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Universal Precautions Training of Preclinical Students: Impact on Knowledge, Attitudes, and Compliance[1]

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Background. **Little information exists regarding the impact of universal precautions training programs on preclinical students' knowledge, attitudes, and behavior.**

Methods. **We developed, implemented, and assessed an educational program in universal precautions for 2nd-year medical and preclinical physician assistant students. Students (n = 170) completed pre- and post-training questionnaires to assess universal precautions knowledge and to evaluate attitudes about their perceived risk for bloodborne pathogen infection, the importance of universal precautions procedures, and their willingness to provide care for human immunodeficiency virus (HIV)-positive or acquired immune deficiency syndrome (AIDS) patients. Phlebotomy, intravenous catheter insertion, and arterial blood gas sampling techniques were demonstrated, practiced, and evaluated during practical training sessions. Outcome measures included changes in pre- and post-training knowledge scores and attitudes, as well as observed compliance with universal precautions during practical training.**

Results. **Universal precautions knowledge scores increased significantly after training ($P < 0.0001$). Personal assessments of the risk of developing HIV due to patient care significantly decreased ($P < 0.0001$) and willingness to provide care for AIDS patients increased ($P = 0.004$) following training. Importantly, students reported that high expected rates of contact with HIV-positive and other patient groups would not significantly affect their specialty choice. Observed compliance with universal precautions procedures during practical training ranged from 95 to 99% for glove use, 76 to 77% for direct sharps disposal without needle recapping, and 56 to 78% for handwashing after glove removal during phlebotomy and intravenous catheter insertion.**

Conclusions. **This program is effective in increasing students' knowledge of universal precautions. Training favorably affects students' willingness to care for HIV-positive patients and their assessed risk of developing occupational bloodborne infection.** © 1995 Academic Press, Inc.

INTRODUCTION

Health care workers are at increased risk for exposure to bloodborne pathogens, including the human immunodeficiency virus (HIV), hepatitis B virus, and hepatitis C virus. Studies evaluating self-reported rates of exposure to blood and body fluids have found that training and implementation of universal precautions may decrease that risk (1–5). In 1992 the Occupational Safety and Health Administration (OSHA) established the Bloodborne Pathogens Rule, which mandates annual instruction in universal precautions procedures for workers at risk for exposure to blood and body fluids (6). However, medical students are often not considered employees of the hospitals in which they train and thus are not covered by OSHA's regulations, despite having higher rates of needlestick injury than most other health care workers (7–9). Furthermore, their knowledge of universal precautions procedures prior to entering residency may be inadequate (10, 11).

For these reasons the Association of American Medical Colleges has recommended that all medical stu-

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dents be instructed in universal precautions prior to assuming clinical responsibilities (12). However, little information is available on optimal training methods or the effectiveness of training in increasing students' knowledge of and compliance with universal precautions. Similarly, the effect of universal precautions training on students' perceived risk for occupational bloodborne infection or on their willingness to provide care for HIV-positive patients is poorly understood. We therefore developed and assessed an educational and practical training program to instruct 2nd-year medical and preclinical physician assistant (PA) students in universal precautions and the safe performance of bedside invasive procedures. The impact of this training program on students' knowledge and attitudes was assessed by pre- and posttraining questionnaires. Observed compliance with universal precautions was also recorded by trained observers in practical training sessions.

METHODS

Training Program

An educational program to teach universal precautions to 2nd-year medical and preclinical PA students, including both didactic and practical training, was developed and implemented at the University of Iowa College of Medicine in 1991–1992. Initial didactic training included lectures, two brief videotapes, and a question-and-answer period. The lecturers discussed common bloodborne pathogens, occupational transmission, isolation procedures, the use of protective equipment, and the safe performance of phlebotomy and intravenous catheter insertion. The first videotape, *HIV and AIDS: Essentials of Professional Practice,* reviewed universal precautions procedures, including definitions of infectious materials and the use of protective equipment to decrease exposures, as well as instructions for HIV testing and obtaining sexual histories from patients. A second videotape, *The Barbara Fassbinder Story,* developed by the Midwest AIDS Training and Educational Center, related the experience of a midwestern nurse who seroconverted for HIV after a cutaneous (nonsharps) occupational exposure to blood from an AIDS patient. The total didactic component required approximately 2 hr for each student to complete.

During practical training sessions, small groups of four students each received instruction from internal medicine and anesthesia residents and staff on the safe performance of phlebotomy and the insertion of intravenous catheters. Instruction included discussion of glove and tourniquet use, finding a suitable vein, preparation of the skin, control of bleeding by releasing the tourniquet and using gauze pads, direct disposal of the needles and syringes without recapping into an impermeable plastic sharps container, and handwashing after glove removal. Informed consent and release of injury liability waivers were completed by each student prior to the training sessions. Phlebotomy techniques, using both syringe-and-needle and Vacutainer systems, were demonstrated on mannequin arms, after which students practiced the procedure on mannequin arms and then on each other. Intravenous catheter insertion was similarly demonstrated and practiced. Arterial puncture techniques were taught using a locally developed videotape with subsequent demonstration by respiratory therapists. Students practiced arterial puncture only on mannequin arms. Compliance with universal precautions was emphasized during each stage of the practical session, which required approximately 2 hr for each student to complete. This program has been used to train medical and PA students for the past 3 years.

Assessment

Knowledge was assessed over a 1-week period before and after didactic training by the administration of a questionnaire consisting of 16 true–false statements on key universal precautions concepts (13) and 1 multiple choice question on the risk of transmission of HIV from a single percutaneous injury. The true–false statements were derived from the Centers for Disease Control's most recent universal precautions guidelines and other relevant published scientific literature. Statements were phrased so that similar proportions of answers were true and false. Additionally, the respective true and false statements were presented in random order. Sample statements included: (a) Almost all cases of documented seroconversion to the HIV virus after occupational exposure have been associated with blood exposure. (b) Goggles and mask should be worn when caring for any HIV-positive patient. (c) Handwashing is not necessary after glove removal. (d) Seroconversion beyond 6 months after an occupational exposure to HIV is uncommon. (e) The safety and efficacy of the hepatitis B vaccine has yet to be demonstrated convincingly.

Attitudes were measured with 9-point Likert scales before and after training. Students were asked to estimate the importance of wearing gloves when contact with a patient's blood or body fluids is anticipated and the importance of always disposing of sharps directly into a sharps containers without recapping needles, on a scale ranging from 1 (unimportant) to 9 (very important). Students reported their perceived risk of developing HIV or hepatitis B infection due to patient care, ranging from 1 (extremely low) to 9 (very high). Students also rated their willingness as a physician to provide medical care for AIDS patients in the future on a scale from 1 (never) to 9 (as needed). Finally, students were asked to estimate the effect of high rates of ex-

pected contact with specific patient groups (including HIV-positive, cancer, pediatric, and geriatric patients) on their anticipated likelihood of choosing the specialty. The endpoints of these latter four questions ranged from 1 (much increased) to 9 (much decreased), with a midpoint of 5 (no effect).

Compliance with universal precautions procedures during the practical training sessions was determined using three components of the Universal Precautions Assessment Tool described by Gauthier and colleagues (14). Instructors were trained in the assessment of compliance using the tool. The instructors then directly observed the students and, following the session, recorded whether they successfully performed the procedures, used gloves during procedures, directly disposed of needles without recapping, and washed their hands after glove removal.

Statistical Methods

Differences in universal precautions knowledge scores and attitudes were compared for the demographic factors of age and gender. Change in universal precautions knowledge was evaluated with a paired t test comparing the sum of true–false statements answered correctly before and after training. The Mantel–Haenszel χ^2 test was used to compare pre- and postcategorical estimates of the risk of seroconversion after percutaneous exposure to HIV-infected blood. The test–retest reliability of the attitudinal scales were assessed over a 1-week period with the Guttman split-half reliability scale. Wilcoxon matched-pairs signed-rank tests were used to assess pre- and posttraining attitude changes. The effect size of the attitude changes was calculated as described by Cohen by dividing the mean change by the standard deviation of the baseline value (15). Compliance with universal precautions during practical training by procedure, age, and sex was compared with the χ^2 test. All statistical analyses were performed in SPSS for Windows (Chicago, IL). α was set at 0.05 and all P values are two-tailed.

RESULTS

A total of 170 students participated in the practical training sessions (151 medical students and 19 PA students). One hundred sixty-five students (146 medical students and 19 PA students) attended the didactic training sessions and completed both the pre- and the posttraining questionnaires. The results for medical and PA students were not significantly different, so data from the two groups were combined for subsequent analyses.

Students' knowledge of universal precautions, as evaluated by true–false content statements, increased significantly after the training program (from a mean of 85% correct to 98% correct, $P < 0.0001$). There were no significant differences in levels of universal precautions knowledge by age or gender.

The overall test–retest reliability of the attitudinal scales was good ($r = 0.69$). There were no significant differences in the attitudinal scales by age or gender. The training program did not significantly change students' attitudes regarding the importance of glove use when contact with blood or body fluids was anticipated; all considered it "very important" both pre- and posttraining. However, the students rated the direct disposal of sharps without recapping needles as significantly more important following universal precautions training (effect size = 0.291, $P < 0.0001$). Students assessed their risk of developing HIV due to patient care as significantly less following training (Table 1, effect size = 0.296, $P < 0.0001$). Willingness to provide care for AIDS patients was high and increased after training (effect size = 0.167, $P = 0.004$). Similarly, students' perceived risk of acquiring hepatitis B due to patient care changed following training (effect size = 0.159, $P = 0.022$). Students reported that high rates of expected contact with HIV-positive patients would slightly de-

TABLE 1

Changes in Attitude Measured before and after Didactic Training

Factor	Baseline mean	Posttraining	Mean difference	Effect size[a]	P value[b]
Importance of glove use when contact with blood or body fluids is anticipated[c]	8.92	8.91	−0.01	0.028	1.00
Importance of direct sharps disposal without recapping needles[c]	8.35	8.76	0.41	0.291	<0.0001
Risk of infection from HIV patients due to direct patient care[d]	2.76	2.23	−0.53	0.296	<0.0001
Risk of infection from hepatitis B patients due to direct patient care[d]	4.28	3.98	−0.30	0.159	0.0215
Willingness to care for AIDS patients[e]	7.44	7.76	0.32	0.167	0.004

[a] Effect size = mean difference divided by baseline SD.
[b] Wilcoxon signed-rank test for matched-pairs (two-tailed).
[c] Likert scale ranging from 1 "unimportant" to 9 "very important."
[d] Likert scale ranging from 1 "extremely low" to 9 "very high."
[e] Likert scale ranging from 1 "never" to 9 "as needed."

TABLE 2

Changes in Attitude Regarding Specialty Choice Measured before and after Didactic Training

Factor	Baseline mean	Posttraining	Mean difference	Effect size[a]	*P* value[b]
Effect of high rates of expected contact with HIV patients on future specialty choice[c]	5.53[d]	5.57	0.04	0.024	0.689
Effect of high rates of expected contact with elderly patients on future specialty choice[c]	4.96	4.88	−0.08	0.075	0.735
Effect of high rates of expected contact with cancer patients on future specialty choice[c]	4.82	4.87	0.05	0.043	0.348
Effect of high rates of expected contact with children on future specialty choice[c]	4.55	4.38	−0.17	0.096	0.323

[a] Effect size = mean difference divided by baseline SD.
[b] Wilcoxon signed-rank test for matched-pairs (two-tailed).
[c] Likert scale ranging from 1 "much increased" to 9 "much decreased."
[d] $P < 0.001$ compared with mean scores for other specialty choices.

crease the likelihood of choosing a specialty in the future ($P < 0.001$, Table 2), compared with the results for elderly patients, oncology patients, and children. However, there was no effect of training on the likelihood of future specialty choice.

Success in the performance of procedures during practical training was good. Overall, 88% of students successfully performed phlebotomy while 83% successfully inserted iv catheters. There were no significant differences in compliance between men and women or by age. Compliance with universal precautions guidelines during the practical training session was excellent for glove use (Fig. 1, 95% during phlebotomy, 99% during iv insertion), good for direct sharps disposal (76 and 77%, respectively), but only fair for handwashing after glove removal (56 and 78%).

DISCUSSION

There are several novel aspects to the current study. We assessed knowledge of universal precautions and attitudes toward patient care using a pre- and posttraining intervention design. The major advantage of this design is that it allows assessment of the effects of training within subjects over time, a statistically powerful approach. Both knowledge of universal precautions concepts and attitudes toward patient care were changed in the desired directions. Another important aspect of the study was development and assessment of the effect of practical training sessions which used skilled instructors to teach safe performance of bedside invasive procedures, in concert with routine use of universal precautions. Importantly, we were able to directly measure observed compliance with universal precautions during these practical training sessions without difficulty.

The transition from preclinical to clinical training is a stressful one, particularly for health sciences students learning new procedures that place them at risk for occupational exposure to HIV and hepatitis B virus. Reports of improved compliance with hepatitis B vaccination among medical students are encouraging (16, 17). However, with up to three-fourths of medical students and residents reporting at least one occupational blood or body fluid exposure per year, even greater efforts are needed to prevent as many hazardous exposures as possible (7, 18, 19). Ensuring that medical students are familiar with universal precautions guidelines is the first step toward improving their compliance with such procedures, which should minimize occupational exposures and the potentially devastating consequences.

Two recent studies have found knowledge of universal precautions procedures among senior medical students and entering 1st-year residents to be inadequate (10, 11). Koenig and Chu (10) surveyed 151 4th-year medical students, asking them to choose, for a variety of different procedures, the required level of protection (e.g., none, mask only, gloves only, mask and gloves, etc.). Describing the students' knowledge of universal

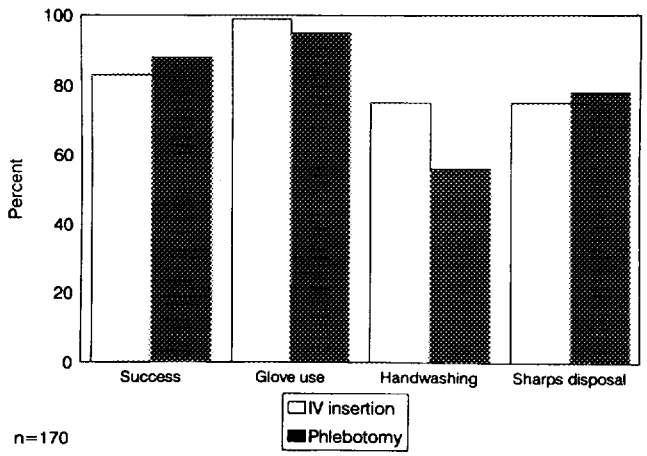

FIG. 1. Rates of successful performance of phlebotomy, intravenous catheter insertion, and universal precautions procedures among medical and physician assistant students.

precautions as "stunningly inadequate," the authors note that only approximately one-half of students surveyed correctly identified the proper protective equipment needed for procedures that required the use of masks, gloves, and protective eyewear. Goetz and colleagues (11) similarly surveyed entering 1st-year residents regarding their knowledge of and experience with infection control. Less than one-third of the residents evaluated knew the risk of contracting hepatitis B after percutaneous exposure, even though 40% reported having had a percutaneous (needlestick) injury during clinical training. Interestingly, although 74% of residents reported having received universal precautions training, there was no relationship between prior training and either knowledge scores or needlestick exposure rates. These reports emphasize the importance of both improving medical students' knowledge of universal precautions concepts and assessing the effectiveness of universal precautions training programs in doing so.

Sokas and colleagues recently reported the development and implementation of a training program in universal precautions that significantly improved medical students' knowledge and sense of competency. Their program included didactic and practical training sessions, although compliance with universal precautions during the practical training session was not directly measured (20).

The educational program we describe also significantly increased medical students' knowledge of universal precautions. Additionally, students in our study rated the practice of direct sharps disposal without recapping as significantly more important following training.

The measured rates of handwashing compliance in our study are similar to or higher than those observed in the few published studies of handwashing compliance among health care workers (21–23). It should be noted that the importance of handwashing in preventing nosocomial infection and as part of effective universal precautions, e.g., following glove removal, has been convincingly demonstrated (23–25).

Our estimates of compliance with universal precautions likely represent a "best-case" scenario, since compliance was frequently reinforced during training and students were anxious to perform well. We also could not ensure complete standardization of teaching methods or direct compliance evaluation, since a number of different instructors were involved in the practical training session. Nonetheless, improved knowledge and compliance with universal precautions during training should translate into decreased risk of occupational exposure.

Students' attitudes with regard to their own risks for occupational infection and their willingness to care for AIDS patients also changed following universal precautions training. The measured decreases in perceived risks of occupational HIV and hepatitis B infection by students probably reflect a more realistic assessment of a previously overestimated risk.

Students' increased willingness to provide care for HIV patients after training is encouraging and may also reflect this more realistic risk assessment. This is in contrast to a recent report by Weyant and colleagues of a trend toward the development of increasingly restrictive attitudes about the care of HIV patients among medical students during clinical training (26). In their study, medical students (surveyed before and after clinical training) also reported decreasing interest in performing recommended infection control practices to protect themselves. The effect of intensive universal precautions training and/or blood and body fluid exposures during clinical training on willingness to provide care for HIV-positive patients could have important implications for specialty choice and should be further investigated. Our study is obviously limited by its short-term follow-up period. Further study is underway of the long-term impact of universal precautions training on knowledge retention, on universal precautions compliance, and on rates of occupational exposure to blood and body fluids during clinical training.

The training program described herein improved medical students' knowledge of universal precautions. More extensive practical training, including direct observation, assessment and reinforcement of compliance with aspects of universal precautions procedures, may be necessary to optimally prepare medical students to begin clinical training. These practical training sessions should include demonstration of engineering devices (i.e., needleless iv systems, self-sheathing catheters) designed to prevent sharps injuries. We feel students should be trained with the devices actually in use at the site where they will receive clinical training and thus will most likely encounter.

The combination of this training with discussions of professional ethics and historical perspectives on risks assumed by health care professionals during caregiving may further accentuate the positive effects of training on students' willingness to provide care for HIV-positive or other high-risk patients.

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