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I, JAMES E. REEB,

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This work and its defense approved by:

Chair: Carol Kim

Michael J. Alleger Ph.D.

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BY

James E. Reeb

B.A., Miami of Ohio, 1993

Committee Chair: Carol H. Rice, Ph.D.

Abstract

This investigation evaluated whether an active learning focused (ALF) training session resulted in better retention of the knowledge presented and/or self-reported behavioral changes in attitudes and work practices compared to a comparison group that was passively trained by reading through the same ALF training materials. The knowledge of trainees was evaluated prior to and immediately following training sessions conducted in 2002 and 2003. An overall positive trend was observed of higher scores and retention on select measures for the group that participated in the ALF training over the four time periods measured. Data suggests that ALF training has produced more self-reported attitudinal/perceptual changes (69%) than behavioral changes (55%). Due to differences in employment history, no statistical comparisons were made between the ALF and comparison groups. Selection of a more appropriate comparison group should be a part of any additional follow-up research.

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1.0 PURPOSE and HYPOTHESIS

1.1 PURPOSE

The purpose of this investigation was to evaluate whether active learning focused training (conducted one year prior) resulted in outcomes of better retention of the knowledge and higher self-reported behavioral changes in attitudes and work practices compared to a comparison group that was passively trained by simply reading through the same training materials used in the ALF training.

1.2 HYPOTHESES

Active learning focused training produces better retention of knowledge compared to a comparison group that was passively trained by simply reading through the same training materials used in the active learning focused training.

Active learning focused training produces more self-reported behavioral changes compared to a comparison group that was passively trained by simply reading through the same training materials used in the active learning focused training.

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2.0 BACKGROUND

Every year, United States employers spend billions of dollars on training and workplace development programs for their employees. In 2001, approximately 54.2 billion dollars were budgeted for such training (Training, 2002). Given that so much money is spent annually on training, it is important to understand the factors behind the effectiveness of different training techniques so that valuable resources are spent in a manner that produces the most return on investment. Ideally, training will result in a more knowledgeable workforce that is able to apply knowledge and concepts to improve job performance and reduce exposures to workplace hazards.

One significant aspect of job performance is the attitudes and behaviors of employees in regards to health and safety. Effective health and safety training should inform employees and empower them with some of the knowledge and responsibility for protecting their health and safety on the job. Ideally such training will result in fewer injuries, illnesses and deaths in the occupational setting.

A previous investigation by Wolbers (2002) compared the effectiveness of a training session that employed active learning focused (ALF) training techniques versus a lecture/slide show-type training session. These ALF training techniques allowed each student to be involved through active participation in the learning process. Using teaching methods that included two simulations, each person in the ALF training session performed a task being taught and reviewed by the instructor.

The first simulation was an exercise where each trainee cleans up a simulated blood spill from a table. The instructor goes through the proper steps to safely clean up the spill while the trainees follow along. The second simulation was an exercise where each trainee responds to a simulated exposure to blood. A small amount of simulated blood is placed on their arm and once again the instructor takes the trainees through the proper steps to safely clean off the spill and the steps they need to take if they have been exposed to a blood including notification of their supervisor, their employer, and health services.

This type of active training is in contrast to a lecture/slide training session where a speaker typically presents information to a group of individuals who passively listen with no participation in the training per se, except perhaps for brief, verbal interaction during or at the end of the session.

The purpose of Wolbers' study was to find out whether this type of training would result in changes in the trainee's self-efficacy in regard to the learning objectives developed from the Occupational Safety and Health Administration's (OSHA) bloodborne pathogen (BBP) training requirements (29CFR1910.30). Simply put, self-efficacy refers to an individual's confidence that they have the knowledge and skills to perform a task (Bandura 1986).

Wolbers' hypothesis was that a positive change in self-efficacy would occur in these trainees, consistent with the theory that adults learn best when their learning is self-directed, active, and engaging (learning by doing), relevant to their experience, and

immediately relevant to their work (Knowles, 1990; Wallerstein *et al.*, 1993). In addition Wolbers wanted to find out if this change was more than these trainees gained from previous BBP work experience and previously attended pedagogical lecture/slide BBP training sessions.

The target audience for Wolbers' training was eighteen university laboratory workers who had a potential for an occupational exposure to bloodborne pathogens. While work duties, exposures and years of experience on the job were varied among the trainees, all the workers had been employed at the university long enough to have attended one previous lecture/slide show-type bloodborne pathogen training session administered by the Department of Heath and Safety (H&S) staff. These workers are required to attend BBP training annually to meet the requirements of OSHA's BBP standard.

In the Wolbers' study, the researcher had trainees in both the ALF group and passively trained comparison group complete a Pre- and Post-Training Survey in order to evaluate self-efficacy. Both surveys asked the trainee to rank (choose a number between one and five: one being completely confident and five being completely unconfident) their confidence to perform a particular task. The Pre-Training Survey asked each trainee to rank their confidence to perform tasks before they had any training. The Post-Training Survey again ranked each person's confidence to perform tasks before training was given in addition to their confidence immediately after this training session. Both the Pre- and Post- Training evaluations also included a knowledge check.

A comparison group (that had a potential for occupational exposures to BBPs, but did not take part in the ALF training) also completed the Pre- and Post- Training Survey. This passively trained group was instructed to read independently through a packet of information consisting of the same training materials presented to the ALF group. There was no interaction with a trainer/instructor nor did they participate in any of the simulations that were used with the ALF group. This comparison group was made up of seven full-time employees from the H&S staff at the university.

The following learning objectives were to be accomplished during the ALF training session:

- Comprehension of general risks and consequences of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) exposures
- Application of how to safely clean up a BBP spill
- Application of what to do if exposed to a BBP.
- Analysis of engineering and work practice controls to reduce or minimize potential exposures in their work area
- Analysis of types and limitations of personal protective equipment (PPE) that can protect against BBP in their work area.

These objectives were accomplished using various ALF training techniques to engage the trainees throughout the training session. After introducing himself, the trainer posed the following questions to the group of trainees:

- Why are you here taking this training?
- What is a BBP?
- What is an occupational BBP exposure?
- What is the chance that a body fluid you come in contact with might be infected with a BBP?
- What are some common modes of occupational BBP exposure?
- What is the chance of contracting HBV, HCV, or HIV after an exposure via a needlestick or cut?
- What is the chance of contracting HBV, HCV, or HIV after an exposure via a skin splash?

Each of these questions was copied onto a large flip chart resting on an easel at the front of the classroom. The trainer elicited and steered responses from the trainees until the facts were clear and the correct answers were written on the chart. After each question, the page from the chart was removed from the easel and posted on the wall where it could still be viewed.

The trainer handed out a packet of information that each trainee was encouraged to keep as a reference. These materials included a fact sheet on BBPs, a list of BBP definitions and a HBV vaccine handout. The fact sheet contained detailed information on the health effects, prevalence, risks of contraction, and symptoms for some common BBPs, namely

HIV, HBV, and HCV. The trainer read aloud the information contained on the HBV vaccine handout. This handout detailed the effectiveness of the HBV vaccine, its safety, and how the university must offer this vaccine free of charge to individuals who have a potential for occupational exposures to BBPs.

After a brief review of all the flip charts created during the training session, the trainer continued the training with a simulated BBP spill cleanup and an exposure response session. During this part of the training, each trainee used the steps detailed in a Spill Clean-up Checklist provided to properly clean his or her own simulated blood spill. The trainer demonstrated each step detailing the proper sequence of steps used to clean up a blood spill. Trainees were given the opportunity to clean up their spills as the trainer led them through the steps of the Spill Clean-up Checklist. The trainees also were instructed to splash a small amount of the simulated blood on their arm. The trainer then led them through the steps to properly clean the fake blood from their arms.

At the end of the training session, each trainee was given an Exposure Evaluation Sheet (EES) and instructed to take this back to their work areas. The sheet was designed to identify potential exposures in the work areas, list engineering controls and/or work practice controls that could be used to minimize or eliminate potential exposures, and list PPE available in their work area or PPE that could be obtained to help mitigate potential exposures. Also included was a Container Survey to evaluate the functionality and accessibility/visibility of both the Sharps Disposal Containers as well as the Regulated Waste Disposal Containers in their work areas.

The comparison group completed the same Pre-Training Survey given to the ALF group before refresher training. They were instructed to read independently through a packet of information consisting of the same training materials presented to the ALF group. After they completed the reading, they were asked to complete the Post- Training Survey without using the materials provided.

The results from the knowledge check questionnaires showed a gain in knowledge for both the ALF and comparison groups. The ALF group scored an average of 39% before and 62% after the ALF training session. The comparison group scored an average of 90% before and 93% after reading through the training materials independently. This 51% difference between the average scores for the ALF and comparison groups is most likely due to the fact that the comparison group was comprised of health and safety staff from the university rather than selected randomly from the study group as a whole. This biased selection of the comparison group resulted in a group of individuals that had markedly different work experiences and a greater initial knowledge base than the selected ALF group.

Upon review of intervention studies compiled through 1996 in a NIOSH Literature review (Cohen *et al.*, 1998), no follow-up studies were listed that measured the impact of interventions within one year following such an intervention. A further review of available literature published after 1996 and up to November of 2002 was conducted by searching Eric, PubMed, PsycINFO, and the OhioLINK research databases. Within

these databases, keywords and phrases were used to locate articles published in a variety of journals that contained intervention studies pertaining to worker health and safety. The following keywords and phrases were used in various combinations: training, education, learning, attitude, behavior, follow-up, laboratory, bloodborne pathogens, employee attitudes, work attitudes, questionnaire, job training, laboratory training, educational attitudes, attitude measures, behavior modification, behavior change, transfer of training, higher education, academic achievement, industrial training, self-efficacy, health education, medical education, occupational exposure, occupational safety, adult attitudes, health attitudes, occupational safety, personnel training. Relevant articles were retrieved from periodicals and examined to see if the impact of interventions were studied.

This extensive literature search yielded only one paper (Jeffe, 1999) where the impact of an intervention was studied after one year's time. In this study, the authors evaluated an "educational and skills-training program emphasizing double gloving for high-risk surgical procedures." The aim of the program was to improve students' use of blood and body fluid precautions. Baseline surveys measuring knowledge, attitudes, and readiness to use specific precautions were completed by the study participants and follow-up surveys were completed 1 year later. The results from this research found that "the ALF group showed improvements in attitudes toward double gloving and use of double gloves during surgery." In addition, this group also expressed "better attitudes and readiness to use double gloves compared with controls at follow-up."

It was the intent of this current research project to look at the impact of ALF training after one year compared to a comparison group that did not participate in this type of training. This project sought to not only look at the amount of knowledge retained by trainees, but also any self-reported changes in attitudes or behaviors. It is important to investigate whether this type of active learning focused training has a lasting effect on the attitudes, behaviors and the retention of knowledge for those trained using this method.

3.0 RESEARCH METHODOLOGY

3.1 RECRUITMENT OF PARTICIPANTS AND TRAINING PROTOCOL

The ALF and comparison groups that took part in the Wolbers' BBP Training Session in May 2002 were contacted in the fall of 2002 in order to recruit them for the current study. They were asked to participate in another BBP training session employing the same training techniques used one-year prior. They were told that this study would be a follow-up to the last one and that it would once again satisfy their employer's requirement for annual refresher training. An exemption was requested and obtained from the Institutional Review Board.

The training method used in this research project was identical to the training given by Wolbers in May 2002, albeit by a different instructor. The same training materials, order and style of presentation, simulations, Pre- and Post-tests, and knowledge check questionnaire were used during the 2003 training sessions. In addition, another survey tool called the Follow-Up questionnaire was developed for use in this study. The only difference beside the addition of the Follow-Up questionnaire was the fact that the comparison group did not repeat the passive training or complete the Post-test survey. Table 1 presents a summary of the measures collected and analyzed in this current study.

Table 1: Summary of the Measures Collected and Analyzed in this Current Study

Time of Survey	Before Training 2002	After Training 2002	Before Training 2003	After Training 2003
Trainer/Researcher	Wolbers	Wolbers	Reeb	Reeb
Number of Participants in ALF Group	18	18	17	10
Number of Participants in Comparison Group	7	7	6	0
Knowledge Check Questionnaire	Yes	Yes	Yes	Yes
Follow-up Questionnaire	No	No	Yes	No

Each survey instrument is described in the following sections.

3.2 KNOWLEDGE CHECK QUESTIONNAIRE COLLECTION AND ANALYSIS

A Knowledge Check Questionnaire (Appendix A) was part of the original Pre- and Post-test completed by the study participants in May 2002. This questionnaire was composed of seven questions based on the key learning objectives from the training program designed by Wolbers. This same Pre- and Post- test was given to the trainees before and after attending the annual refresher training in 2003. During the refresher training of 2003, the Pre- and Post-test were administered in the same way that Wolbers had administered these surveys in May of 2002. The Pre-test was administered before the training took place and the Post-test was administered immediately after the training. The questions that were contained in the Knowledge Check Questionnaire were made up of a combination of fill-in-the-blank, task ordering, and short answer questions. All the answers to the questionnaire were supplied during the training session with the exception of an item that asked the participants to describe their own potential for exposures to BBP in their work area.

Answers supplied by the participants were evaluated for the Pre- and Post- tests taken in May 2002 and in 2003. Each participant was assigned a score based on the percentage of correctly answered questions. Each of the five separate parts of Question #1 was worth one point as was the remaining questions (#2-#7) for a total possible score of 11 points.

Question #1 was composed of five separate fill-in-the-blank questions. Each trainee was instructed to choose the correct percentage associated with each of the five separate questions from a list of five possible answers that were to be used only once. Each correctly answered question was awarded 1 point (therefore question #1 was worth a total of five points).

Questions #2 and #3 were both task-ordering questions. In each of these questions, participants were instructed to choose the correct order of the five steps that should be performed to safely respond to a BBP spill and a BBP exposure. All the steps had to be listed in the correct order to receive the one point rewarded for each question. However, specific attention was made regarding the type and frequency of errors made on the task-ordering questions

Question #4 asked the participant to identify a potential BBP exposure in their work area. Since answers to this question were specific and unique depending on the individual, one point was rewarded for any potential BBP exposure the participant wrote in the space provided.

Question #5, #6 and #7 asked the participant to list 3 controls (Engineering, Work Practice, or PPE, respectively) in the space provided below. One-third of a point was awarded for correctly providing an answer to each of the three blank spaces below the question. Each question was worth a total of 1 point each.

The group averages were calculated by taking all the individual scores from one time period, adding them together and dividing by the total number of individuals making up that group during that time period.

The standard deviation was calculated by taking the difference between each individual's score and the average score for the group, squaring the difference, adding the squares of all the scores together, and dividing this sum by a number one less than the total number of individuals making up that group during that time period.

3.3 FOLLOW-UP QUESTIONNAIRE COLLECTION AND ANALYSIS

An additional questionnaire was developed for use in the present study. The purpose of this questionnaire, the Follow-Up Questionnaire (Appendix B), was to collect information from each trainee about any changes in behaviors and/or attitudes that may have occurred following the sessions in May 2002. This questionnaire was developed using questions that were drawn from those asked on the Exposure Evaluation Sheet (EES) (Appendix C) that each trainee completed after returning to the work area where the potential BBP exposure could occur.

Follow-up questionnaires were administered to both the ALF and comparison groups who took part in the original study in May 2002. These questionnaires were administered to the returning participants before they attended their annual refresher training in 2003.

Seventeen questions were designed to gather information that included the availability of supplies, the use of PPE and the implementation of safe work practices in the time since the participants' last training session in May 2002. Questions focused primarily on two self- reported categories -- changes in attitudes and changes in behaviors since May 2002.

For purposes of analysis these questions were grouped into one of three categories -- changes in attitude/perception, changes in behavior, or neither.

Four reviewers (including this researcher) went through the questions in the Follow-up questionnaire one by one and gave their opinion as to which of the three categories each question applied. These opinions were tabulated and in instances where there was a difference of opinion between the reviewers a simple majority decided on the classification. The classification of items was defined with attitudinal/perceptual changes referring to a self-assessment or subjective evaluation (#8,11,13) and behavioral changes referring to an objective, measurable behavior (#2,4,7,9,10,12,14,15,16). The rest of the questions were classified as neither because they were either associated with the opportunity for an event to occur (#1) or referred to the availability of supplies (#3,6) or both where evenly split between the reviewers (#5). Descriptive statistics (proportion

reporting "YES" for each question) were used to present the results from the sixteen questions contained in the Follow-Up Questionnaire.

Question #1 was used to find out whether a participant had had an opportunity to respond to a blood spill/potential exposure since the last BBP training session. The following four questions (#2-#5) asked specific information about how they responded to such a situation for those who answered "Yes" to Question #1.

Question #2 was used to see if the participant was able to recall the correct steps covered in the training used to clean up a BBP spill. A positive response would indicate a possible change in behavior.

Question #3 was used to inquire about the availability of proper supplies used in the cleanup of BBP spill. A positive response would indicate that the needed supplies were available.

Question #4 was used to find out whether the participant was more or less likely to use PPE as compared to the time before the last training session. A response of "more likely" would point to a possible change in behavior.

Question #5 was used to gauge whether the participant reacted more safely in their opinion as a result of their training in May 2002. A positive response to this question may indicate a possible change in behavior or attitude since the last training session.

Question #6 was used to evaluate whether the participant had the proper supplies available after the last training session. A positive response would indicate that the needed supplies were available.

Question #7 was used to find out whether the participant made any effort to correct any deficiencies in the proper PPE available to them since the last training session. A positive response would indicate a possible change in behavior.

Question #8 was used to see if a participant had been more self-aware of safety concerns in general since their last training session. A positive response would indicate that a change in attitude had occurred.

Question #9 was used to see if a participant had made any efforts to obtain PPE not related to BBP. A positive response would indicate a possible change in behavior.

Question #10 was used to see if a participant had talked with others about using PPE since their last training session. A positive response would indicate a possible change in behavior.

Question #11 was used to see if a participant had been more eager to learn more about PPE since their last training session. A positive response would indicate that a change in attitude had occurred.

Question #12 was used to see if a participant had made any extra effort to gather supplies that would be necessary to properly cleanup a BBP spill. A positive response would indicate a possible change in behavior.

Question #13 was used to see if a participant was more motivated to refer to the training materials provided at their last training session. A positive response would indicate that a change in attitude had occurred.

Question #14 was used to see if a participant had made more of an effort to wash their hands after removing their gloves since their last training session. A positive response would indicate a possible change in behavior.

Question #15 was used to see if a participant had eliminated any unnecessary steps that involved the handling of potentially contaminated materials since their last training session. A positive response would indicate a possible change in behavior.

Question #16 was used to see if a participant had been less likely to eat drink, or store food in their work area since their last training session. A positive response would indicate a possible change in behavior.

4.0 RESULTS

4.1 RECRUITMENT OF PARTICIPANTS AND TRAINING PROTOCOL

Ten out of twenty-four individuals making up the ALF group in the Wolbers' study were willing and available to participate in the 2003 annual refresher training session. An additional seven participants were unable to attend the refresher training but were willing to complete the Knowledge Check and Follow-Up questionnaires used to gather data in this study. One individual was unable to attend refresher training and was not willing to complete the questionnaires. The remaining six participants were no longer working at the university. Six out of seven individuals comprising the original comparison group were available to participate in the follow-up portion of this study. The participant who was unavailable was no longer working for the university.

4.2 KNOWLEDGE CHECK QUESTIONNAIRE COLLECTION AND ANALYSIS

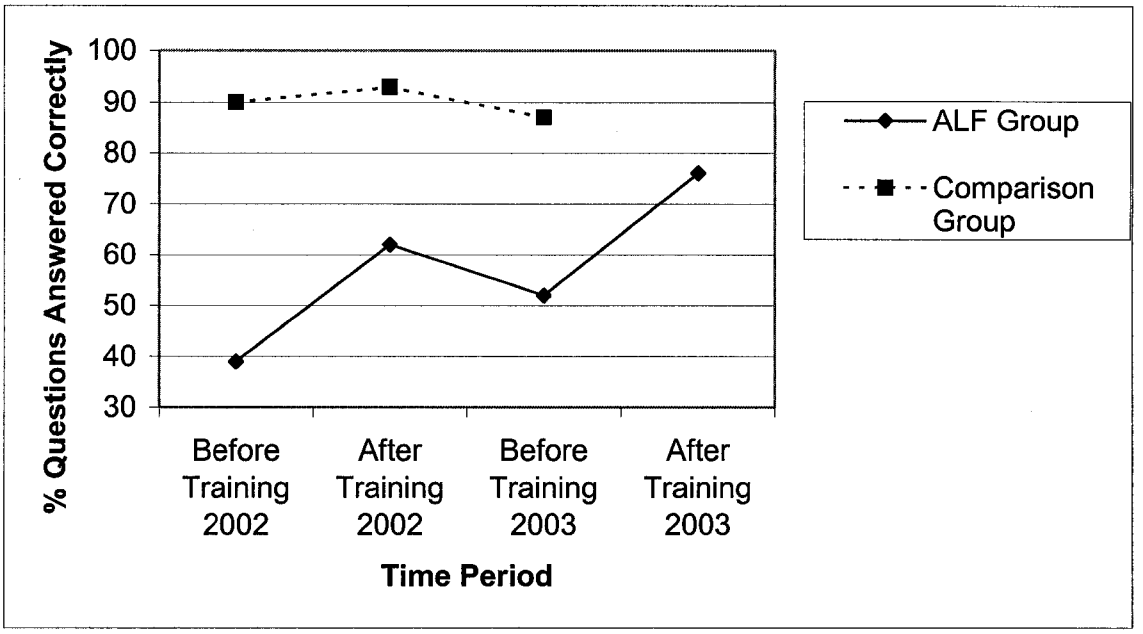
For each individual in the ALF and comparison groups, composite scores were calculated for each time period based on the number of correct answers given in response to the seven questions contained in the Knowledge Check Questionnaire (KCQ). Group averages and standard deviations were calculated from these scores.

The results for the ALF and comparison groups are detailed in Table 2 and illustrated in Figure 1.

TABLE 2: Mean (and standard deviation) of Knowledge Scores for ALF and Comparison Groups at various times during the training programs.

	Time Period When Knowledge Check Was Completed			
	Before Training 2002 [ALF n=18] [Comparison n=7]	**After Training 2002** [ALF n=18] [Comparison n=7]	**Before Training 2003** [ALF n=17] [Comparison n=6]	**After Training 2003** [ALF n=10] [Comparison n=0]
ALF Group	39 (15)	62 (21)	52 (19)	76 (14)
Comparison Group	90 (14)	93 (11)	87 (8)	---

Figure 1: Average Knowledge Check Questionnaire Scores by Group and Time Period



The first score represents the performance of the group just prior to participating in the training session in May 2002. The second score corresponds to their performance after the May 2002 training. The third score corresponds to their performance one year after their May 2002 training and prior to their refresher training in 2003. The forth score

corresponds to their performance after the refresher training in 2003 for those who participated.

The ALF group showed a knowledge gain of 23 percentage points after the ALF training session in May 2002. After one year, the ALF group's average was 10 percentage points lower compared to their scores after the May 2002 training. The remaining participants who took the refresher training in 2003 showed a knowledge gain of 24 percentage points.

The comparison group showed a knowledge gain of 3 percentage points after their passive training session. After one year, the comparison group lost an average of 5 percentage points compared to their scores after the May 2002 training. The comparison group did not participate in the passive training in 2003, therefore there are no scores reflecting knowledge gain for that time period.

The results from individual questions in the knowledge check questionnaire for the ALF group are shown in Table 3 and Figure 2 illustrates these results.

TABLE 3: Knowledge Check Data - Individual Questions for ALF Group

Question# and Content	AFL Pre-2002 % Correct	ALF Post-2002 % Correct	ALF Pre-2003 % Correct	ALF Post-2003 % Correct
1A. Potential for exposure during disposal process	56	77	72	89
1B. Chance of Hepatitis B after exposure	33	50	50	89
1C. Chance of Hepatitis B after vaccination	61	89	61	89
1D. Chance of Hepatitis C after exposure	22	39	56	89
1E. Chance of HIV after exposure	22	72	61	89
2. Steps to clean up BBP spill	0	50	11	44
3. Steps to respond to BBP exposure	22	44	39	67
4. Potential exposure in work area	56	61	44	44
5. Engineering controls	6	22	6	44
6. Work practice controls	17	33	44	56
7. PPE used to protect against BBP	72	89	94	100

Figure 2: ALF Group - Average Scores for Individual Questions on Knowledge Check

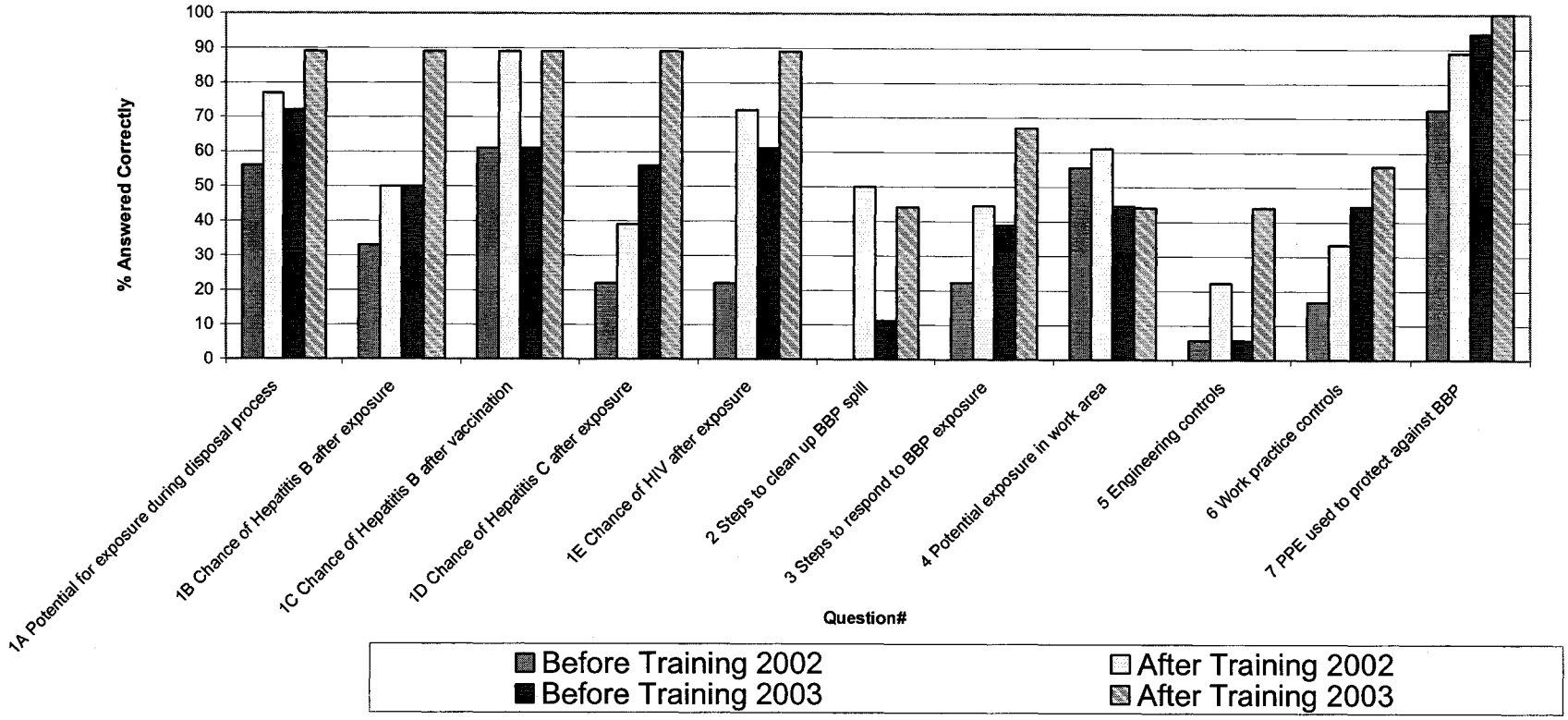


Figure 2 shows the percentage of correctly answered questions at each of the four time periods for the ALF group as a whole. (It must be noted that the average scores before the 2003 training and after the 2003 training reflect only seventeen and nine, respectively, of the original twenty-four individuals making up the ALF group in the Wolbers' study whose scores are captured in the first two time periods.)

In question #1A, the ALF group answered the question correctly 21 percentage points better after the initial ALF training in 2002. After one year, the ALF group lost an average of 5 percentage points compared to their scores after the training in 2002. The remaining group answered the question correctly 17 percentage points better after the Active Learning Focused (ALF) refresher training in 2003 compared to their scores before the refresher training in 2003.

In question #1B, the ALF group answered the question correctly 17 percentage points better after the initial training in 2002. There was no measured loss of this knowledge in one year's time. In addition, the remaining group answered the question correctly an additional 39 percentage points better after the refresher training in 2003 compared to their scores before the refresher training in 2003.

In question #1C, the ALF group answered the question correctly 28 percentage points better after the 2002 ALF training. After one year, the ALF group lost 28 percentage points (the original amount gained) of this knowledge. The remaining group answered the

question correctly 28 percentage points better after the ALF refresher training in 2003 compared to their scores before the refresher training in 2003.

In question #1D, the ALF group answered the question correctly 17 percentage points better after the initial 2002 ALF training. After one year, the ALF group scored an average of 17 percentage points higher compared to their scores after the training in 2002. The remaining group answered the question correctly an additional 17 percentage points better after the ALF refresher training in 2003 compared to their scores before the refresher training in 2003.

In question #1E, the ALF group answered the question correctly 50 percentage points better after the initial ALF training in 2002. After one year, the ALF group scored an average of 11 percentage points lower compared to their scores after the training in 2002. The remaining group answered the question correctly 28 percentage points better after the ALF refresher training in 2003 compared to their scores before the refresher training in 2003.

Table 4 shows the percentage of correctly answered questions at each of the three time periods for the comparison group as a whole.

TABLE 4: Knowledge Check Data- Individual Questions for Comparison Group, % Correct.

Question# and Content	Comparison Pre-2002	Comparison Post-2002	Comparison Pre-2003
1A. Potential for exposure during disposal process	100	100	100
1B. Chance of Hepatitis B after exposure	100	100	100
1C. Chance of Hepatitis B after vaccination	100	100	100
1D. Chance of Hepatitis C after exposure	100	100	100
1E. Chance of HIV after exposure	100	100	100
2. Steps to clean up BBP spill	67	67	0
3. Steps to respond to BBP exposure	50	67	67
4. Potential exposure in work area	67	83	83
5. Engineering controls	83	100	50
6. Work practice controls	83	100	100
7. PPE used to protect against BBP	100	100	100

The comparison group scored perfectly over all the time periods on the questions encompassed in Question #1A-E.

In question #2, the ALF group ordered the sequence correctly 50 percentage points better after the initial ALF training in 2002. After one year, they scored 39 percentage points lower compared to their scores after the training in 2002. The remaining group answered the question correctly 33 percentage points better after the ALF refresher training in 2003 compared to their scores before this training.

The comparison group scored the same before and after the passive training in 2002. However after one year, none of the comparison group was able to correctly order the sequence.

In question #3, the ALF group ordered the sequence correctly 22 percentage points better after the initial ALF training in 2002. After one year, they scored 5 percentage points lower compared to their scores after the training in 2002. The remaining group answered the question correctly 28 percentage points better after the ALF refresher training in 2003 compared to their scores at before the 2003 training.

The comparison group improved 17 percentage points after the passive training in 2002 and maintained that score one year later in 2003.

In Question #4, the ALF group scored 5 percentage points better after the initial ALF training in 2002. After one year, they scored 12 percentage points lower compared to their scores after the training in 2002. The remaining group answered the question correctly at the same level before the 2003 training compared to after the ALF refresher training in 2003.

The comparison group improved 16 percentage points after passive training in 2002 and maintained that score one year later in 2003.

In Question #5, the ALF group scored 16 percentage points higher after the initial ALF training in 2002. After one year, however, their scores returned to the same level as measured before the initial ALF training in 2002. The remaining group answered the question correctly 38 percentage points better after the ALF refresher training in 2003 compared to their scores before the training in 2003.

The comparison group scored 17 percentage points better after the passive training in 2002 but scored 50 percentage points lower after one year in 2003 compared to their scores after the 2002 training.

In question #6, the ALF group scored 16 percentage points higher after the initial ALF training in 2002. After one year, they scored 11 percentage points higher before the ALF refresher training in 2003 compared to their scores after the training in 2002. Interestingly, the remaining group answered the question correctly an additional 12

percentage points better after the ALF refresher training in 2003 compared to their scores before the training in 2003.

The comparison group scored 17 percentage points higher after the passive training in 2002 and maintained this score one year later.

In question #7, the ALF group scored 17 percentage points higher after the ALF training in 2002. After one year, they scored 6 percentage points higher compared to their scores after the training in 2002. The remaining group answered the question correctly an additional 6 percentage points better after the ALF refresher training in 2003.

The comparison group scored perfectly over all of the time periods.

4.3 FOLLOW-UP QUESTIONNAIRE COLLECTION AND ANALYSIS

These questions were used to find out whether there had been any self-reported changes in attitudes or behaviors since the training session in May 2002 and prior to the refresher training in 2003. Table 5 presents the results of the Follow-Up Questionnaire.

TABLE 5: Follow-Up Questionnaire Results

		ALF Group	Comparison Group
Question	Content	% Answering Yes	% Answering Yes
1	BBP Event?	0	50
2	Recall Steps?	n/a	100
3	Proper Supplies for Cleanup?	n/a	100
4	More Likely to Use PPE?	n/a	Same
5	Reacted more safely b/c of Training?	n/a	33
6	Proper Supplies in Work Area?	94	100
7	If not, did you get proper supplies?	22	0
8	More Conscious of Safety in General?	89	67
9	Obtain PPE for non-BBP related work?	50	83
10	Talked with others about PPE?	72	100
11	More eager to learn about PPE since training?	56	100
12	Extra effort to gather/centralize supplies since training?	56	67
13	More Motivated to Refer to Training or Info provided?	61	33
14	More effort in Hand Washing since training?	72	83
15	Eliminated any unnecessary steps?	50	67
16	Less likely to eat, drink, smoke in work area?	61	67

None of the individuals in the ALF group reported responding to a blood spill/potential exposure since the last BBP training session in 2002 while 50% of the comparison group reported such an occurrence.

5.0 DISCUSSION

Knowledge Check Questionnaire

An evaluation of the results of the knowledge check questionnaire illustrates the fact that the comparison group was poorly selected in the original study design. This explains much of the disparity in average scores and relative knowledge gain between the ALF and comparison groups over all the time periods. The comparison group was comprised of health and safety staff from the university rather than selected randomly from the study group as a whole. The ALF group was made up of eighteen university laboratory workers. The result of this method of recruitment biased the comparison group in such a way as to make any meaningful comparisons difficult. As a result, the discussion that follows will focus primarily on the data gathered from the ALF group who participated in the Active Learning Focused (ALF) training session.

The first question in the knowledge check questionnaire evaluated whether the trainees could choose the correct value or range of values associated with five separate questions centered on their risk of exposure to certain bloodborne pathogens. The answers to these questions were provided during the training session. While such questions may be a good measure of rote memory or knowledge, they do not necessarily provide the trainee with information that is useful to control the potential for exposure to BBPs. Rather, this question sets the tone for the importance of understanding the nature of the potential risk that these workers face in their work area.

By contrast, questions #2 and #3 instructed trainees to supply the correct order in which to complete a task properly. Both of these questions contained five steps that should be performed to safely respond to a BBP spill or a BBP exposure. The two simulations used in the ALF training focused on teaching the trainees in the ALF group the correct order of these steps. All the steps had to be listed in the correct order to receive the one point rewarded for each question. This is valuable information for the trainees to be able to recall in order to reduce their risk for exposure. Looking at the results from all of the time periods, a positive trend can be observed of higher scores and retention for the ALF group over the four time periods measured.

The results from question #2 showed that none of the ALF group knew the correct sequence of steps used to safely clean up a BBP spill before the initial ALF training. While this percentage jumped to 50% after the training, this information was not retained well as measured one year later prior to their annual refresher training (11%). This may be due to the fact that the ALF group did not have the opportunity to use the information presented in the last training session. However, after the refresher training the scores once again showed a large jump of 33%. This shows that the correct sequence of the steps was being successfully learned during both of the training sessions, but did not translate into long-term retention for the ALF group.

In contrast to the previous question, the ALF group (which initially scored low on the task ordering in the question concerning the steps and proper response to a BBP spill) had significant increases in their scores for question #3 (proper steps for responding to a BBP

exposure) across all time periods. This included the one-year time period after the initial training in 2002 and another increase in scores after the second refresher training in 2003. Since following the correct order of the task best minimizes the risk of a BBP exposure, this researcher would recommend that future training continue to focus on the correct ordering of these tasks during the BBP training sessions.

Question #4 was useful to see if the trainees understood their own potential for exposure in their work area. This type of information is crucial if the training is expected to benefit the trainee in the way in which it is designed. For if the trainee cannot identify the potential sources for BBP exposure in his or her work area, then how would they be expected to use their knowledge to best avoid or prevent these exposures? The results show that approximately half of the trainees understood their potential for exposure and were able to articulate it correctly on the knowledge check questionnaire over all four time periods. This researcher believes that the trainees could benefit from future training that emphasizes and clarifies the potential hazards that trainees are likely to encounter in their work area. In addition, this training should make sure that each of the trainees understands their particular potential sources of BBP exposures in their work area.

This researcher believes that questions #5, #6 and #7, which asked the participant to list 3 controls (Engineering, Work Practice, or PPE, respectively) should be modified if this training protocol is repeated. In evaluating these questions, it was observed that most of the incorrect answers were a result of a misclassification of the controls into the wrong category. Engineering controls were listed as Work Practice controls, PPE controls were

given as work practice controls, and so forth. In fact, 34% of those trainees that answered incorrectly on these questions made errors in classification. Asking the participants to identify a variety of controls rather than limiting them to narrowly defined categories could improve the questionnaire and be more valuable to the trainees by not focusing training efforts on the definition of certain types of controls, but rather the controls themselves.

Three of the questions in the knowledge check questionnaire (Questions 1C, 4 and 5) showed a gain after the first training session but then returned to a score that was the same or lower than the score measured before the initial ALF 2002 training session by the time the refresher training in 2003 was administered. This information would not appear to have been retained by the trainee. This researcher feels that future training using these training materials should put more emphasis on Question 1C (chance of contracting hepatitis B after a vaccination), Question 4 (major potential for BBP exposure in work area), and Question 5 (Name three engineering controls). It is important that the trainees understand the protection they have available to them through the hepatitis B vaccination (Question 1C). Also, it is critical that they can identify their personal potential for exposure to BBPs in their work area (Question 4). Future training could be improved by focusing on the types of engineering controls (Question 5) if the trainer feels that this is an important training outcome.

The most positive training gain was measured for questions 1B (Chance of Hepatitis B after exposure), 1D (Chance of Hepatitis C after exposure), 6 (Name three work practice

controls), and 7 (Name three types of PPE to reduce risk to BBP). All four of these questions showed an increase in correct responses over all the time periods for the ALF group. This researcher attributes these rising scores to the effectiveness of the ALF training techniques.

While the comparison group scored highly over all the time periods, their scores on two of the questions before the refresher training in 2003 were concerning. None of the comparison group answered Question 2 (Steps to properly clean up a blood spill) correctly before the refresher training and 50% of the comparison group could no longer correctly supply the answers to Question 5 (Name three engineering controls). Considering that these individuals are part of the health and safety staff and scored significantly better before and after the initial training, this researcher is at a loss to understand why these scores dropped so dramatically. Perhaps the passive training confused some of the participants.

Follow-up Questionnaire

A number of interesting results were also observed from the data analyzed from the follow-up questionnaire.

The first notable difference was seen in the analysis of question #1. While none of the ALF group had participated in the cleanup of a BBP spill in the prior year before 2003 refresher training, half of the comparison group had participated in such an activity. This is not surprising given the job duties of this group composed of staff from the university's health and safety department. They are routinely responsible for the cleanup of incidents

on campus involving bodily fluids. These can include such events as fights, attempted suicides, or accidents. Such active and routine potential for exposures would undoubtedly raise the awareness and reinforce the desire to protect themselves from the hazards of BBP inherent in their jobs. It is reassuring to document that the group that had the higher incidence of potential exposure in the past year reported that they were able to recall the correct steps (#2) and had the proper equipment (#3). It is not surprising that they also reported that the likelihood that they would use the provided PPE in this situation had not changed since their passive training (#4). Interestingly one of the three respondents to question #5 felt like he/she had reacted more safely during the clean up as a result of the passive training session in May 2002.

The entire comparison group indicated that they had access to the proper supplies to properly respond to a BBP spill and similarly the majority of the ALF group did as well. This information is valuable in so far as knowing that their employer is doing a good job supplying their employees/staff with the necessary supplies and equipment to enable them to safely respond to a BBP spill.

As hypothesized, a higher percentage of the ALF group (89%) indicated that their training session had actually influenced their overall attitude about safety (question #8) compared to the comparison group that participated in the passive training (67%).

Question 9 shows extra effort by the comparison group to obtain appropriate PPE needed for other tasks in their work area not related to BBP. This could reflect the diversity of

their jobs compared to the ALF group that was made up primarily of laboratory workers. The comparison group has a variety of health and safety functions on the campus. This type of job diversity found in the health and safety staff would likely have these participants in contact with and aware of other types of hazards.

Both questions 10 (Talked with others about PPE?) and 11 (More eager to learn about PPE since training?) were likely influenced by the diverse work environment and experiences of the health and safety staff. The percentages are higher for the comparison group that all answered affirmatively in response to these two questions. Question 10, which asks whether the trainees had talked with others about using PPE, is an obvious example where job experience has likely influenced the results. Many of these individuals not only talk with staff and students regularly about health and safety, but also conduct health and safety training throughout the year. However, it is encouraging to observe that the majority of the ALF group answered affirmatively (72%). This would suggest that the training may have had a positive impact on the trainees resulting in their willingness to speak with others about PPE. Question 11, which gathered data about the eagerness of the trainee to learn more about the varieties or types of PPE available for protection in the workplace was likely influenced in a similar fashion. Over half (56%) of the ALF group answered affirmatively about their eagerness to learn more about the varieties or types of PPE since participating in the ALF training. This would suggest that the ALF training might have positively motivated some of the trainees.

After tabulating the subjective opinions of the four reviewers, the questions were divided primarily between two classifications. Questions 8, 11, and 13 were classified as questions gather data on attitudinal/perceptual changes. Questions 2, 4, 7, 9, 10, 12, 14, 15, 16 were classified as questions gathering data on behavioral changes.

Of those questions selected to gather data on attitudinal/perceptual changes, the ALF group answered on average more affirmatively (69%) than on those questions focused on behavioral changes (55%). The comparison group had equal levels of affirmative responses (69%) on both classifications of questions. After looking at these results, this researcher feels that the ALF training produced more attitudinal/perceptual changes in the trainees than behavioral changes.

The results of this follow-up study are consistent with another study (Rice et al., 2003) that focused on empowering employees to change their workplace through interactive training. In this study, the researchers observed that trainees attending 8-hour emergency response or site worker refresher training reported that they changed their own work behavior to perform a task more safely 63% and 85%, respectively, during the previous 12 months since participating in an interactive training session. In addition, 54% and 71% of the 8-hour and ERR groups, respectively, reported talking with a relative or friend about a safer way to do things around the house/apartment.

Along with data showing that the majority of the trainees gained and retained knowledge presented during the ALF training session, a number of positive comments were given in

writing and verbally. At the end of the knowledge check questionnaire, there was a space for trainees to put comments about how the training could be improved. While relatively few people responded (10), the majority (8) wrote positive notes including: "I really like it.", "Just fine how it is.", "I like the specifics regarding exposure, time elapsed before pathogen takes effect.", "More time on protective ideas and engineering controls.", "I think it good the way it is. I do like the idea of small groups.", "It can't (be improved).", "More experiments to let the employees understand better.", "Give us the number to call if sharps discovered in regular trash. (happens a lot)". One person suggested the idea of putting the correct steps to clean a BBP or respond to an exposure on a card that could be kept in a purse/wallet. Another suggested less paperwork One person commented negatively saying that they thought the simulated blood spill exercise was "stupid" and another commented that there was "too much paperwork".

Taking these comments into consideration and modifying the content where feasible could improve future training using this protocol. If future ALF training sessions are planned using the materials in this study, this researcher would suggest limiting the amount of paperwork associated with this training.

Due to the small number of participants in the Wolbers' study, an additional group of trainees was included in the 2003 training and are available for follow-up. Their data are included in Appendix D.

6.0 CONCLUSIONS

A positive trend was observed of higher scores and retention for the ALF group that participated in the ALF training over the four time periods measured. The greatest gains where observed in the trainees' knowledge dealing with their chance of contracting Hepatitis B and C after an exposure to a blood spill and their ability to correctly name three work practice controls and three types of PPE to reduce risk to BBP.

As hypothesized, a higher percentage of the ALF group (89%) indicated that the ALF training session had actually influenced their overall attitude about safety compared to the comparison group that participated in the passive training (67%). Data from the Follow-up Questionnaire suggests that ALF training has produced more self-reported attitudinal/perceptual changes (69%) than behavioral changes (55%).

Both ALF training sessions resulted in significant increases in the scores of the trainees in regards to a question that asked for the proper steps for responding to a BBP exposure. One year after the initial ALF training, the ALF group's averages scores fell only by a few percentage points in comparison to their scores recorded immediately after the initial training. In addition, trainees successfully learned the correct sequence of the steps in the proper cleanup of a blood spill during both ALF training sessions. However, this knowledge gained during the ALF training session did not result in retention of this knowledge after one year for this group.

The analyses of the data suggests that the ALF training helped these trainees better recognize hazards and various methods to reduce exposures.

This study was unable to show evidence that ALF training produced better retention of knowledge compared to a comparison group. This was likely due to the employment history of the comparison group.

Trainees could benefit from future training that emphasizes and clarifies the potential hazards that trainees are likely to encounter in their work area in addition to making sure the trainees understand their particular potential sources of BBP exposures in their work area. Asking the participants to identify a variety of controls rather than limiting them to narrowly defined categories could improve the questionnaire used in this study and be more valuable to the trainees by not focusing training efforts on the definition of certain types of controls, but rather the controls themselves. If future follow-up were to be planned using the participants in this study and it's training method/protocol, this researcher would recommend that a new comparison group be randomly selected so that the retention of knowledge can be compared between groups participating in ALF and passive training sessions.

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Appendix A: Knowledge Check Questionnaire

Knowledge Check Questionnaire

Name _____

1. Fill in the blanks of the following questions with one of the following 0%, 0.3%, 5-10%, 6-30%, and 33% (each percent will be used once).

   ___of occupational bloodborne pathogen exposures happen during the disposal process.

   The chance of contracting hepatitis B after an exposure via a needlestick or cut is ____.

   The chance of contracting hepatitis B if successfully vaccinated is _____.

   The chance of contracting hepatitis C after an exposure via a needlestick or cut is ____.

   The chance of contracting HIV after an exposure via a needlestick or cut is ____.

2. Number the following tasks in the order they should be performed to safely clean up a bloodborne pathogen spill, with 1 as the first step and 5 as the last step.

   ___ Control the contaminated area so others cannot enter.
   ___ Cover the spill with a layer of paper towels.
   ___ Disinfect the spill with bleach solution for at least 10 minutes.
   ___ Don your personal protective equipment.
   ___ Wash your hands with soap and water.

3. Number the following tasks in the order they should be performed to safely respond if exposed to a bloodborne pathogen, with 1 as the first step and 5 as the last step.

   ___ Complete initial report on exposure by completing form A-1352(a).
   ___ Inform supervisor.
   ___ Call University Health Services at 584-STIX
   ___ Get a University Health Services medical evaluation
   ___ Wash exposed area with soap and water.

4. List the major potential bloodborne pathogen exposure in your work area in the space below.

_____

_____

_____

5. List three engineering controls that can be used to protect against bloodborne pathogen exposures.

1. _____
2. _____
3. _____

6. List three work practice controls that can be used to protect against bloodborne pathogen exposures.

1. _____
2. _____
3. _____

7. List three types of personal protective equipment that can be used protect against bloodborne pathogen exposures.

1. _____
2. _____
3. _____

Appendix B: Follow-up Questionnaire

Date_____

Follow-up Questionnaire

1. Since your last BBP training session, have you been involved in a situation where you participated in the clean up of a blood spill?

   YES NO

   If yes, continue on to the next question.
   If No, Go to question #6 beginning at the top of page 2.

2. During the clean up, were you able to recall the correct steps in order to properly clean up the spill?

   YES NO UNSURE

3. During the clean up, did you have access to the proper personal protective equipment (gloves, safety glasses, etc...)?

   YES NO UNSURE

4. During the clean up were you more or less likely to use the protective equipment provided compared to the time before you participated in your last training session?

   More Likely Same Less Likely

5. Did you feel that you reacted more safely during your clean up as a result of the training session you attended last year?

   YES NO

6. When you completed the container survey as part of your last training session, did your workplace have all the proper supplies (PPE, waste containers) to properly deal with a BBP spill?

   YES NO

   If No, continue to question #7
   If Yes, go to question #8.

7. Since your last BBP training session, did you take any steps to obtain personal protective equipment (PPE) that was previously unavailable to you that you realized was needed to properly handle a BBP spill?

   YES NO

   If Yes, please list the PPE or other equipment you obtained.

   _____

8. Since your last BBP training session, do you feel that you have been more conscious of safety in general while you are working?

   YES NO

9. Since your last BBP training session, have you made any efforts to obtain appropriate PPE that was needed for other tasks in your workplace NOT related to BBPs?

   YES NO

10. Since your last BBP training session, have you talked to others about using PPE?

    YES NO

11. Since your last BBP training session, have you been more eager to learn more about the varieties or types of PPE available for your protection in the workplace?

    YES NO

12. Since your last BBP training session, have you made any extra effort to gather the necessary supplies needed to properly clean-up a BBP spill into a centralized or conveniently located area.

    YES NO

13. Do you feel more motivated to refer to information learned or provided in your last BBP training session when responding to a BBP spill compared to prior previous training sessions?

YES NO

14. Since your last BBP training session, have you made more of an effort to always wash your hands after removing your gloves?

YES NO

15. Since your last BBP training session, have you eliminated any unnecessary steps that involve the handling of blood and infectious materials in your job tasks?

YES NO

16. Since your last BBP training session, have you been less likely to eat, drink, or store food in your work area?

YES NO

Appendix C: Exposure Evaluation Sheet

Exposure Evaluation

Fill out this worksheet to evaluate your bloodborne pathogen exposure.

List your job tasks that have a potential exposure to bloodborne pathogens in the space below (some examples of potential exposures are - use of needles and their disposal containers, use of sharps and their disposal containers, use of contaminated equipment, work procedure that could lead to a splash of blood, patient interaction, bleeding co-worker).

For the following sections (Engineering Controls, Work Practice Controls, and Personal Protective Equipment), read the question and if the answer is yes, check the YES box, and if the answer is no, check the NO box. If the box is gray, take the action on the next line, if it is white, no action is needed so skip to the next question.

Engineering Controls	YES	NO
Do you have hand washing facilities available in the work area where your potential bloodborne pathogen exposure occurs?		
If no, discuss getting hand washing facilities installed in your work area with your supervisor; hand washing facilities are required by OSHA.	YES	NO
Do you use self-sheathing needles in the performance of your job?		
If no, discuss with your supervisor if self-sheathing needles or needleless systems could be used instead. See [1] below for websites with more information on safer needles.	YES	NO
Do (or should) you use sharps disposal containers?		
If yes, evaluate the effectiveness and placement of the container with the attached Container Survey for Sharps Disposal Containers	YES	NO
Do (or should) you use regulated waste disposal containers?		
If yes, evaluate the effectiveness and placement of the container with the attached Container Survey for Regulated Waste Disposal Containers	YES	NO
Do you use Autoclaves to treat infectious waste?		
If yes, ensure the autoclave meets the requirements of U.C. Advisory 10.5 and has been certified.	YES	NO
Do you use Biosafety Cabinets?		
If yes, evaluate your use of the cabinet with the attached Biosafety Cabinet Use Survey	YES	NO
Do you use sharp instruments to make incisions in humans or animals?		
If yes, discuss with your supervisor if instruments with engineered sharps protection or safer medical devices that could be used instead.		

Work Practice Controls	YES	NO
Do you use needles that must be recapped?		
If yes, end this practice immediately. If recapping is absolutely necessary it must be accomplished through the use of a mechanical device or the one-handed "scoop technique".	YES	NO
Do you always wash your hands after removing your gloves?		
If no, adopt this practice immediately; it is required by OSHA and will protect yourself and others against infections.	YES	NO
Could you eliminate any steps that involve the handling of blood and infectious materials in your job tasks?		
If yes, eliminate the steps.	YES	NO
Do you eat, drink, smoke, or store food in your work area?		
If yes, end these practices immediately; it is not allowed by OSHA and can lead to infections.	YES	NO
Do you always dispose of needles and syringes in sharps disposal containers?		
If no, adopt this practice immediately, all needles and syringes must be disposed of as infectious waste.	YES	NO
Do you always dispose of sharps contaminated with blood or bodily fluids in a sharps disposal container?		
If no, adopt this practice immediately; it is required by OSHA and will protect yourself and the custodial staff from infection.		

[1] Safer Needle Devices Web Resources - http://www.tkict.org/criteria.html, http://www.med.virginia.edu/medcntr/centers/epinet/products.html, http://www.dhs.ca.gov/ohb/sharps/diclaim.htm

Exposure Evaluation (cont.)

Personal Protective Equipment	YES	NO
Do you have nitrile protective gloves and safety glasses available in your work area.		
If no, request these items from your supervisor.	YES	NO
Do you have tweezers, tongs, a broom, and a dustpan available in your work area?		
If no, request these items from your supervisor.	YES	NO
If you have the potential for a large bloodborne pathogen spill*, do you have protective tyvek gowns, shoe covers, a face shield, and an absorbent/desiccate available in your work area?		*
If no, request these items from your supervisor.		

* If you do not have the potential for a large bloodborne pathogen spill (a large spill is one that cannot be covered by one unfolded paper towel) ignore this question.

Appendix D: Data From Additional Group of Trainees Participating in 2003 ALF Training Session

Time of Survey	Before Training 2003	After Training 2003
Trainer/Researcher	Reeb	Reeb
Number of Participants in Additional ALF Group	27	26
Knowledge Check Questionnaire	Yes	Yes
Follow-up Questionnaire	No	No

Mean (and standard deviation) of Knowledge Scores for Additional ALF Group

	Before Training 2003	**After Training 2003**
Additional ALF Group	20 (4)	48 (5)

Knowledge Check Data - Individual Questions for Additional ALF Group, % Correct

Question# and Content	ALF Pre-2003	ALF Post-2003
1A. Potential for exposure during disposal process	18	46
1B. Chance of Hepatitis B after exposure	22	54
1C. Chance of Hepatitis B after vaccination	48	77
1D. Chance of Hepatitis C after exposure	7	27
1E. Chance of HIV after exposure	15	37
2. Steps to clean up BBP spill	15	23
3. Steps to respond to BBP exposure	7	37
4. Potential exposure in work area	30	73
5. Engineering controls	0	4
6. Work practice controls	4	12
7. PPE used to protect against BBP	26	46