EPINet Report:

Clinical Laboratories:
Reducing Exposures to Bloodborne Pathogens

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Introduction

IN THE PAST DECADE, OCCUPATIONAL RISKS TO laboratory workers have become more serious than ever with the advent of the AIDS epidemic. One of the most disturbing statistics on the occupational transmission of HIV is the large proportion of clinical laboratory workers among the documented and probable cases of occupationally transmitted HIV in the United States. Clinical laboratory workers accounted for 20% (30/151) of all cases reported through December 1995, ranking second only to nurses despite the fact that nurses are far more numerous in the health care work force than clinical laboratory workers.[1] One explanation for this is that most of the cases attributed to clinical laboratory workers involved phlebotomists who sustained needlesticks from blood-drawing needles. It has become clear that the types of exposures that are most likely to result in HIV transmission are those that involve the direct inoculation of significant quantities of blood.[2]

In addition to HIV, numerous studies have documented an impressive array of pathogens transmitted to clinical laboratory personnel, foremost among them hepatitis B.[3-8] In one study, HBV seropositivity rates were highest among lab workers who routinely got blood on their clothes, those who frequently performed blood gas analysis, and those working on multi-channel autoanalyzers.[9] These observations suggest that transmission of some bloodborne pathogens can also be associated with frequent contact and skin contamination. The potential for exposure to laboratory specimens contaminated with bloodborne pathogens remains high. One study in a hospital chemistry laboratory found that 6% of serum or plasma specimens received were HBV-contaminated, and 3% were HIV-contaminated.[10]

Nevertheless, during the past ten years great strides have been made to reduce the risk of laboratory worker exposures to, and infections by, bloodborne pathogens. The two most important landmarks in prevention have been the availability of an effective hepatitis B vaccine, and the implementation of the Occupational Safety and Health Administration (OSHA) Bloodborne Pathogen Standard, which was enacted in its final form in December of 1991.[11] The Standard requires employers to provide the hepatitis B vaccine at no cost to employees, to provide an adequate supply of appropriate personal protective equipment, and to clean, maintain, and/or replace this equipment regularly. Puncture-resistant, leak-proof disposal containers must be provided in convenient locations, and must be replaced before becoming overfilled. If an employee is exposed to blood or body fluids, the employer must provide post-exposure follow-up, including employee and source patient testing for bloodborne pathogens, and records of reported exposures must be maintained. Finally, the employer must provide training in Universal Precautions, safe work practices, and the employer's obligations under the Standard to its employees.

Although it is widely believed that these measures have resulted in significant improvements, there is little documentation of

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the effects of the Standard on the frequency of exposures and infections in the clinical laboratory environment. This is because there were no standardized exposure surveillance programs in place before the implementation of these measures that would have made before-and-after comparisons possible. Another reason is that the number of exposure incidents reported from clinical laboratories in a single institution is likely to be too small to draw general conclusions about exposure and risk patterns. One approach for obtaining enough data to draw meaningful conclusions is to combine data from numerous institutions, provided they all use a standard surveillance system. The present analysis, including data from 70 hospitals, was carried out to determine exposure patterns in clinical laboratory settings in order to identify high-risk equipment and activities, and to accurately focus prevention initiatives in the areas of greatest need and opportunity.

Methods

All percutaneous injuries or mucocutaneous exposures to blood or body fluids that occurred in clinical laboratory settings and were reported to the 70 participating EPINet[12] hospitals during a two-year period, beginning in September 1992, were included in this analysis (306 cases). In order to identify the unique characteristics of the clinical laboratory environment that distinguish it from other areas of the hospital, these cases were compared to exposures occurring in patient rooms (3,468 cases). Incidents that occurred to clinical laboratory personnel outside of the clinical laboratory environment and incidents that occurred with non-contaminated items were not included in this analysis.

Results

More than 80% of the 306 exposures occurring in clinical labs were to lab technicians, technologists or phlebotomists. A small proportion were to nurses, physicians, and housekeepers. **Figure 1** shows the types of devices causing sharp-object injuries in clinical labs. Needles caused the greatest number of injuries, accounting for 38% of all injuries. Of needle injuries, 51% were caused by blood-drawing needles in clinical labs, while in patient rooms only 23% of needle injuries

were caused by blood-drawing needles (χ^2 = 32.8, p< .0001). This is significant because blood-drawing needles are among the devices most commonly associated with the transmission of bloodborne pathogens. Another unique finding was that 22% of needle injuries in clinical labs were associated with needles that were

used as tools, while only 3% of needle injuries in patient rooms were attributed to needles used as tools (χ^2 = 85.5, p<.0001). It is a common practice in clinical labs to use needles and syringes for purposes other than what they were designed for. The lack of safer equipment specifically designed for laboratory appli-

Figure 1. Devices Causing Sharp-Object Injuries in Clinical Laboratories

EPINet, 64 hospitals, 2 years, cases=208
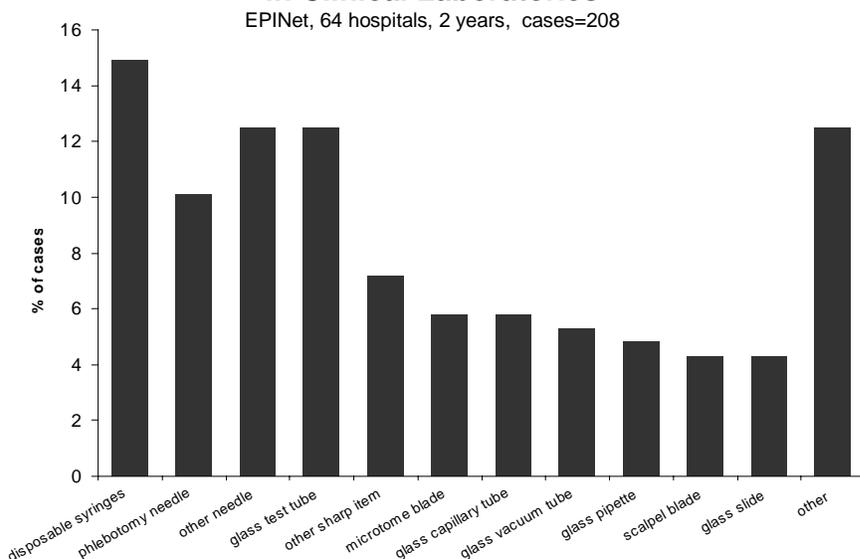
International Healthcare Worker Safety Center, University of Virginia

Figure 2. Mechanism of Glass Injuries in Clinical Laboratories
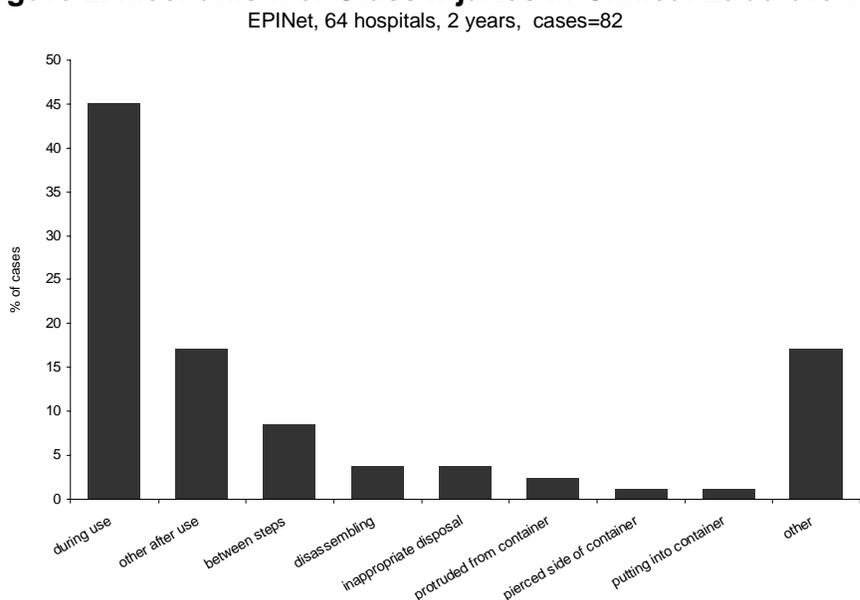
EPINet, 64 hospitals, 2 years, cases=82

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cations often leaves lab workers no alternative but to use available equipment that puts them at unnecessary risk of injury.

Of particular interest was the finding that glass injuries (specimen tubes, capillary tubes, pipettes, and slides) accounted for 39% of injuries as opposed to only 0.3% of injuries in patient rooms ($\chi^2 = 918.9$, p< .0001). These are especially serious injuries because glass items are often containers for blood, so that when a laceration occurs, there is often the potential for the introduction of a large blood inoculum into the wound. **Figure 2** shows how glass injuries happened. The greatest number of incidents occurred during use of the glass item, which means that glass items frequently broke as they were being handled. There are many plastic products available that are safer alternatives than conventional glass equipment. Vacuum tubes, specimen tubes, and capillary tubes, the devices most commonly used as blood receptacles, are now available in plastic and are highly resistant to breakage. Plastic pipettes are now more common in most labs than glass ones. The use of glass pipettes should be strictly limited to procedures for which plastic cannot be used.

There were 76 mucocutaneous exposures reported in clinical labs during the two-year interval. In 74% of these incidents the body fluid involved was blood, while in patient rooms only 54% of mucocutaneous exposures involved blood ($\chi^2 = 10.9$, p<.001). However, the quantity of blood or body fluid involved in exposures was smaller in clinical lab settings, where only 1% of exposures exceeded 5cc of biological fluid, whereas in patient rooms 12% of exposures exceeded 5cc of biological fluid ($\chi^2 = 8.4$, p<.01). Smaller amounts of biological fluids pose less risk to health care workers. In clinical labs, the amount of biological fluid in a single exposure usually does not exceed the capacity of a specimen container, which is relatively small. However, risk could be even further reduced by limiting the amounts of blood or body fluids collected from patients to the minimum required for testing. Often only drops are needed for testing, while several ccs are collected from patients.

A notable characteristic of blood and body fluid exposures in clinical labs was the high percentage of cases in which the exposure was due to specimen containers leaking or breaking, or other product-related failures, as shown in **Figure 3**. In clinical labs, 97% of mucocutaneous exposures involved a product-related failure, whereas in patient rooms, 48% of cases were product-related, in comparison to direct patient contact ($\chi^2 = 69.2$. p<.0001). The design and integrity of specimen containers is an issue requiring more attention. In addition to leakage and breakage, the need to uncap specimen tubes to access contents creates a significant problem. Methods of specimen access and transfer that do not require uncapping of specimen tubes would constitute an important advance in safety.

Another finding of interest is shown in **Figure 4**. Clinical lab personnel more frequently wore personal protective garments at the time of mucocutaneous exposures than health care workers exposed in patients' rooms. In particular, 78% of

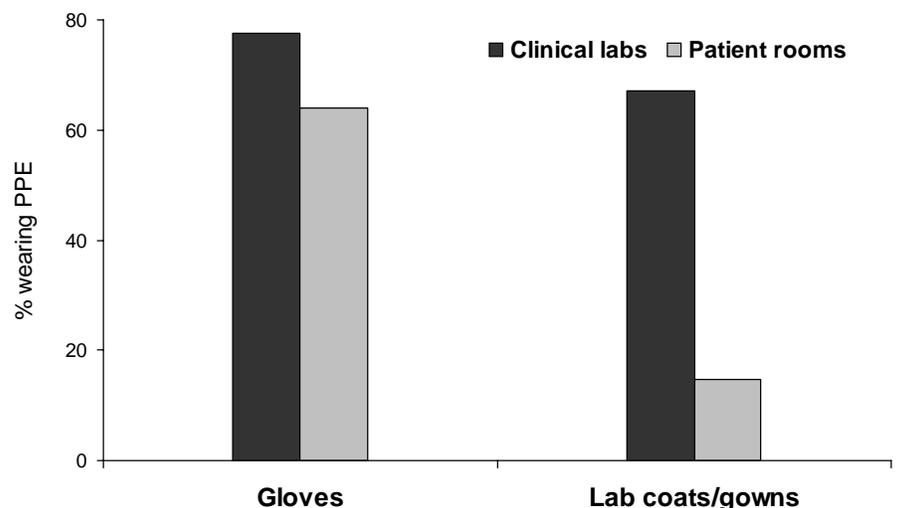**Figure 3. Mechanism of Blood and Body Fluid Exposures in Clinical Laboratories**

EPINet, 64 hospitals, 2 years, cases=76

% of cases
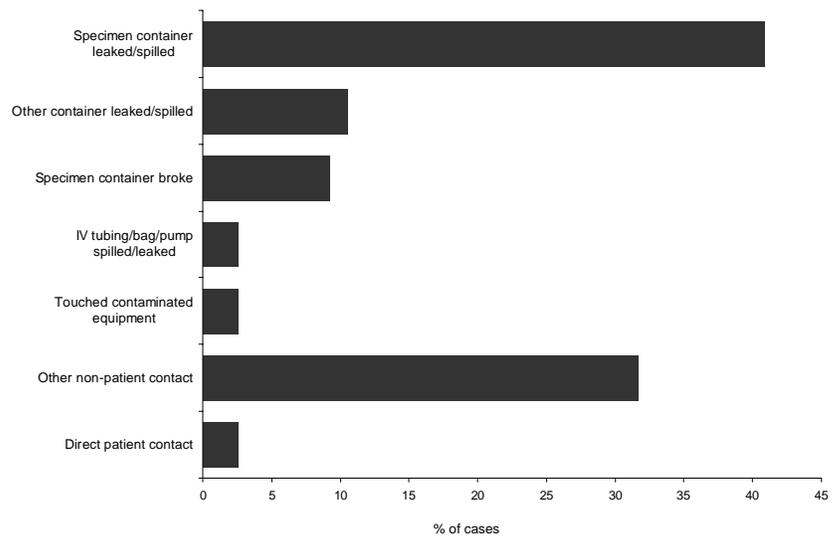
International Healthcare Worker Safety Center, University of Virginia

Figure 4. Personal Protective Equipment Worn at the Time of Exposure: Clinical Laboratories vs. Patient Rooms

EPINet, 64 hospitals, 2 years, cases=909

■ **Clinical labs** □ **Patient rooms**

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lab workers were wearing gloves at the time of exposure, as opposed to 64% of health care workers exposed in patients' rooms ($\chi^2 = 5.9$, p<.05). Sixty-seven percent of lab workers were wearing cloth lab coats or gowns at the time of their exposures, while only 15% of workers in patients' rooms were wearing lab coats or gowns ($\chi^2 = 123.2$, p<.0001). Clinical lab personnel appear to be more consistent in their use of personal protective equipment than other health care workers. This may be explained in part by the controlled environment of the clinical lab in contrast to patient care, where contact with blood or body fluids can occur without warning.

On the other hand, previous studies we have conducted provide evidence that cloth lab coats provide only an illusion of protection without reducing the risk of skin contact with biological fluids.[13,14] The cloth lab coat remains the most common garment for covering the torso and arms of clinical lab personnel. If its purpose is to serve as a work uniform, or to prevent the soiling of clothes, the cloth lab coat can meet these goals. If its purpose is to prevent skin contact with biological fluids, the cloth lab coat is irrelevant. At a minimum, fluid-resistant gowns or coats should be available in locations where there is a risk of splashing or spraying of biological fluids, although it is not clear that all lab workers would need this degree of protection at all times.

There is another reason, however, to explain why lab coats and gloves did not prevent mucocutaneous exposures. We found that 74% of reported mucocutaneous exposures were to the eyes, nose, mouth, or other areas of the face. There is surely a reporting phenomenon contributing to this finding. We have noted similar selective reporting patterns among emergency department workers.[14,15] A blood exposure to the eyes, mouth or other areas of the face is a shocking experience and more likely to be reported than blood contact with arms or hands. Face exposures are relatively infrequent, but it is clear that lab personnel rarely wear protective eyewear or faceshields. These findings point to the need to identify situations and procedures that may result in splashing or spraying in which face exposure is a risk, and to selectively implement the use of protective face and eyewear under those circumstances.

Conclusions

The most serious risk of exposure to bloodborne pathogens among clinical lab workers is from needles used to draw or transfer blood samples, and from glass specimen tubes and glass capillary tubes used for collecting and storing blood samples. Plastic specimen and capillary tubes should be substituted for glass tubes wherever possible. For blood drawing, protective devices that shield or blunt phlebotomy and syringe needles after their use should be implemented not only among clinical lab personnel but hospitalwide. The use of needles and syringes as lab tools, which place lab workers at unnecessary risk, should be eliminated to the extent possible. The use of the common cloth lab coat as a fluid barrier should be eliminated and replaced, in at-risk locations and for at-risk procedures, by fluid-resistant gowns. The use of protective face and eyewear should be implemented under circumstances in which face exposure is a risk. Manufacturers should improve the designs of specimen containers to minimize risk of leakage, breakage, and spillage, and should introduce features that would allow the transfer of fluid contents without the need to open containers. Quantities of blood and body fluid samples collected from patients should be limited to the minimum required for testing. Finally, every effort should be made to achieve a 100% hepatitis B vaccination rate among clinical laboratory personnel.

References

1. Centers for Disease Control and Prevention. *HIV/AIDS Surveillance Report.* 1995;7(2):21.
2. Centers for Disease Control and Prevention. Case-control study of HIV seroconversion in health care workers after percutaneous exposure to HIV-infected blood (France, United Kingdom, and United States, January 1988-August 1994). *MMWR.* 1995;44:929-933.
3. Collins CH, Kennedy DA. Microbiological hazards of occupational needlestick and "sharps" injuries. *J Appl Bacteriol.* 1987;62:385-402.
4. Grist NR, Emslie J. Infections in British clinical laboratories. *J Clin Pathol.* 1985;38:721-5.
5. Jacobson JT, Orlob RB, Clayton JL. Infections acquired in clinical laboratories in Utah. *J Clin Microbiol.* 1985;21:486-9.
6. Vesley D, Hartman HM. Laboratory-acquired infections and injuries in clinical laboratories: a 1986 survey. *Am J Public Health.* 1988;78:1212-5.
7. Levy BS, Harris BC, Smith JL, et al. Hepatitis B in ward and clinical laboratory employees of a general hospital. *Am J Epidemiol.* 1977;106:330-335.
8. Wruble LD, Masi AT, Levinson MJ, et al. Hepatitis-B surface antigen (HB Ag) and antibody (anti-HB) prevalence among laboratory and nonlaboratory hospital personnel. *South Med J.* 1977;70:1075-1079.
9. Pattison CP, Boyer KM, Maynard JE, et al. Epidemic hepatitis in a clinical laboratory. *JAMA.* 1974;230:854-857.
10. Handsfield HH, Cummings MJ, Swenson PD. Prevalence of antibody to human immunodeficiency virus and hepatitis B surface antigen in blood samples submitted to a hospital laboratory. *JAMA.* 1987;258:3395-3397.
11. Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1920.1030, Occupational exposure to bloodborne pathogens, final rule. *Federal Register*, December 6, 1991;56:64004-64182.
12. Jagger J, Cohen M, Blackwell B. EPINet: A tool for surveillance and prevention of blood exposures in health care settings. In: *Essentials of Modern Hospital Safety*, 3rd edition. Ed. W. Charney. Lewis Publishers/CRC Press, Inc. Ann Arbor, 1994.
13. Jagger J, Detmer DE, Cohen ML, et al. Reducing blood and body fluid exposures among clinical laboratory workers: meeting the OSHA standard. *Clin Lab Manage Rev.* 1992;6:416-424.
14. Jagger J, Balon M. EPINet Report: Blood and body fluid exposures to skin and mucuous membranes. *Advances in Exposure Prevention.* 1995; Jan/Feb 1(2):1-9.
15. Jagger J, Powers R, Detmer DE, et al. Epidemiology and prevention of blood and body fluid exposure among emergency department staff. *J Emerg Med.* 1994;12:753-765.