6
Samonella typhi and S. agona	U ING	SO, F TERR???	IBOA, PWP	2, 3, 4
Hepatitis B virus	U SK	F	PWP, NIMM	2, 3, 4, 5
Bacillus cereus	U SK	SI	NASS, IBOA, PWP	1, 2, 3, 4
Shigella sonnei	U ING	SI	NASS, IBOA, PWP	1, 2, 3, 4, 6
SARS-CoV	U AER-L	SO, F	IBOA, PWP	1, 2, 3, 4, 5, 6
Macacine Herpesvirus 1 (B-virus)	U MM	F	NASS, PWP	1, 3, 4, 5
Dengue virus	SK		PWP	2, 3, 4
Vaccinia virus VA	U SK		NASS, PWP, NIMM	2, 3, 4

EXPOSURE ROUTE

AER-L: aerosol exposure to lung
AER-MM: aerosol exposure to mucous membranes
ING: ingestion
MM: mucous membranes (splash, hand contact)
SK: percutaneous, skin
U: unknown route of exposure
TERR: terrorism

NOTEABLE IMPACT

LAI: laboratory acquired infection
F: fatal LAI
SI: secondary infection of others in lab or building
SO: secondary infection of others outside the institution

FACTORS

NASS: no awareness of signs and symptoms
NIMM: no immunization
PWP: poor work practices
IBOA: infected by others actions

RISK ASSESSMENT

1: pathogen
2: procedures
3: personnel
4: practices (work practices)
5: protective equipment (personal protective equipment and engineering controls)
6: place (facility design)

Pathogen	Exposure Route	Notable Impact	Factors	Risk Assessment or Risk Management Failures	Table Legend
Vaccinia virus PA	U MM		NASS, PWP, NIMM	1, 2, 3, 4, 5	**EXPOSURE ROUTE** **AER-L:** aerosol exposure to lung **AER-MM:** aerosol exposure to mucous membranes **ING:** ingestion **MM**: mucous membranes (splash, hand contact) **SK:** percutaneous, skin **U:** unknown route of exposure **TERR:** terrorism **NOTEABLE IMPACT** **LAI:** laboratory acquired infection **F:** fatal LAI **SI:** secondary infection of others in lab or building **SO:** secondary infection of others outside the institution **FACTORS** **NASS:** no awareness of signs and symptoms **NIMM:** no immunization **PWP:** poor work practices **IBOA:** infected by others actions **RISK ASSESSMENT** **1:** pathogen **2:** procedures **3:** personnel **4:** practices (work practices) **5:** protective equipment (personal protective equipment and engineering controls) **6:** place (facility design)
Vaccinia virus VA	U SK		NASS, PWP, NIMM	1, 3, 4	
Shigella dysenteriae	ING TERR	SI SO	IBOA, PWP	1, 2, 3	
HIV	SK		IBOA, PWP	2, 3, 4	
HIV & Hepatitis C virus	SK	Multiple F	IBOA, PWP	2, 4, 5	
Borrelia burgdorferi	U SK		PWP	2, 4	
Francisella tularensis	U AER-L		NASS, PWP	1, 2, 3, 4, 5	
Brucella Melitensis	U AER-L		NASS, IBOA, PWP	1, 2, 3, 4, 5	
Cryptosporidium parvum	U MM AER-MM AER-L		NASS, PWP	1, 2, 3, 4, 5, 6	

Quick Overview of the 6 P's of Risk Assessment and Risk Management

1-Pathogen

Policy that requires registration for possession, use, storage and transfer of biohazards and regulated biological materials including human pathogens. The PI and the IBC must conduct a formal risk assessment of the proposed research with biohazards and a review also of the standard operating procedures developed to work safely with the biohazard.

2-Procedures

Identify all of the proposed procedures, supplies and equipment that will be used in the protocol and ensure that this is part of the risk assessment review and assignment of the final biocontainment level and SOPs created for the work. All procedures and all work locations, including animal experiments must be part of this review. Evaluation of sharps risks, aerosol risks, splash and splatter containment, etc. and the commensurate containment needed is part of this process.

3-Personnel

A medical surveillance review is required to determine what pre- and post-exposure prophylaxis may be indicated, a review of the signs and symptoms of disease caused by the biohazard and all clinical manifestations must be completed with all involved in the project (researchers to animal handlers, etc.) The PI and IBC must also ensure that all involved have relevant work experience, training, education, awareness and comfort for the proposed research. If needed a competency work practice evaluation should be conducted. Researchers must be reminded to not work with breaks in the skin, to have changes in their health evaluated and to report any potentially related symptoms or illnesses to Occupational Health.

4-Practices

The work practices that will be used as part of the SOP to work safely and contain the pathogen must be developed, reviewed and approved by the IBC. These SOPs should be part of the institution's overall Biosafety Manual to create a site-specific biosafety manual. Some registration forms can guide the PI to develop site-specific work practices.

5-Protective Equipment

This part of the Risk Management side of Biorisk Management involves personal protective clothing and equipment and the use of engineering controls. Individuals require training on the use of both. Both must be evaluated to ensure that they are present, adequate, in good condition and used appropriately.

6-Place

Facility or lab design is the final part of the Risk Management side and this is the required evaluation by the IBC and Biosafety Officer to ensure that all work locations are appropriate for the proposed research. High traffic areas, large open areas, directional airflow and labs that open directly to public access corridors are some of the factors that must be critically evaluated to ensure that the proposed research will not lead to high risk situations for those performing the work and those outside the lab.

Pathogen LAI	Reference
Salmonella typhimurium (CDC MMWR) 2011, 2014, 2017	https://www.cdc.gov/salmonella/2011/lab-exposure-1-17-2012.html https://www.cdc.gov/salmonella/typhimurium-labs-06-14/index.html https://www.cdc.gov/salmonella/typhimurium-07-17/index.html
Lassa Fever virus	http://www.nytimes.com/2004/02/21/nyregion/jordi-casals-ariet-who-found-lassa-virus-dies-at-92.html
Rabies virus 1973	Winkler WG, Fashinell TR, Leffingwell L, et al. Airborne rabies transmission in a laboratory worker. JAMA. 1973;226:1219-21.
Rabies virus 1977	Centers for Disease Control and Prevention. Rabies in a laboratory worker, New York. MMWR Morb Mortal Wkly Rep. 1977;26:183-4.
Neisseria meningitidis 2012	http://www.sciencemag.org/news/2012/05/death-california-researcher-spurs-investigation https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6335a2.htm
Yersinia pestis 2009	https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6007a1.htm
Sabia virus 1994	https://www.aiha.org/get-involved/VolunteerGroups/LabHSCommittee/Pages/Sabia-Virus-in-Centrifuge-Incident.aspx http://www.nytimes.com/1994/12/13/science/yale-accepts-blame-for-safety-lapses-linked-to-lab-accident.html
Salmonella agona, Salmonella typhi, 1980	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC273903/
Hepatitis B virus, 1985	Personal communication in Clinical Chemistry laboratory
Bacillus cereus, 2011	http://www.sciencemag.org/news/2011/09/updated-university-chicago-microbiologist-infected-possible-lab-accident https://sites.google.com/site/bioterrorbible/lab-accidents/bio-lab-accidents-2011?tmpl=%2Fsystem%2Fapp%2Ftemplates%2Fprint%2F&showPrintDialog=1
Shigella sonnei, 1996	http://jcm.asm.org/content/35/12/3163.full.pdf
SARS-CoV, 2003, 2004	http://www.who.int/csr/don/2004_04_30/en/ http://www.nytimes.com/2004/04/26/world/new-cases-identified-in-china-s-sars-outbreak.html http://www.cidrap.umn.edu/news-perspective/2003/12/taiwanese-sars-researcher-infected http://www.nejm.org/doi/full/10.1056/NEJMoa032565
Macacine Herpesvirus 1, 1997	https://www.cdc.gov/mmwr/preview/mmwrhtml/00056008.htm

Dengue infection, 2014	https://my.absa.org/LAI
Vaccinia virus, CT VA Hospital, 2005	https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5715a3.htm
Vaccinia virus, PA, 2004	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3291406/
Vaccinia virus, VA, 2008	https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5829a1.htm
Shigella dysenteriae, 1996	https://jamanetwork.com/journals/jama/fullarticle/417894
HIV needlestick 1988	http://www.nytimes.com/1997/12/18/nyregion/yale-must-pay-12.2-million-to-a-physician-who-got-hiv.html
HIV/Hepatitis C virus 1998, 1990	https://www.ahcmedia.com/articles/20911-the-needlestick-that-changed-her-life https://www.ahcmedia.com/articles/58948-double-deadly-needlestick-transmits-hiv-and-hcv http://www.nejm.org/doi/full/10.1056/NEJM199703273361304
Borrelia burgdorferi 1996	Personal communication, bite of infected nymph tick
Brucella abortus, 2006	http://www.cidrap.umn.edu/news-perspective/2007/07/cdc-suspends-work-texas-am-biodefense-lab http://www.cidrap.umn.edu/news-perspective/2007/09/cdc-details-problems-texas-am-biodefense-lab
Cryptosporidium parvum, 2011	https://absaconference.org/wp-content/uploads/2016/10/ABSA2016_Session17_Philpott.pdf
Francisella tularensis	http://www.cidrap.umn.edu/news-perspective/2005/04/inquiry-leaves-boston-tularemia-mystery-unsolved http://massspectrometryconsortium.arizona.edu/sites/default/files/Boston_Univerity_Tularemia_report_2005.pdf