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University of Kentucky

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Needle stick injuries and blood born pathogen exposures among health care workers in University of Kentucky health care facilities

CAPSTONE PROJECT PAPER

A paper submitted in partial fulfillment of the requirements for the degree of
of
Master of Public Health in the University of Kentucky College of Public Health.

By

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Lexington, Kentucky

March, 2015

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Abstract:

Objectives:

The number of cases of needle stick and sharps-related injuries among healthcare workers are difficult to estimate due to underreporting. Multiple research studies have been done in this area but the scale of the problem is substantial and requires further attention. This study focuses on the cases of needle stick injuries and blood born pathogen exposure among health care workers at the University of Kentucky. The purpose of this study is to examine the rates of needle stick vs splash related injuries among the University of Kentucky health care workers from 2009 to 2014, and stratify the frequencies of those cases by job categories and location of injury. We also studied the effect of several variables such as year of exposure, previous exposure, wearing protective equipment, job categories and location of occurrence on the risk to certain types of exposure (sharp, splash or both).

Methods:

Data were obtained from the University of Kentucky health service and these data represent 2,819 cases of body fluids exposures among health care workers at the University of Kentucky from 2007 to 2014.

Descriptive statistical analysis of the trends of exposure rates stratified by job categories and locations of exposure are described. A linear regression model was used to describe the trend of the reported blood born pathogen (BBP) exposure cases among the University of Kentucky (UK) health care workers from 2007 to 2014, and the rate of needle stick injuries vs splash related exposures among UK health care workers from

2009 to 2014. The Chi-square test was used to examine the association between the type of exposure and five variables, and logistic regression model was used to examine the strength and the direction of this association.

Results:

The number of the reported blood born pathogen (BBP) exposure cases increased gradually from 304 to 420 cases between the years 2007 to 2012, then decreased again to 314 in 2014. The rates of needle stick injuries ranged from 40.92 per 100 beds in 2009-2010 to 44.67 per 100 beds in 2013-2014, with a mean of 46.86 and standard deviation of 6.88. This is higher than the rates of splash related injuries that ranged from 14.72 in 2009-2010 to 12.28 in 2013-2014, with a mean of 14.88 and standard deviation of 3.68. The number of reported blood born pathogen exposure cases among the health care workers at UK has been increasing gradually, with a higher rate of reported cases were among nurses and medical residents/fellows. Locations with the highest number of reported cases were operating rooms and patients' rooms. Several variables, like wearing protective equipment, previous exposure, job category and location of injury were found to be associated with the type of exposure (sharp, splash or both).

Conclusions:

Our data showed that the rate of reported blood/body fluid exposures among health care workers at the University of Kentucky have been nearly stable over the last few years (between 2008 to 2014) . The rate of needle stick injuries and splash exposures at UK hospital in 2009-2010 was almost double the national rate reported by

the exposure prevention information network (EPINet), which is a group of hospitals that voluntarily report information about their exposed workers, in the same period. The results that were found in this study were similar to previous studies, but further research is needed. The University of Kentucky reporting system requires modification especially to address the underreporting issues. Efforts should be directed to decrease injuries among the highest risk jobs and locations, with the highest number of cases.

Introduction:

In 2004, CDC reported that about 385,000 needle stick and sharps-related injuries occur annually in the hospital settings among healthcare workers. The accuracy of these numbers is questionable due to underreporting, however the magnitude of this problem is substantial and requires further efforts for injury control and prevention. Regarding the issue of underreporting, many studies and health care organization conduct anonymous surveys about blood born exposure in and compare the results with the reported cases by the employees for diagnosis and treatment. It was found in most studies that only about 50% of those injuries get reported. (1)

A large number of needle stick injuries are unreported, which makes the estimation of the financial and emotional costs, associated with this type of injury, challenging. The direct costs associated with the initial follow-up and treatment of

healthcare workers who sustained a needle stick injury in 2004 was estimated to be about \$1750 for each injury.(1)

In addition, needle stick injuries cause significant emotional and psychological stress, which is a very difficult to estimate and quantify. The uncertainty of the infection status in the injured health care workers in the short term period following the injury, in addition to the long-term consequences if they become infected, are very stressful consequences. (1)

There are many modifiable and non-modifiable risk factors of needle stick injuries for health care workers including job category and occupation. Studies show that residents, medical students, and nurses have the highest rate of needle stick injury among health care workers. Certain healthcare settings such the intensive care unit (ICU) and the operating room (OR) have the highest rate of needle stick injuries. (1)

Based on recent studies, about 40% of injuries occur in inpatient hospital settings, 25% occur in the operating rooms and 13% in intensive care units. Lack of training and education on the use of sharps devices is another important risk factor for this type of injury. Recent studies suggested that medical students have a significant rate of needle stick injuries and noted significant difference between first, third, and final year students, with final year students exhibiting the most knowledge and lowest rates of needle stick injuries. It is recommended that healthcare organizations should direct more resources toward educating and training the employees on using sharp devices in addition to providing safer medical instruments.(1)

Literature review:

Rates and risk factors:

Many factors play a role in needle stick injuries; inadequate training of healthcare students is among the most crucial of them. Medical students are the future healthcare professionals and need to be educated about the risks of needle stick injuries, and learn about preventive measures and safety procedures available to reduce the occurrence of those injuries. Another problem is the lack of resources in small, rural hospitals and clinics. Those healthcare facilities should receive more federal support from government organizations such as CDC or OSHA. Many other factors increase the risk of needle stick injuries among health workers, such as the number of blood contacts experienced by the worker, and the prevalence of blood-borne pathogen infection among patients in their health care facilities.(1)

With limited time in their work schedules, it is difficult for healthcare workers to make time for training and learn safe procedures. Additionally, many health care workers think it will never happen to them; the consequence being that many of them may not change their routine use of those sharp objects. Due to the above attitude among health care workers, the OSHA blood borne Pathogen Standard requires that all employers undergo training on an Exposure Control Plan; enforcing this policy among high risk health care professionals could be key in preventing these injuries. (1)

Job category is an important risk factor for blood born pathogen exposures. In 2012, Butsashvili et al., examining data from 1368 health care workers in Georgia and found that the highest rate of needle stick injuries occur during recapping the needles due to a false move, or handing the device to another colleague. Accidental needle stick injury was reported in (45%) of the cases, and blood splashes in (46%) of them. The highest rate of sharp related injuries occurred among physicians (22%) and nurses (39%) and was mainly during the recapping of used needles. The prevalence of HCV infection was 5%.(9)

Doebbeling et al. (2003) published a study that examined factors associated with needle stick injuries among health care workers in Iowa community hospitals, using a random sample of 5123 physicians, nurses, and medical technologists. The response rate was 63% and the rate of underreporting sharps injuries was 32%. Logistic regression was used to estimate the odds ratios of needle stick injuries, which increased by 2%-3% for each sharp used in a week. The use of protective equipment and precautions was higher among physicians. The use of safety precautions was found to be suboptimal in general and underreporting was common.(22)

Another study looked at occupational exposures to potentially infectious materials in a large dental teaching institution. The total number of documented body fluid exposures were 504. Ninety eight percent were percutaneous and 2% were mucosal. Additionally, 82.1% of the cases occurred among dental students, and 11.9% occurred among other supporting staff. Regarding the risk factors of the exposure, the majority of the cases (54.5 %) occurred post-operatively, and most occurred during instrument clean-up.(24)

A survey-based study published in 2014, performed by Swary et al., surveyed a sample of 142 dermatology residents from 44 residency programs in the United States and Canada. The study focused on self-reported rates of dermatology residents committing errors and identifying local systems errors. It was shown in this study that 45.2% of respondents failed to report needle-stick injuries that occurred during procedures, this emphasizes the need for specific curricula and safety systems development to reduce the rate of those injuries and underreporting among residents.(26)

Some studies discussed workload and work related stress as a risk factor for needle stick injuries. In 2002, Clarke et al. analyzed data both retrospectively and prospectively from nurses with needle stick injuries, and found that low staffing and lack of organization in certain units put the nurses at a higher risk of needle stick injuries. The retrospective data was from 732 nurses and the prospective data was collected from 960 nurses. The data were about needle stick injuries over 1-month periods in 1990 and 1991, and were collected on 40 units in 20 hospitals. The results of this study emphasize the role that understaffing, and inadequate administrative support can play in increasing the risk of needle stick injuries.(14)

Merchant et al. conducted a retrospective study among first responders in Rhode Island and found that blood or body fluid exposures were the lowest in October and highest in April, and were lowest at 7 am and highest at 7 pm. this may be explained by work stress at certain times of the day or the year and long working hours.(19)

Gershon et al. published a study to address the risk of body fluid exposure among registered nurses in New York. The rate of needle stick injuries was 13.8 per 100 person years. Only 51% of the injuries were reported and 70% of the exposed nurses did not get post-exposure prophylaxis. The reasons for not reporting were time limitation and lack of information on reporting. Significant correlation was found between the rate of needle stick injuries with patients load and working hours.(21)

Some studies discussed blood born pathogen exposures among home health care workers. Backinger et al. in 1994, collected data from a random sample of 600 home health care agencies in the United States and concluded that agencies with safe sharp using procedures did not have statistically significantly rates of lower needle stick injuries compared to agencies without these procedures.(16)

In a study conducted by Quinn et al., among nine home health care agencies from 2006 to 2007. Results showed that about 35% of nurses had at least one sharp related injury during their career, while 15.1% of nurses had other types of body fluid exposure during their career. It was estimated that about half of the exposures were not reported. (17)

Another study in 2009, Lipscomb et al., found that unlicensed home personal care assistants who were involved in handling sharps and changing wound dressings had a higher risk of sharp related injuries compared to nurses. This indicates that further training and education is required for unlicensed home personal care assistant who are handling sharps.(18)

Prevention and consequences:

Multiple preventive measures can be used to reduce the rate of needle stick injuries including trying to reduce the use of sharps, using needles with safety devices, providing training, educating with adequate resources, and avoiding hand-to-hand passing of sharp instruments. Removing a cap from the needle generally increase the risk of needle stick injuries, so attempts have been made to develop safe needles and needle removers. It was found that the "no-touch" protocols, which include avoiding contact with needles during their use and disposal, is very effective in reducing the rate of needle stick injuries (5). In the operation room and other surgical settings, the use of blunt-tip suture needles reduced the rate of needle stick injuries by about half (5).

Several other recommendations by the American College of Surgeons (ACS) such as double gloving has been directed toward reducing the rate of needle stick injuries and has been found to decrease the risk of needle stick injuries in surgical settings. (5)

They are many short and long term negative consequences of needle stick injuries.

Because of the cost of these consequences, which are very difficult to estimate, safety measures and policies need to be emphasized. The cost of needle stick injuries also include loss of employee time and work productivity, cost of the staff member investigating the injury, cost of laboratory testing, and cost of the treatment if needed.

(6)

In addition to the financial burden on health care facilities, the emotional and psychological stress on the workers and their families can be substantial. Feelings of

anxiety, uncertainty and distress for the period of time including testing and waiting for the results can cause a great emotional pressure. (6)

Multiple studies have focused on safety measures and policies; to address the effects on the rates of injuries. In a 2008 study, by Mathews et al., a mail survey was given to paramedics in the United States, and it was found that access to protective equipment from sharp injuries is a major barrier. The sample included 2588 paramedics, 720 from California. Eighty four percent of participants thought that the protective equipment decreased blood and other body fluids exposures, but the majority thought that safety needles and masks interfered with medical procedures and that using them was a time consuming process. About 20% of the paramedics said that they need more training and education about the use of safety devices and protective equipment.(10)

Gershon et al. (2000), mailed a survey to 150 health care workers with a recent body fluid exposure. The survey revealed satisfaction with the post exposure care but many participants describe the lack of social support during the process of testing and follow up. Due to the low response rate of 43%, further studies need to be conducted in that field to find out about the short and long term consequences of this type of injury.(15)

Alvarado-Ramy et al. published a multicenter study (2003) in which participants that were health care workers of 10 university-affiliated hospitals. The authors found that the phlebotomy safety devices reduced the rates of needle stick injuries compared to conventional devices. The use of safety devices was associated with the preference and training among health care workers.(23)

Infection risk and post exposure prophylaxis:

Needle sticks injuries put workers at great risk of getting blood borne pathogen infections and cause a significant risk of serious illness among health care employees. Blood borne pathogens are defined as microorganisms that are present in human blood and can cause infections in humans upon exposure. The most important blood borne pathogens are Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV). Despite the adoption of multiple policies and safety measures, needle stick injuries among health care workers remain an important problem, but there is an increased awareness of the issue and increase use of safety measures. (3, 4)

In the various health care settings, blood-borne pathogen exposure is a serious issue and transmission can occur by percutaneous or mucosal exposure to bodily fluids of infected patients. Transmission of about twenty pathogens by needle stick injuries has been reported. The risk of HIV, HCV and HBV transmission after a needle stick injury is around 0.3%, 3%, and 30%, respectively. Health care facilities usually have a complete system with clear written instructions for reporting such injuries, then testing, counseling, treatment, and follow-up of injured workers. (7)

Post-exposure prophylaxis (PEP) means taking antiretroviral medications soon after the exposure of infected body fluids, to prevent the occurrence of that infection. It can decrease the rate of HIV infection in exposed individuals by about 79%, though it is not 100% effective. PEP should begin within 72 hours after the exposure to HIV. Treatment with two or three antiretroviral should continue for at least four weeks. These

medications have serious side effects and may be difficult to tolerate, and treated individuals should be monitored closely. (8)

Multiple studies discussed infection risk and post exposure prophylaxis, Gershon et al. (2007) did a cross-sectional study among health care workers in the correctional systems in three states during 1999-2000. Among the 310 individual participating in the confidential self-administered questionnaire, the rate of sharp related injuries were 32 per 100 person-years in workers overall and higher (42 per 100 person-years) for workers with clinical duties. Serologic markers of hepatitis B virus infection were found in 10% of the participants, and the prevalence of hepatitis C virus infection was 2%. Underreporting was a problem, as only 49% of the participants officially reported the injuries.(11)

Ciesielski et al. (2001) did a review of data reported through December 2001 in the National Surveillance for Occupationally Acquired HIV Infection and found that among the 57 reported cases, 86% were exposed to blood and 88% were due to needle stick injuries, most cases (41%) occurred after a procedure, 35% occurred during a procedure, while 20% of the cases occur during the disposal of the used needles. Most cases (69%) had acquired immunodeficiency syndrome (AIDS) at the time of exposure, but about (11%) of the cases remained asymptomatic despite being HIV positive. Of the exposed healthcare workers, 14% became infected despite receiving the appropriate prophylaxis.(13)

Rogowska-Szadkowska et al. (2010) published a study about the nurses' awareness of the risks of HIV, hepatitis B and hepatitis C infections during performing their clinical duties. The author of this study developed a confidential questionnaire that was distributed to a sample of nurses in 2008, and found that only 64% of the respondents occasionally recapped the used needles despite knowing that this procedure is obligatory at the ward.(25)

Policies and legislations:

Several policies are adopted by the federal, states, and local healthcare authorities regarding needle stick injury prevention. In 1992, the Occupational Safety and Health Administration (OSHA) proposed its Blood borne Pathogen Standard, which is a universal precaution, focusing on handling human blood and other potentially infectious materials, engineering standards, employer education and training, and using personal protective equipment (PPE).(1) The federal Needle Stick Safety and Prevention Act was signed at that time. In 2000, 21 states adopted legislations for evaluation and implementation of safer sharps devices used by healthcare workers. Making policy changes are not enough, so William J. Haddon developed an epidemiological model that may help to think about those injuries in pre-event, event, and post-event phases. Thinking about the problem in the context of Haddon's matrix suggests risk factors for those injuries and preventive efforts that can help reduce the rate of occurrence of these injuries in the future (2). Despite the improvement in needle stick injuries prevention and control measures, there is still much more to be accomplished. The OSHA Blood borne Pathogen Standard requires all employers to report and maintain a

record of all needle sticks or sharps devices injuries, but we continue to have a problem of underreporting needle stick injuries. This an area for public health improvement; reinforcement of those policies and their implementation in health care facilities may help to reduce this problem. (1)

Trapé-Cardoso et al. conducted a five-year review at University of Connecticut Health Center and found that the incidence rates of percutaneous injuries declined among medical students and the nursing staff, but less for residents from 2000 to 2004. It is believed that active surveillance and periodic review of interventions play an important role in this reduction.(12)

In 2008, an article by Jagger J et al. discussed the history of U.S. policies regarding occupational blood exposures and the effect of safety engineering devices on the rate of needle stick injuries over a 20 years period, the rate of sharp related injuries among health care workers declined by 34% overall and 51% in nurses.(20)

The number of cases of needle stick and sharps-related injuries among healthcare workers are difficult to estimate due to underreporting. Multiple research studies have been done in this area but the scale of the problem is substantial and requires further attention.

Methods:

Research questions and objectives of the study:

1. Examine the rates of needle stick vs splash related injuries among University of Kentucky health care workers from 2009 to 2014.
2. Describe the distribution of needle stick and splash injuries by job categories and location of occurrence in the health care setting.
3. Examine the distribution of reported injuries by previous exposure, wearing protective equipment, type of the exposure, source of the bodily fluids and severity of the injury.
4. Assess predictive factors, such as year of exposure, previous exposure, wearing protective equipment, job categories and location, for the risk of certain types of exposures (sharp, splash or both)

Sample:

Data were obtained from the University of Kentucky Health Service. The data represent 2,819 cases of blood and body fluids exposures among health care workers at the University of Kentucky for the period from 2007 to 2014.

Study design:

This is a cross sectional study of the data from the University of Kentucky Health Service self-reported survey among health care workers with blood born pathogen exposures. All UK Health Care hospitals including: University of Kentucky Chandler Medical Center, Good Samaritan, Eastern State and the University of Kentucky Health

Care ambulatory clinics, are included in the study. Any UK worker is supposed to report a Blood borne Pathogen Exposure (BBE). The data also includes BBE that have occurred in the dorms, and to UK housekeeping employees (that sustained a needle stick due to improper disposal of diabetic testing lancets and insulin needles). All data are currently entered by one nurse into the database (see attached form in the appendix). However, prior to 2005, the data were entered into the database by an administrative assistant. Quality control checks of the data have been limited. The data are obtained to comply with the regulations of the Blood borne Pathogen Standard, 29 C.F.R. 1910.1030, set forth by OSHA December 6, 1991. IRB approval was obtained from the University of Kentucky.

Data analysis:

Univariate descriptive statistical analysis on the trends of exposure rates stratified by job categories and location of exposure were described. Linear regression (beta coefficients) was used to describe the trend of the reported blood born pathogen BBP exposure cases among the University of Kentucky (UK) health care workers from 2007 to 2014, and rate of needle stick injuries vs splash related exposures among UK health care workers from 2009 to 2014. Rates were calculated based on the annual exposure per 100 daily occupied beds (the denominator was the average daily occupied beds in UK health care facilities for 2013 to 2014).

Cross tabulation between the types of exposure (sharp, splash, both) and previous BBP exposure, wearing PPE, job categories, year of injury and locations of

occurrence were created; a chi-square test was used to determine if the association between the type of exposure and the covariates were statistically significant. Logistic regression was used to examine the strength and the direction of effect of those variables on the type of exposure {type of exposure= β (Wearing PPE) + β (previous BBP exposure) + β (Job category) + β (Location of injury) + β (Year)}, and calculate the adjusted odds ratios (ORs).

The missing variables were deleted from the data. For the purpose of running a logistic regression model and because there are too many variables for the number of observations and many of those variables have sparse categories, we removed the (both) category from the Exposure type variable and collapsed the Location of injury variable into five categories. The outcome of the dependent variable (Type of the exposure) in our logistic regression model was categorized as either a sharp or splash injury.

All analyses were performed using SPSS statistical software (27). Descriptive analysis was completed with means, frequencies, and percentages calculated to provide a clear description about the distribution of injuries among different job categories and locations of occurrence. The relation between the type of injury and other variables was assessed using a logistic regression model. The odds ratios and 95% confidence intervals (CI) were estimated for each variable, including job category, location of occurrence, previous exposure, wearing protective equipment and injury year.

Variables:

The effect of several variables such as job category, location of exposure, and previous exposure on the rate of exposure were examined. The severity of exposure was also described. Certain studied variables were related to health care workers reporting the BBP exposure cases, such as previous exposures and wearing personal protective equipment, while other variables were related to the type of exposure such as exposure type, source of the body fluids and the severity of the injury. Other variables that are only related to splash injuries were described such as wearing a gown, mask and gloves.

Results:

The number of the reported blood born pathogen (BBP) exposure cases increased gradually from 304 to 420 cases between 2007 to 2012, then decreased again to 314 in 2014 (Figure 1). The rate of needle stick injuries ranged from 40.92 per 100 beds in 2009-2010 to 44.67 per 100 beds in 2013-2014, with a mean of 46.86 and standard deviation of 6.88. This is higher than the rates of splash related injuries that ranged from 14.72 in 2009-2010 to 12.28 in 2013-2014, with a mean of 14.88 and

standard deviation of 3.68. Rate is calculated as the annual exposure per 100 daily occupied beds (Figure 2).

The rates of blood born pathogen related injuries stratified by job categories and location of occurrence given in Table 1. The highest proportion of reported injuries was among nurses (32.4%), followed by medical interns/residents/fellows (17.0%), medical attending (13.1%), nursing care technician (7.6%), then dental students (5.6%), while the rate among medical students was 4% . Regarding the location of occurrence of the injuries, most of the injuries occurred in the operation room (27.1%), patients' room (19.6%) and the intensive care unit (16.6%), followed by 8.7% of the cases in the emergency room then 7.9% in the dental clinic (Table 2).

The majority of those cases were sharp related injuries (74.1%). Workers with previous exposures were identified in 41.9% of the cases (Table 3) and source of the body fluid was known in 93.3% of the reported exposures (Table 4). An estimated 90.4% of the exposed individuals were wearing personal protective equipment during the incident (Table 3) which may be an overestimation because of self-reporting bias.

Gloves were worn in 77.3% of the cases while double gloving was reported in only 13.4% of the cases. Gowns were worn by 51.2% of the exposed individuals. Wearing a mask is an important measure to decrease splash exposures to the mouth and the eye, and was noted in 39.9% of the cases. An estimated 56.4% of the reported cases were recorded as superficial, 17.6% recorded as moderate and 1.3% as severe (Table 4).

Table 1. Number of blood born pathogen exposure BBP cases and their percentages stratified by job categories (from 2007 to 2014)

Job category	Number of reported BBP exposure cases (N)	Percent (%)
Nurses	912	32.4
Medical (residents/interns/fellows)	479	17.0
Medical doctors	368	13.1
Nursing care technicians	214	7.6
Dental students	157	5.6
Medical students	112	4.0
OR technician	102	3.6
Others	436	15.3
Missing data	39	1.4
<i>Total</i>	2819	100

Table 2. Number of blood born pathogen exposure BBP cases and their percentages stratified by location of exposures (from 2007 to 2014)

Location of exposure	Number of reported BBP exposure cases (N)	Percent (%)
Operative room OR	764	27.1
Patients' room	552	19.6
Intensive care unit ICU	467	16.6
Emergency room ER	245	8.7
Dental clinic	224	7.9
Outpatient clinic	98	3.5
Pathology/autopsy	37	1.3
Others	393	13.9
Missing data	39	1.4
<i>Total</i>	2819	100

Table 3. Characteristics related to health care workers reporting the BBP exposures cases from 2007 to 2014

	Number of reported BBP exposure cases (N)	Percent (%)
Previous BBP exposures		
Previous exposure	1182	41.9
No previous exposure	1569	55.7
Missing data	68	2.4
Total	2819	100
Wearing personal protective equipment PPE		
Wearing PPE	2547	90.4
Not wearing PPE	176	6.2
Missing data	96	3.4
Total	2819	100

Table 4. Characteristics related to the type of exposure in the reported blood born pathogen exposure cases (from 2007 to 2014)

	Number of reported BBP exposure cases (N)	Percent (%)
Exposure type		
Sharp exposure	2090	74.1
Splash/contact exposure	623	22.1
Both types of exposure	2	0.1
Missing data	104	3.7
Total	2819	100
Source of body fluids involved		
Known source	2631	93.3
Unknown source	127	4.5
Missing data	61	2.2
Total	2819	100
Severity of sharp injuries		

Superficial	1590	56.4
Moderate	495	17.6
Severe	36	1.3
Missing data	698	24.8
Total	2819	100

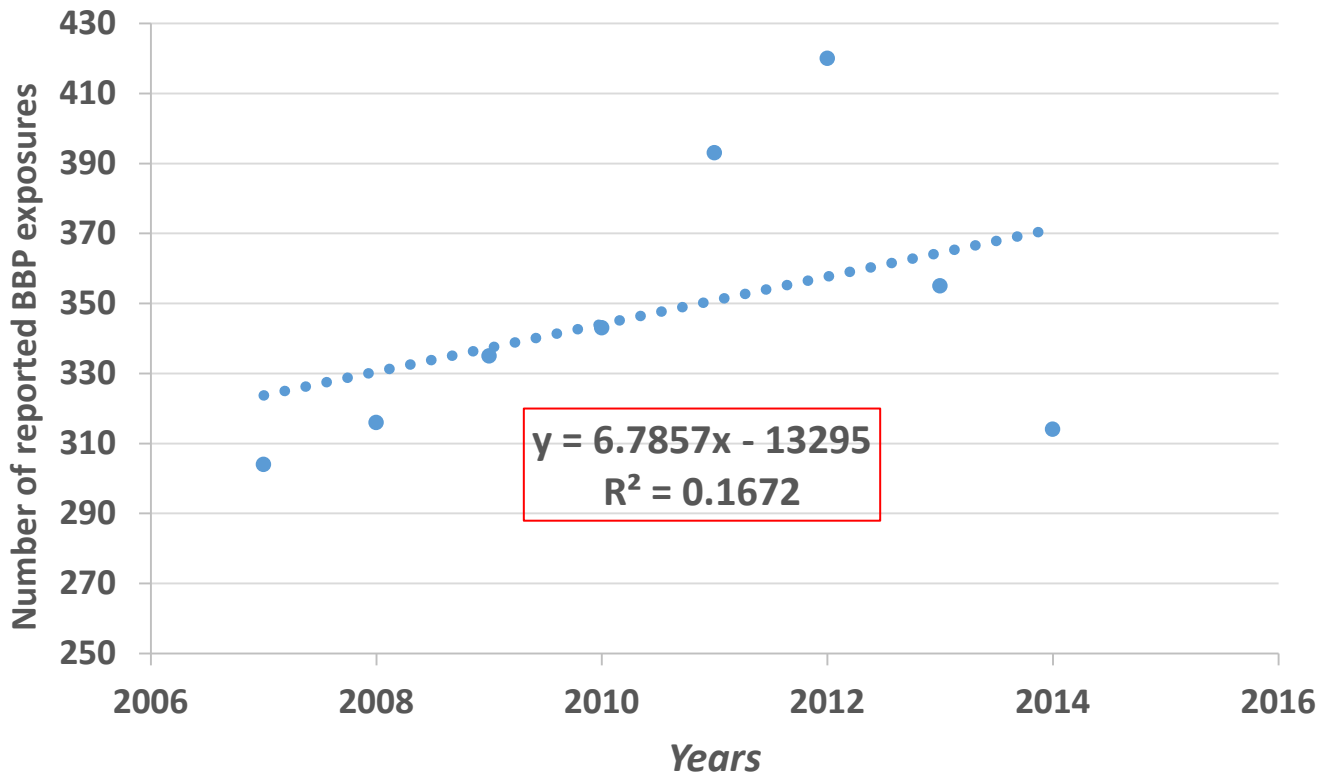


Figure 1. Number of reported blood born pathogen BBP exposure cases among the University of Kentucky (UK) health care workers from 2007 to 2014

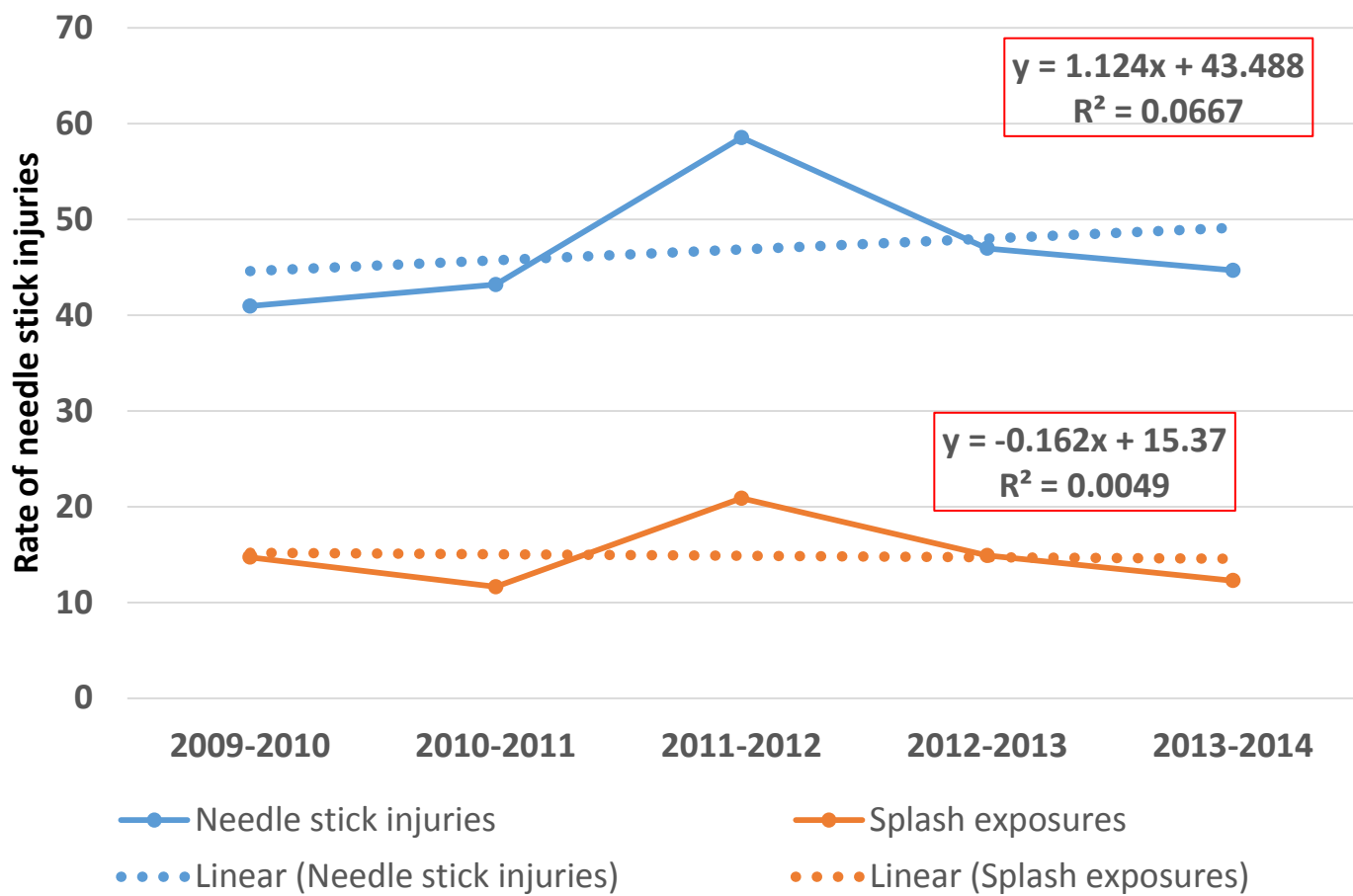


Figure 2. Rate* of needle stick injuries vs splash exposures among UK health care workers from 2009 to 2014

* Rate= annual exposure per 100 daily occupied beds

Chi-square and logistic regression analysis:

Cross tabulation were performed to examine the relationship between the exposure type (sharp, splash and both) and variables such as wearing PPE, previous BBP, job categories, locations of injury and injury year. Chi-square testing was used to examine the association between those variables and exposure type. The association between exposure type and the following variables (wearing PPE, previous BBP, job categories and locations of injury) was statistically significant (P value < 0.0001) while the association between exposure type and injury year was not statistically significant (P value= 0.321). (See Tables 5-9)

A logistic regression model was used to describe the relationship between those variable and exposure type, [type of exposure= β (Job category) + β (Location of injury) + β (Previous BBE) + β (Wearing PPE) + β (Injury year)]. Adjusted odds ratio were calculated for splash injuries compared to sharp injuries (referent).

The outcome of the exposure type in this model was either sharp or splash exposure. Regarding the year of the injury, all odds ratios were not statistically significant. Workers with previous BBP exposure were less likely to have splash exposure compared to sharp injuries (OR=0.783, 95% C.I=0.637-0.963). The odds ratio for workers wearing PPE was not statistically significant. Regarding the location of injury, all odds ratios were statistically significant except the odds ratio for the emergency room (ER). Workers in the ICU were more likely to have splash injuries compared to sharp injuries

(OR=1.537, 95% C.I.=1.161-2.035), while splash injuries were less likely in all other locations. Regarding the job categories, all odd ratios were statistically significant except those for nurses and nursing care technician. Splash injuries compared to sharp injuries were less likely in all job categories. (See table 10)

Table 5. Cross sectional table between the cases of workers wearing personal protective equipment (PPE) vs EXPOSURE TYPE

Wearing PPE?	EXPOSURE TYPE		
	SHARP N (%)	SPLASH N (%)	TOTAL
YES	1920 (72.12)	568 (21.33)	2490
NO	127 (4.77)	45 (1.69)	172
TOTAL	2047	613	2662

P value < 0.0001

***P value <0.05 is considered statistically significant**

***The number of cases in the both category is 2**

***Odds ratio=1.19**

Table 6. Cross sectional table between the cases of workers with previous blood born pathogen (BBP) exposure vs EXPOSURE TYPE

Previous BBP exposure?	EXPOSURE TYPE		
	SHARP N (%)	SPLASH N (%)	TOTAL
YES	880 (32.72)	270(10.04)	1152
NO	1192 (44.33)	345(12.83)	1537
TOTAL	2072	615	2689

P value < 0.0001

***P value <0.05 is considered statistically significant**

*** The number of cases in the both category is 2**

***Odds ratio=0.94**

Table 7. Cross sectional table between JOB CATEGORIES vs EXPOSURE TYPE

JOB CATEGORIES	EXPOSURE TYPE		
	SHARP N (%)	SPLASH N (%)	<i>TOTAL</i>
Nurses	602(22.17)	286(10.53)	<i>889</i>
Medical (residents/interns/fellows)	390(14.36)	81(2.98)	<i>471</i>
Medical doctors	304(11.19)	56(2.06)	<i>361</i>
Nursing care technicians	141(5.19)	64(2.35)	<i>205</i>
Dental students	143(5.26)	7(0.25)	<i>150</i>
Medical students	95(3.49)	15(0.55)	<i>110</i>
OR technician	93(3.42)	9(0.33)	<i>102</i>
Others	322(11.86)	105(3.86)	<i>427</i>
<i>TOTAL</i>	<i>2090</i>	<i>623</i>	<i>2715</i>

P value < 0.0001

***P value <0.05 is considered statistically significant**

*** The number of cases in the both category is 2**

Table 8. Cross sectional table between the LOCATION OF INJURY vs EXPOSURE TYPE

LOCATIONS OF INJURY	EXPOSURE TYPE		
	SHARP N (%)	SPLASH N (%)	TOTAL
Operative room OR	639 (23.53)	114(4.19)	753
Patients' room	373(13.73)	157(5.78)	531
Intensive care unit ICU	274(10.09)	181(6.66)	456
Emergency room ER	186(6.85)	57(2.09)	243
Dental clinic	206(7.58)	10(0.36)	216
Outpatient clinic	84(3.09)	11(0.4)	95
Pathology/autopsy	33(1.21)	4(0.14)	37
Others	295(10.86)	89(3.27)	387
<i>TOTAL</i>	<i>2090</i>	<i>623</i>	<i>2715</i>

P value < 0.0001

***P value <0.05 is considered statistically significant**

*** The number of cases in the both category is 2**

Table 9. Cross sectional table between the INJURY YEAR vs EXPOSURE TYPE

INJURY YEAR	EXPOSURE TYPE		
	SHARP	SPLASH	TOTAL

2007	240	59	299
2008	253	57	310
2009	243	81	325
2010	264	71	335
2011	285	97	382
2012	316	99	415
2013	259	88	347
2014	230	71	302
TOTAL	2090	623	2715

P value =0.321

***P value <0.05 is considered statistically significant**

*** The number of cases in the both category is 2**

Table 10. Logistic regression model [type of exposure* = β (Job category) + β (Location of injury) + β (Previous BBE) + β (Wearing PPE) + β (Injury year)]

Covariates	β	Exp(β)= OR ^{**}	95% Confidence interval for OR
Job category			
Nurses	-0.632	0.532	0.254-1.114
Medical (residents/interns/fellows)	-1.209	0.298	0.137-0.651
Medical doctors	-1.223	0.294	0.132-0.656
Nursing care technicians	-0.559	0.572	0.259-1.261
Dental students	-2.369	0.094	0.032-0.277
Medical students	-1.225	0.294	0.116-0.743
OR technician	-1.667	0.189	0.067-0.529
Others	Reference	1	-
Location of injury			
Operative room OR	-0.536	0.586	0.415-0.824
Patients' room	***	***	***
Intensive care unit ICU	0.43	1.537	1.161-2.035
Emergency room ER	0.208	0.812	0.559-1.179
Others	Reference	1	-
Previous BBP exposure			
No previous BBP exposure	-0.224	0.783	0.637-0.963
Previous BBP exposure	Reference	1	-

Wearing PPE			
Not wearing PPE	0.018	1.018	0.698-1.485
Wearing PPE	Reference	1	-
Injury year			
2007	-0.158	0.854	0.556-1.312
2008	-0.268	0.765	0.503-1.164
2009	0.145	1.156	0.782-1.709
2010	-0.164	0.849	0.572-1.260
2011	0.096	1.101	0.757-1.6
2012	0.078	1.081	0.747-1.567
2013	0.170	1.185	0.811-1.732
2014	Reference	1	-

***Type of exposure= sharp vs splash injury**

**** The reference category are sharp injuries**

***** Very small number (less than 0.0001)**

Pseudo R square (Cox and Snell) =0.085

Hosmer Lemeshow goodness of fit test=235.7

Discussion:

Our data showed that the rate of reported blood/body fluid exposures among health care workers at the University of Kentucky have been nearly stable over the last few years (between 2008 to 2014) (figure 1, figure 2). We could not obtain the rate prior to 2009 but we had the number of the reported cases. We were unable to calculate the rate prior to 2009 because the lack of information about the hospital occupied beds (the denominator for the rate). The rate of needle stick injuries and splash exposures at UK hospital in 2009-2010 was almost double the national rate reported by the exposure prevention information network (EPINet), which is a group of hospitals that voluntarily

report information about their exposed workers, in the same period. Unfortunately, we did not have enough information about the rate of reporting of those cases among the university health care workers. (28)

Regarding other variables, comparing percentages to what was found in other studies is very difficult due to the unknown factor of underreporting but in general the percentage of splash related exposures was much lower than what was reported in the other studies. In term of ranking job categories and locations of occurrence with the highest rates of injuries, medical students ranked lower than what was found in most studies and also patients' room ranked higher than the ICU which is different than reported in other studies. This may be attributed to better preventive measures in the ICU and among medical students or due to the underreporting issues. Otherwise, results from this study were similar to other studies, the majority of the cases occur in the inpatient setting. The type of exposure (sharp vs splash) was found to be affected by various factors like previous exposure, wearing protective equipment, job category and location of injury. The strength and the direction of this relationship varies within those categories.

Workers with previous BBP exposure were less likely to have splash exposure compared to sharp injuries (OR=0.783, 95% C.I=0.637-0.963). Regarding the location of injury, all odds ratios were statistically significant except the odds ratio for the emergency room (ER). Workers in the ICU were more likely to have splash injuries compared to sharp injuries (OR=1.537, 95% C.I=1.161-2.035), while splash injuries were less likely in all other locations. Regarding the job categories, all odd ratios were

statistically significant except those for nurses and nursing care technician. Splash injuries compared to sharp injuries were less likely in all job categories. (See table 10)

Limitation:

Limitations of this study include missing data especially in the sections of previous exposure, wearing protective equipment and severity of the injury, due to inadequate reporting and incomplete filling of the questionnaire. Also, the results reflect only the reported cases, which can be an underestimation because many cases go unreported. Also, the denominator to calculate the rate of blood and body fluids exposure can be a controversial issue, some authors used the total number of occupied hospital beds, representing the population at risk for exposure, while others used the total number of cases as a denominator. Our sample represents the total number of cases for exposure (including repeated exposures) and not the number of exposed health care workers, but we address previous exposure to blood and body fluid exposure as a risk factor for future exposures.

Self-reporting bias is another major problem with this data, since this can lead to overestimation of the results in certain categories, especially wearing the personal protective equipment and gloving. Answering the used questionnaire depends on both the nurse and the exposed individual, who may tend to forget important details under a stressful situations which can lead to recall bias.

Missing data was an issue in certain categories, we recommend that the University of Kentucky health service improve their reporting process by adding more

information to the questionnaire like time of the injury, working hours and previous training, and ensuring adequate completion and answering to all the questions in the survey, also some questions about the severity of exposure are subjective and need more clarification. The injury, in this data, is usually considered superficial unless pressure is required to stop the bleeding then it is considered moderate, if the injury is by scalpel or blade then it may be considered severe depending on the depth, all that is up to the subjective assessment of the nurse and the exposed individuals.

Future directions:

We need to emphasize the need of training and education about the use of safety measures among certain job categories and health care workers in certain locations. Training and education about BBP exposure is usually provided to all new employers but probably refreshing courses should be considered especially to workers at high risk for this type of exposure. We need to direct our limited resources to improve safety measures and decrease the rate of needle stick injuries and other body fluids related exposures. This will have a great impact on decreasing both the emotional stress and the financial cost of those injuries in health care workers. On the other hand, expanding the questionnaire and adding more questions can be a time consuming process and may affect the rate of injuries reported.

The reporting system for blood born pathogen exposure at the University of Kentucky needs improvement. In addition to issues of missing data, and lack of confidentiality which may lead to underreporting the number of exposures in general or over reporting

of certain variables like wearing protective equipment, other problems exist regarding the questions in the survey like the subjectivity of some questions and the limited information obtained from it. Conducting an anonymous survey can help in showing a better picture about trends and patterns of injuries at the University of Kentucky health care facilities.

Conclusion:

Future studies need to be done to see what we can do to improve the reporting of those injuries and exposures, and appropriately estimate their short and long term negative consequences. Also, more prospective studies need to be done to evaluate the effect of various safety measures and educational interventions on the rate of those injuries, so a lot needs to be explained and evaluated in this important public health area.

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Acknowledgement:

Thank you to Dr Black and all his staff in the University of Kentucky (UK) student health service (Nurse Joey) and UK IT department (Cheryl) for their help in this project.

Appendix:

Attached is a Sample of university health service blood born exposure surveillance program

UNIVERSITY HEALTH SERVICE

830 South Limestone Street
Lexington, KY 40536-0582

BLOOD-BORNE EXPOSURE SURVEILLANCE PROGRAM

Employee / Student: Complete items 1-9.

1. Date of injury: _____ Time: _____
2. Department in which you are employed: _____
3. Job category: (Check one)

<input type="checkbox"/> Anesthesia Technician	<input type="checkbox"/> Dentist	<input type="checkbox"/> Med Student 1 2 3 4	<input type="checkbox"/> Nursing Care Tech	<input type="checkbox"/> Physical Plant Worker
<input type="checkbox"/> Med/Lab Technician	<input type="checkbox"/> Equipment Technician	<input type="checkbox"/> Nurse	<input type="checkbox"/> Nursing Student	<input type="checkbox"/> Physician Assistant
<input type="checkbox"/> Dental Hygienist/Asst	<input type="checkbox"/> Housekeeping	<input type="checkbox"/> Nurse Anesthetist	<input type="checkbox"/> OR Technician	<input type="checkbox"/> Radiology Technician
<input type="checkbox"/> Dental Student 1 2 3 4	<input type="checkbox"/> MD/Attending	<input type="checkbox"/> Nurse Practitioner	<input type="checkbox"/> Phlebotomist	<input type="checkbox"/> Respiratory Therapist
	<input type="checkbox"/> MD/Intern/Resident/Fellow			<input type="checkbox"/> Other: _____
4. Where did injury occur? (Room #/Floor) _____

<input type="checkbox"/> Central Sterile	<input type="checkbox"/> Dental Sterilization	<input type="checkbox"/> ICU	<input type="checkbox"/> Pathology/Autopsy	<input type="checkbox"/> Patient unit (outside room)
<input type="checkbox"/> Clinical Lab	<input type="checkbox"/> Dialysis	<input type="checkbox"/> OR/Endoscopy/L&D	<input type="checkbox"/> Patient home	<input type="checkbox"/> Service/Utility area
<input type="checkbox"/> Dental Clinic	<input type="checkbox"/> Emergency Room	<input type="checkbox"/> Outpatient Clinic	<input type="checkbox"/> Patient room	<input type="checkbox"/> Other: _____
5. Type of exposure: A. Sharps injury B. Splash/contact exposure
6. Sharps injury? Yes No If yes, complete A-H and skip #7. If no, go to #7.
 - A. What type of sharp was it? (Size if known) _____

<input type="checkbox"/> Blood gas syringe	<input type="checkbox"/> Dental instrument	<input type="checkbox"/> Lancet	<input type="checkbox"/> Scissors	<input type="checkbox"/> Vacutainer needle
<input type="checkbox"/> Butterfly needle	<input type="checkbox"/> Glass	<input type="checkbox"/> Needle (Type _____)	<input type="checkbox"/> Spinal/epidural	<input type="checkbox"/> Other: _____
<input type="checkbox"/> Capillary tube	<input type="checkbox"/> IV catheter	<input type="checkbox"/> Scalpel blade/knife	<input type="checkbox"/> Suture needle	<input type="checkbox"/> Unknown
 - B. For what purpose was the item used?

<input type="checkbox"/> Body fluid/tissue	<input type="checkbox"/> Dental procedure	<input type="checkbox"/> Injection	<input type="checkbox"/> Start IV	<input type="checkbox"/> Suturing
<input type="checkbox"/> Connect/flush IV	<input type="checkbox"/> Draw blood	<input type="checkbox"/> Insertion of deep line	<input type="checkbox"/> Surgery	<input type="checkbox"/> Other: _____
				<input type="checkbox"/> Unknown
 - C. When or how did the injury occur?

<input type="checkbox"/> After use	<input type="checkbox"/> During use	<input type="checkbox"/> Preparing for reuse	<input type="checkbox"/> Putting into disposal	<input type="checkbox"/> Other: _____
<input type="checkbox"/> Disassembling/cleaning	<input type="checkbox"/> Inapp. trash container	<input type="checkbox"/> Protruding from needlebox	<input type="checkbox"/> Recapping	
 - D. Was the injured person the original user of the item? Yes No
 - E. Was the item used a safety design? Yes No N/A
 - F. Name / brand used: _____
 - G. Was the safety device activated? Yes No N/A
 - H. Did exposure incident happen: Before During After Activation
 - I. Was the injury: Superficial Moderate Severe
7. Splash/contact exposure? Yes No If yes, complete A-C. If no, go to #8.
 - A. Which body fluids were involved?

<input type="checkbox"/> Blood	<input type="checkbox"/> Pleural	<input type="checkbox"/> Urine	<input type="checkbox"/> Unknown
<input type="checkbox"/> Sputum	<input type="checkbox"/> Vomitus	<input type="checkbox"/> CSF	<input type="checkbox"/> Amniotic
			<input type="checkbox"/> Other
 - B. Amount of fluid: Small Moderate Large
 - C. Which body part(s) was exposed? Eyes Nose Mouth Non-intact skin Intact skin Other
8. Was the exposed person wearing personal protective equipment? Yes No N/A
 Type: Gloves Double Gloved Goggles Gown Mask Mask w/face shield
9. Was the wound/area cleaned? Yes No Alcohol/Betadine Soap

<input type="checkbox"/> Water/Saline	<input type="checkbox"/> Bleach	<input type="checkbox"/> Peroxide	<input type="checkbox"/> Hand Gel	<input type="checkbox"/> Other
---------------------------------------	---------------------------------	-----------------------------------	-----------------------------------	--------------------------------

Signature: _____

To be completed by UHS staff:

10. Employee health history:

A. Received HBV:	<input type="checkbox"/> Yes <input type="checkbox"/> No	# of Doses: _____	Date(s): _____
B. HBsAB Tested:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Date: _____	Results: _____
C. Previous Blood-Borne Exposure:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Date: _____	
D. History of Hepatitis:	<input type="checkbox"/> Yes <input type="checkbox"/> No	Type: _____	Date: _____
11. Employee Treatment / Labs:

A. PEP meds:	Other: _____	PEP med info given: _____
B. <input type="checkbox"/> HBsAB <input type="checkbox"/> HBsAG <input type="checkbox"/> HBcAB <input type="checkbox"/> HCV <input type="checkbox"/> HIV <input type="checkbox"/> Chem 18 <input type="checkbox"/> CBC <input type="checkbox"/> Follow-up Guidelines	Other: _____	

SOURCE PATIENT INFORMATION:

1. Unknown Known Location: _____ MR#: _____
2. Was patient a known positive for: Hepatitis B Hepatitis C HIV High risk behavior? _____
3. Labs drawn on patient:

Test	Result	Date Reviewed	Not ordered – Why?
HBsAG			
HIV			
HCV			

Initial evaluation summary letter given to patient

Signature: _____

Source labs reviewed w/patient

Date: _____

forms.Blood-borne exp surv prog
rev JPapst 4/6/07; 8/13/09;8/29/14