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Long-term Effectiveness of Infection Control Training among Fourth-year Medical Students

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Abstract - The purpose of this study was to determine the long-term knowledge retention of infection control training among fourth-year medical students (n=110) who received training in their second year. Previous infection control training focused on standard precautions and infection control procedures. The evaluation of knowledge retention two years after the planned intervention demonstrated that although there was a significant knowledge increase about infection control immediately after participating in the intervention, there was no significant knowledge retention about infection control two years later. Furthermore, when the knowledge scores of the intervention group two years post training were compared to a control group, there were no differences. When compared to the control group, an improvement in reporting exposure incidents was found among the intervention group. More research is needed to determine effective training methods that can improve retention of infection control and safety precautions. Retraining on a regular basis may be indicated.

Key words: infection control, health education, exposure reporting, evaluation, medical students

Exposure to infectious diseases is one of the most frequently identified occupational hazards facing health care workers.[1] The provision of training programs that provide information about protecting healthcare workers from exposure to bloodborne pathogens is mandated by federal law.[2] Two major health and safety guidelines exist that address the issue of infection control. First, the Bloodborne Pathogen Standard describes blood and body fluid precautions required for use in health care facilities for the care of all patients. In addition, the regulation requires that employers implement a plan that reduces the risk of exposure to blood and hazardous body fluids for employees.[2] Second, Isolation Precautions in Hospitals emphasizes decreasing the transmission of infectious disease in hospitals.[3]

The directives of the Bloodborne Pathogen Standard protect health care workers. Unfortunately health care students, who may be at increased risk due to a variety of factors, are not covered under this standard.[4] Subsequently, training for health care students in protection from bloodborne pathogens is not carried out systematically in medical schools in the United States. Students undergoing medical training may be exposed to patients who are HIV-positive in hospitals and public health clinics. In addition, students may lack both experience and practice when performing invasive procedures.[5,6]

Training about measures to reduce exposure to blood and body fluids for medical students is recommended by the American Association of Medical Colleges (AAMC).[4] The result of a survey of 42 medical schools found that the topic of avoiding occupational exposures to blood and hazardous body fluids is traditionally covered by lectures in the first or second year of medical school.[7]

Successful programs for medical students have been developed and evaluated that included strategies for infection control and/or precautions needed to reduce the acquisition of disease from patients to health care workers[8,9] Recognizing that reducing the risks of occupational exposure to blood and body fluids is a high priority, we developed, implemented, and evaluated a customized infection control intervention for second-year medical students that was administered before they began clinical experience. Development of this intervention was the result of an earlier health education needs assessment that identified infectious exposures as sources of significant concern to staff and students at the target university medical center. Results of the customized infection control educational intervention that have been previously reported, demonstrated significant improvement in short-term knowledge of infection control practices by second-year medical students.[10] The aims of this follow-up study included first evaluat-

ing the long-term effectiveness of the infection control intervention and secondly evaluating the program for the effect on medical students regarding a change in the awareness for reporting potentially infectious exposure incidents. These aims were accomplished through comparing a control group of medical students from the same school who did not receive the educational intervention with the medical students who participated in the intervention.

Methods

Study Question and Design - We conducted this study to determine the long-term knowledge retention of infection control education among fourth-year medical students (n=110) who received an educational intervention in 1996 during their second year of medical school and to compare test results with a control group. To accomplish this study objective, in 1998, two years following the intervention, we administered a second post-test to the intervention group. The results of the 1998 post-test were compared with the 1996 post-test results.[10] In addition, the results of the study group's second post-test were compared to the test results of a baseline control group. This group consisted of fourth-year students, who in 1996, were graduating from the same medical school and who completed an infection control knowledge test before the intervention was implemented. Figure 1 presents the study design graphically.

Description of Educational Intervention - The sequence for the educational intervention included: pre-testing, a handwashing exercise, a 30-minute lecture, two interactive case studies, and post-testing. During the intervention, students received a handout that covered the lecture and a pocket-sized booklet that summarized the personal protective measures and the precautions needed to decrease transmission of infectious agents encountered within the clinical setting. Testable learning objectives for the two-hour intervention included: 1. use of Isolation Guidelines for Hospitals and the Bloodborne Pathogen Standard; 2. whether special isolation precautions are needed during pregnancy; 3. strategies for decreasing tuberculosis transmission; and 4. the procedure for reporting infectious exposures to the appropriate department.[10]

Evaluation Instrument - As previously reported, the pre- and post-tests were developed based on the learning objectives for the infection control program. The tests consisted of 20 multiple-choice questions.[10] There were 16 identical multiple choice questions used for comparison with the control group. In addition, a separate survey collected information about the number of potentially infectious incidents recalled and reported by the fourth-year students in both the intervention and the control group.

Sample Population - The sample for the intervention group who completed the second post-test was fourth-year medical students from a medical school located in the southwestern United States (n=110). The fourth-year students are usually not available as a group in their last year. An exception was that a required training session provided an opportunity to access most of the fourth-year students. Although we anticipated that most students would attend the required training, apparently 68 of the students were able to attend the required training at another time and location. All of the fourth-year students who attended the training session completed one of the infection control post-tests. This subset represented 60.7% of the original study population who attended the mandatory educational intervention during the second-year skills training. The sample of the control group who completed an infection control test during a skills training class but did not receive the infection control intervention was a group of graduating fourth-year students from the same school who also attended the required training prior to graduation (n=111). Testing materials included no identifiers, they were numerically coded, and were not paired. Since there were no identifiers, only group data could be compared. The institutional review board approved this study.

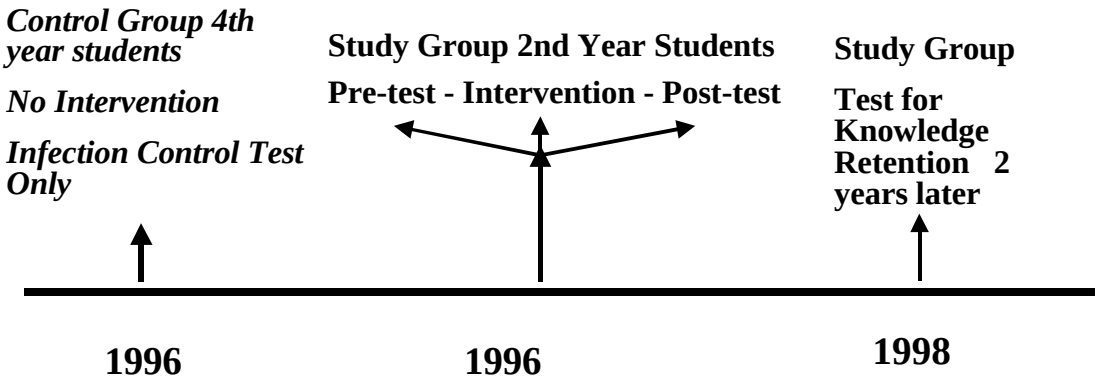
Statistical Analysis - Overall change in knowledge was determined. First, the respondents' selections were coded, assigning "1" for correct answers and "0" for incorrect answers. A total score was computed by summing the responses to individual questions. In order to test the hypotheses: 1. there would be a significant difference in the knowledge scores between the intervention and control groups, and 2. there would be a significant difference between knowledge scores at the first and second post-tests. A t-test was used to test group differences on the basis of total knowledge scores. The level of statistical significance was set at $p < 0.01$. Additionally, descriptive statistics were employed to

present the frequencies of exposure incidents.

Results

Long-term Retention of Infection Control Knowledge - The time effect on the retention of infection control knowledge in the intervention group was statistically significant. Specifically, the mean knowledge scores decreased from the first post-test (M = 13.30, SD = 1.60) to the second post-test (M = 10.70, SD = 1.80) periods, (t = 15.20, p < .001). A comparison of the control group (M = 10.00, SD = 1.65) and the intervention group (M = 10.04, SD = 1.65) showed no significant difference on knowledge about infection control (t = .159, p = .874).

Figure 1 : Study Timeline



Infectious Incidents Recalled and Reported by the Fourth-Year Students -The results of the survey of exposures to potentially infectious diseases indicated that the intervention group reported greater numbers of needlesticks and cuts with sharp objects than did the control group (Table 1). The intervention group reported greater numbers of splashes and contact with non-intact skin than did the control group (74.5% vs. 22.0% for splashes; 55.0% vs. 7.7% for contact with non-intact skin). Students in the intervention group recalled exposures through contact with non-intact skin and splashes more frequently (Table 1).

Discussion

Long-term Retention of Infection Control Knowledge for the Intervention Group - Medical students showed no significant long-term gain in knowledge about infection control two years following the educational intervention. This finding was unexpected and contrary to our assumption that the customized intervention would be successful, because it was designed specifically to increase medical students' knowledge of infection control. The researchers expected that the intervention would be successful over the long term

because the immediate post-test scores indicated significant gains in knowledge of infection control.[10] Furthermore, in the two years following the intervention the students had the opportunity to apply the knowledge of infection control to clinical practice as well as increase their knowledge of infectious disease. In addition, the results of an earlier needs assessment with fourth-year medical students indicated that the educational intervention was essential for their health and safety. [10]

Table 1. Comparison of Recalled and Reported Exposures

Type of exposure	Control group fourth-year students		Intervention group fourth-year students	
	Number students who recalled exposures	Number students who reported exposures correctly	Number students that recalled exposures	Number students who reported exposures correctly
	Frequency	Percentage	Frequency	Percentage
Needlestick	60/139	43.0	54/110	49.0
Splashes	32/142	22.0	82/110	74.5
Contact with nonintact skin	11/142	7.7	61/110*	55.0
Sharp objects	25/141	18.0	39/110	35.0

***** 4 individuals recalled 5 incidents and 2 recalled 10 incidents.

Although the test scores were universally poor, in some cases the low test scores were the result of the students' responses that they would "overprotect" themselves for certain procedures. Instances where students would overprotect are of less concern; however, this indicates that they still do not know the correct procedures. One item relating to the hand washing time in particular raised the question of the validity of the students' responses as most students selected a minimum duration of one minute for proper hand washing. Research shows that health care providers and students habitually fail to wash their hands or fail to follow the correct procedures for hand washing.[11,2] Perhaps of greater concern is the finding that students reported that they would "under protect" themselves. Both situations indicated that there was overall confusion among the students about the proper personal protective equipment required for the workplace.

The researchers considered several possible explanations for the results of the study. One possible explanation may be related to the timing of the intervention and the timing of the testing. The second year educational intervention was conducted prior to the clinical practice. Conducting the intervention prior to the clinical practice may not have been as effective since the students had no point of reference with which to associate the infection control information. In addition, the training was conducted immediately following an intense examination period; therefore the students' preparation for learning may have been reduced. Furthermore, the infection control training was part of a lengthy 2-day session that was conducted *en masse* and may unwittingly have created apathy and disinterest among the students. The cumulative effect of these three factors may have decreased the memory retention of the students. With respect to the timing of testing, the first post-test was conducted within moments of the intervention and resulted in relatively high test scores that may have been more closely associated with mimicry than with knowledge. In addition, the timing of the second post-test for the intervention group may not have been optimal since the students had little or no academic incentive to perform well on an anonymous, voluntary test.

Another possible explanation for the poor test scores may have been attributed to the nature of the intervention itself. In spite of the fact that the intervention was

based on a systematic health education approach that involved the conduct of a needs assessment, development of a curriculum, implementation, and evaluation, it may not have been sufficient to improve the long-term knowledge scores of the students.[10] Furthermore, the intervention was strictly knowledge based and might have failed to address attitude and behavior relating to infection control measures. If the intervention had addressed attitude and behavioral intention[13], it may have led to adoption of the methods and subsequently to improvements in long-term memory. In other words, one short training session should not be relied upon to ensure adoption of the effective infection control practices.

The researchers suspect that the role of instructors, health care workers and the current deficiency in infection control practices in health care institutions all impact the students' learning about and use of infection control practices. [14,15] Without consistent modeling of correct infection control practices, students may be unable to distinguish between the "correct" and the "common" practices, since they vary between instructors and institutions.

Comparing Knowledge Scores Between the Intervention Group and the Control Group - When the total scores of the fourth-year intervention group and the control group were compared no significant differences were found. The lack of variation between the control group and the intervention group in overall test scores led the researchers to consider several possible explanations for this finding. One explanation may be attributed to variation in clinical rotations of the students and experiences during medical school. Another explanation could have involved changes in infection control content in the curriculum. This instruction could have changed during the study period and this could have affected the study's results. In addition, the students may have had different instructors as previously discussed. Again, the attitudes of the fourth-year students and control group may have reflected the view that the infection control test was unimportant since it was voluntary and anonymous.

Infectious Incidents Recalled and Reported by the Fourth-Year Students - The finding that greater numbers of exposure incidents were reported by the intervention group compared to the control group is interesting considering the relatively poor outcomes observed with the infection control knowledge scores (Table 1). The exposure data suggest that there may be heightened awareness of the need to report exposures and to conduct post-exposure evaluation. The heightened awareness may be due to the intervention since the lecture emphasized the need to report all incidents as well as the institutional procedures for reporting. A second factor may have been attributed to greater awareness of the Post-exposure Prophylaxis guidelines developed by the Centers for Disease Control and Prevention.[16] A third factor may have been attributed to the role of instructors who may be proponents of the new post-exposure guidelines and, therefore, encourage students to follow the guidelines.

This study found that there were a greater number of exposures recalled with the intervention group. Although this finding may accurately reflect the true numbers of incidents, the researchers also considered the impact of recall bias. For example, the students from the intervention group may have been more likely to recall and to report greater numbers of incidents simply because they participated in a program that was designed to increase their awareness of the seriousness of these events and of the need to report incidents. The results are intriguing because they suggest that the students possessed the knowledge of the need to report their exposures but the test responses of the students showed that they did not appear to possess the knowledge to implement the infection control methods that were necessary. Even assuming that the students had the knowledge, they may not have had the motivation to protect themselves as evidenced by the number of exposure events, especially splashes (Table 1). This finding suggests that future training may need to address knowledge as well as attitudes and behavior in order to affect change in the behavior of the students.

Conclusion

The researchers were troubled by the results since it had been anticipated that the intervention would become a standard component of the basic skills training for medical students. Based on the importance of infection control training that was identified by the former medical students, the researchers were hopeful that the intervention would prepare the students to practice safely. Furthermore, the numbers of exposure incidents that the students recalled and reported indicates that their lack of

knowledge is, indeed, a problem.

One of the limitations of this study was the potential for selection bias. Initially, readers may assume that the students who participated in the study were different in respect to knowledge about infection control and infectious exposures from those students who did not participate in the study. Only about 60% of students in the fourth-year classes were actually available to the researchers. The best time to access the greatest number of fourth-year students was during a required training session prior to graduation. However, some students choose to obtain this required training at another time and location and were unavailable. The researchers were not convinced that selection bias was an issue since all of the students who were present for the required training completed one of the post-tests. While it is possible that selection bias existed, there was no basis for concluding that the nonparticipants who chose to take in the required training at another time and location were different from those students who participated. Regarding the control group, it would have been optimal to have a 1:1 ratio of study participants to controls, but this was not possible.

Besides the potential for selection bias, there were other limitations to this study that could have affected the interpretation of the results. One limitation was the length of the follow–up period. A two-year waiting period after the intervention may have been too long and may have led to lower test scores. Educational psychologists have found that the students remember significant portions of what they learn for a period of up to 11 months.[17] Interestingly, the 11-month knowledge retention period suggested coincides with many existing training schedules for periodic retraining. Specifically, the Bloodborne Pathogen Standard requires that workers who are exposed to blood and body fluids receive training every twelve months.[2] The researchers propose that a shorter follow-up testing period, such as 11 months, may yield results that indicate greater recall by the medical students. From the results of this study, it appears that it would be important to determine the time interval at which students no longer remember information. Once this time period has been established, an appropriate timeline for refresher courses in infection control may be instituted.

In summary, this study shows that medical students who attended an educational intervention two years before did not retain long-term knowledge of proper procedures for infection control. In addition, when the second post-test knowledge scores of the intervention group were compared to a control group of students who did not receive the intervention, no significant differences were found. Although the results of a previous study indicated that the educational intervention for infection control was successful in the short-term[10], this follow-up study found that the long-term retention of knowledge was universally poor. However, one of the goals of the study was met. Improvement was found among the intervention group when compared to the control group in terms of reporting potentially infectious exposures correctly. Although the results of this intervention were promising initially[10] we recognize that knowledge retention measured immediately post-intervention may not translate into lasting improvements in knowledge. This study is important because it shows that a single infection control educational intervention provided in medical school is inadequate to teach students about infection control and safety techniques. Further research is needed to determine the methods that have the greatest positive impact in teaching and in promoting knowledge retention of infection control for medical students.

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