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Evaluating the Effectiveness of a Continuing Education Program for Prevention of Occupational Exposure to Needle Stick Injuries in Nursing Staff Based on Kirkpatrick’s Model

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Abstract: Background: Nurses are the most vulnerable group that are faced with occupational injuries caused by exposure to needle stick injuries. This study evaluated the effectiveness of a continuing education program about the prevention of occupational exposure to needle stick injuries in the nursing staff, based on the Kirkpatrick model.

Methods: In this study, 120 nurses were selected in the experimental and control groups. A continuing education program for experimental group was performed. After the education program, its effectiveness has been evaluated across four levels (Reaction, Learning, Behavior, Results) of the Kirkpatrick model.

Data analysis was conducted using Pearson’s correlation coefficient, chi-square test, paired t-test, independent samples t-test, and descriptive statistics. The data were analyzed using the SPSS statistical software (V. 22).

Results: The mean score for knowledge in the experimental group improved significantly from 8.32 ± 2.17 to 13.98 ± 1.2 (p < 0.05). The experimental group of 24 nurses (40%) were exposed to needle stick injury before education, but this number was reduced to 9 (15%) after intervention. The chi-square test showed a significant difference (P = 0.013). However, in the experimental group, 15 nurses (25%) were exposed to blood and body fluids before intervention, but again it was reduced to 6 (10%) after education. The chi-square test showed a significant difference (P = 0.002).

Conclusion: The results from the execution of continuing education program showed that through designing training programs and raising awareness in nursing personnel, we can reduce occupational exposure to needle stick injuries.

Keywords: Continuing education, Effectiveness, Occupational exposure, Kirkpatrick’s model.

BACKGROUND

In every organization, the most important resource is the staff; ensuring the personnel’s health, especially their occupational health, plays an important role in increasing the organization’s efficiency. Generally, healthcare workers deal with biological hazards such as; patients’ blood and body fluids. Results from Martins et al., study showed that among healthcare workers, nurses are the most vulnerable group that are faced with occupational injuries caused by exposure to needle stick injuries. Foley in this regard wrote that due to lack of proper educational programs and not reporting them, needle stick injuries have turned into a serious problem for nurses which threaten their occupational health. Annually, approximately three million healthcare workers in the world are exposed to blood transferred viruses, which leads to 16,000 cases of hepatitis C, 66,000 cases of hepatitis B and 200 to 5000 cases of HIV infection. Denis & et al., stated that injuries caused by exposure to needle stick and blood and body fluids are the most common way for transmission of viral infections. The medical costs of infections caused by occupational exposure to needle stick injuries is estimated at one million dollars; these expenses include lab tests, follow-ups, costs of disability and being absence from work. According to reports from the National Institute for Occupational Safety and Health (NIOSH), the best way to prevent infections transmitted through occupational exposure to sharp objects is to educate workers on taking preventive measures. Staff training programs are only valuable if concrete evidence reveals their effectiveness in changing the participants’ behavior and performance; this process is called evaluating the effectiveness of training.

Donald Kirkpatrick’s model is one of the most popular models for evaluation of training effectiveness; this model evaluates effectiveness across four levels. Level 1 (Reaction)
evaluates if the learners are satisfied with the program. Level 2 (Learning) measures if the program was able to increase the knowledge of learners to a favorable degree. Level 3 (Behavior) evaluates if the program could make a favorable change in the behavior of learners. Level 4 (Results) assesses if the educational program was able to solve the existing problems and meet the organizational goals.12

Evaluating the effectiveness of a continuing education program, based on Kirkpatrick’s model leads to making a decision for continuing the program and determining the effectiveness and improvement of program.13,14 Considering the importance of occupational health, and the high prevalence of occupational injuries with sharp objects, blood and body fluids among nursing staff, and the necessity to evaluate the effectiveness of education programs in the nursing profession, the present study aimed to evaluate the effectiveness of a continuing education program for prevention of occupational exposure to needle stick injury, blood and body fluids in a nursing staff based on Kirkpatrick model.

METHODS
This was a two-group before-after quasi-experimental design, which was done in mid-2016 in the Valiasr hospital associated with Fasa University of Medical Sciences, southern Iran. Selected subjects were nurses working in the ER, the internal ward, the surgical unit, the maternity ward and the infection units. The reason for this particular selection was that based on previous studies, there are higher chances of being exposed to sharp objects in these units.

With consideration of similar studies and using the formula for comparing two proportions, with the values $\alpha = 0.05$, Power = 80%, $P_1 = 15\%$, $P_2 = 39\%$ and $n_1 = n_2 = 50$, total sample size was determined at 100 individuals.15 Due to probabilities of losing subjects, we increased sample size to 120 individuals (60 in each group). The researcher visited the Valiasr hospital with a list of its nursing staff in hand; using Systematic Random Allocation and by considering the weekly schedule, odd numbers were placed in the experimental group and even numbers occupied the control group. In this study, experimental and control groups were both involved in all hospital wards, and there were 60 nurses in each group. Inclusion criteria were willingness to participate and not having taken related educational courses in the past six months prior to their participation. Exclusion criteria were refusal to continue and being absent in the training program. To uphold ethical standards, we obtained permission from the hospital management, didn’t indicate their first and last names, and ensured them about the confidentiality of information. Due to ethical issues, at the end of the research, we handed out booklets related to prevention of occupational exposure to the control group as well.

We used the following tools to evaluate the effectiveness of our education program in prevention of occupational exposure based on Kirkpatrick’s model. The first level of Kirkpatrick’s model (Reaction) measures satisfaction levels. For this purpose we used a questionnaire consisting of 12 questions in 3 domains; program contents (5 questions), questions about teacher (4 questions), and questions related to facilities (3 questions). The questionnaire was distributed immediately after the training workshop, and the average score obtained from each domain was reported as the suitable number for the mentioned factors. This questionnaire was rated based on a Likert scale (Poor = 1, Average = 2, Good = 3, Very good = 4 and Excellent = 5). Content validity of the questionnaire was verified by 15 nursing professors, and its reliability was verified using Cronbach’s alpha (87%). The second level (Learning) determines the amount of which the taught skills and techniques are learned.16 In this level, evaluation was done via awareness questionnaire. This questionnaire consisted of 15 multiple choice items with 4 answers. Each item was rated from zero (minimum) to one (maximum), and the sum of all questions made the total awareness score. Zero showed the minimum awareness level of subjects and 15 the maximum. Awareness levels were classified in 3 levels (Poor, Average and Good); Poor: scores 0—7, Average: scores 8—11, Good: scores 12—15. The reliability of this questionnaire was previously verified by Patterson and Askarian through Cronbach’s alpha, which was 87% and 85%, respectively.17,18 Level 3 of Kirkpatrick’s model (Behavior) evaluates the changes in behavior or performance. The performance questionnaire was used to evaluate this level; the questionnaire had 15 multiple choice questions. Method of rating and grading was the same as for the awareness questionnaire. Validity of the questionnaire was verified by 15 nursing professors, and its reliability was verified with a Cronbach’s alpha of 78%. Level 4 (Results) determines the effects of the training program outcome.16 For this section, we used the questionnaire for exposure to sharp objects, blood and body fluids. Patterson evaluated the reliability of this questionnaire using the test-retest method; correlation coefficient between the scores obtained from being tested twice was 0.89 ($r = 0.89$). Askarian as well, assessed the reliability of this questionnaire with the test-retest method and arrived at the correlation coefficient of 0.87 ($r = 0.87$).17,18 In the project execution phase, necessary information on completing the questionnaires was given to nurses during briefings. Before execution of the continuing education program, awareness and performance levels were tested in both control and experimental groups. In order to determine the level of exposure to needle stick, blood and body fluids, the exposure questionnaire was distributed among studied subjects, and they were asked to report their incidents of exposure during the next 2 months. Then the
program was executed for the experimental group, with an emphasis on standard precautions, taking appropriate measures when exposed to needle stick and how to report exposures (the control group received no intervention). Duration of the continuing education program was 10 h. Training was done through lecture, question and answer session, videos and demonstration. Immediately after the program, tests of awareness and performance were carried out in both groups and the questionnaire for exposure to needle stick, blood and body fluids was again given to the subjects for 2 months in order to report the incidents of exposure. At the end, effectiveness of this continuing education program was evaluated in four levels based on Kirkpatrick’s model.

For data analysis, we used descriptive statistics, a chi-square test, a paired t-test and the independent samples t-test. Analysis was carried out via the SPSS-22 software and the significance level $P \leq 0.05$ was statistically accepted.

**RESULTS**

80% of the participants were women and 20% men. Average age was $30.4 \pm 7.8$ years in the control group and $31.7 \pm 8.6$ in the experimental group.

Average work experience in the control and experimental groups were $7.9 \pm 8.8$ and $8.7 \pm 9.8$ years, respectively.

Results from evaluation of effectiveness in level 1 of Kirkpatrick’s model (Reaction) showed that in the experimental group, 3 subjects (5%) expressed their satisfaction with the program as poor, 3 (5%) as average, 6 (10%) as good, 12 (20%) as very good and 36 (60%) as excellent. Generally, the participants’ satisfaction with the executed program was at a satisfactory level. Results from evaluation in level 2 (Learning) revealed that before intervention, awareness score of most subjects was at an average level (50%) in both groups. After educational intervention, the awareness scores remained at the same average level (50%) in both groups. After educational intervention, the awareness scores were reported 8.3 ± 2.17 and 13.98 ± 1.2 before and after intervention, respectively, which was statistically significant ($P = 0.0001$).

Independent t-test also showed that the difference in mean of knowledge scores before and after training between two groups was statistically significant ($P = 0.001$).

Mean awareness scores of the control group before and after training were $8.45 \pm 2.32$ and $8.86 \pm 2.38$, respectively, which wasn’t significant based on the paired t-test ($P = 0.32$); but in the experimental group, mean knowledge scores were reported $8.32 \pm 2.17$ and $13.98 \pm 1.2$ before and after intervention, respectively, which was statistically significant ($P = 0.0001$).

Independent t-test also showed that the difference between the mean scores of knowledge before and after training between the two groups was statistically significant ($P = 0.001$).

Results from evaluation in level 3 (Behavior) showed that before intervention, performance scores were poor for 55% of the control group subjects, and 50% of the subjects in the experimental group. After educational intervention, performance scores were 30% good in the control group, whereas in the experimental group, 75% got a good score.

Independent T-test also showed that the difference in mean of performance scores before and after training was statistically significant between the two experimental and control groups ($p = 0.125$). Pearson correlation coefficient showed a significant relationship between knowledge and performance, with increased awareness level, performance has also increased ($P = 0.004$, $r = 1.647$).

Results from evaluation of training effectiveness in level 4 of Kirkpatrick’s model (Results) showed the number of nurses exposed to needle stick injury in the control group was 21 (35%) and 18 (30%) before and after intervention, respectively. The chi-square test didn’t show any significant differences ($P = 0.54$). But in the experimental group 24 nurses (40%) were exposed to needle stick injury before education, but this number was reduced to 9 (15%) after intervention. The chi-square test revealed a significant difference ($P = 0.013$). (Table 1).

Also, in the control group, the number of nurses exposed to blood and body fluids, was 18 (30%) and 12 (20%) before and after education program, respectively.

**Table 1.** Comparing levels of exposure to needle stick injury in the two groups, before and after education.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Before educational intervention</th>
<th></th>
<th>After educational intervention</th>
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<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
<td>Percent</td>
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<tr>
<td>Experimental group</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exposed</td>
<td>24</td>
<td>40</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Not exposed</td>
<td>36</td>
<td>60</td>
<td>51</td>
<td>85</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Exposed</td>
<td>21</td>
<td>35</td>
<td>18</td>
<td>30</td>
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<tr>
<td>Not exposed</td>
<td>39</td>
<td>65</td>
<td>42</td>
<td>70</td>
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</table>
The chi-square test showed no significant differences (P = 0.65). However in the experimental group 15 nurses (25%) were exposed to blood and body fluids before intervention, but then again it was reduced to 6 (10%) after education. The chi-square test showed a significant difference (P = 0.002). (Table 2).

### DISCUSSION

Considering the serious threat that injuries from exposure to needle stick contaminated with blood and body fluids impose on nurses, we conducted the present study to determine the effectiveness of a continuing education program for occupational exposure to needle stick injury, blood and body fluids in a nursing staff based on Kirkpatrick’s model. In level 1 of Kirkpatrick’s model, satisfaction levels were at the excellent level for most of the participants (60%). Results from Mohan et al., study also showed that in the reaction level, most participants were satisfied with the training course to a very good degree. Tavakoli believes that the first level of Kirkpatrick’s model (Reaction) is the most common kind of evaluation in organizations; this level evaluates reactions of learners immediately after the training course is finished and provides an instantaneous feedback on the teacher’s performance and program contents. Regarding level 2 of Kirkpatrick’s model (Learning), our results showed improvement in awareness scores of participants after training. In a quasi-experiment in China, which aimed to evaluate the effects of a training program on 50 nurses working in a hospital, the awareness of nurses about different aspects of occupational safety was increased. In level 3 of Kirkpatrick’s model (Behavior), our results showed that the performance scores of the nursing personnel improved after execution of education program. In this regard, the study of Wang et al. shows the implementing training programs, other than raising awareness levels, improves the performance of learners relating to health behavior for prevention of exposure to needle stick injury, and blood and body fluids contamination. Results from the present study regarding level 4 of Kirkpatrick’s model (Results) revealed that in addition to the increase in awareness levels and improvement of behavior and performance in the experimental group, there was also a decrease in levels of exposure to needle stick injury, and contamination with blood and body fluids; such that the 40% level of exposure to needle stick injury before education program was reduced to 15% after intervention. Also, levels of contamination with blood and body fluids decreased from 25% before education to 10% after it. In Yang et al., interventional study in Taiwan, 107 nurses participated in a education program and was monitored for occupational exposure to needle stick injury for 4 months. Their results showed the reduction of occupational exposure levels from 57% before education program to 24% after it. None of the mentioned studies used one model to evaluate effectiveness of education program; some evaluated awareness and performance and some results. The advantage of using models for evaluation of education effectiveness is that we can become aware of a program’s strengths and weaknesses, and plan for their improvement; also, we can demonstrate the effects of continuing education program on changing participants’ behavior and performance with concrete evidence; this revealed the importance of the present study.

### Limitations

One of the limitations of the present study is that Kirkpatrick’s model of evaluation has not been used in the similar studies conducted in different countries, so the researcher has limitations in comparing the results of this study with those of the others, and she (he) has solely compared the results of the present research with those of the other studies in terms of knowledge and performance. Thus it is suggested that researchers use evaluation models in similar studies in order to determine the effectiveness of the programs.

### CONCLUSIONS

Results from the execution of continuing education program shows that through designing education programs and raising...
awareness in nursing personnel, we can reduce occupation exposure to needle stick injury and blood exposure.

REFERENCES


