Original Article

Educational Study Based on Kirkpatrick's Model for Reducing False Positive Blood Cultures

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Abstract

Background: Blood culture is an important diagnostic test for identifying severe circulation infections and selecting appropriate antimicrobial treatment. The growth of microorganisms in the blood culture that is not present in blood under normal conditions is termed as false positive and it is caused by skin contamination that occurs while taking the culture.
Objective: The aim of this study is to evaluate an educational approach given to the nurses in the reduction of false-positive blood cultures, which have many negative effects on patient safety and the health care system.
Methodology: In this study nurses trained about taking blood culture performed with aseptic non-touch technique and the effectiveness of the training was assessed by using pre-posttest design. This study also assessed the satisfaction of nurses and their ability to take blood culture. The effectiveness of the training was assessed by using Kirkpatrick's Model.
Results: The nurses' pre/post training knowledge mean scores increased significantly (Z: -3.792; p:0.000). The nurses' mean pre-training score was 39.5±12.86 and 69.47±14.32 after training. The nurses' satisfaction level was high.
Conclusion: This study shows that the educational programme based on Kirkpatrick's Model for reducing false positive blood culture rate can increase nurses' knowledge level and awareness of the topic.

Key words: blood culture; Kirkpatrick, education, training evaluation, pediatric nursing.

Introduction

Blood stream infections are complex processes that occur because of many interactions between a microorganism causing infection and the living creature affected by the microorganism (Park et al., 2015). These infections are defined as the primary cause of morbidity and mortality in comparison with antibiotherapy and adjuvant treatments (Ramirez et al., 2015). Therefore, the early diagnosis of blood circulation infections and providing a treatment appropriate to the diagnosis are vital (Hopkins et al., 2013). Blood cultures are the gold standard for the accurate diagnosis of life-threatening microorganisms in patients (Murphy et al., 2014; Doern et al., 2019). There are several points that health professionals should pay much attention to while taking a peripheral blood culture. Among these points, the possibility of a false-positive blood culture is the most demanding. The growth of microorganisms that are not present in in the blood culture the blood under normal conditions is designated a false positive. A false positive blood culture is caused by skin contamination that occurs while taking the culture. False positivity reduces the reliability of the blood culture test (Pavlovsky et al. 2006). Contaminated (false-positive) blood culture can be also defined as the growth of bacteria of skin flora in a single culture flask *(coagulase-negative staphylococci, Aerococcus, Micrococcus, Propionibacterium spp, Bacillus spp. [except for Bacillus anthracis], Corynebacterium spp. [Diphtheroids] and alpha*

and gamma hemolytic streptococci) (Synder, 2015). When a positive culture result is seen in peripheral blood culture, the ability to decide whether this microorganism is a circulatory system infection that may cause morbidity and mortality, or it is a false-positive blood culture related to skin contamination has vital importance (Doern et al., 2019). False-positive blood cultures have many negative effects, both on patients receiving treatment and the health system. The most striking ones among these negative effects are unnecessary antibiotic use, irrational drug use-related flora change and resistance development, toxic effects on organs, prolonged hospitalization and additional costs. (Self et al., 2014; Alnami et al., 2015; Yodoshi et al., 2019). As stated in the study of Long, patients who have false positive blood culture results are hospitalized for 4.5 days more than those who have true negative (Long & Koyfman, 2016). In another study, it was reported that false positive blood culture brought an additional cost of $ 7500 per patient (Alahmadi et al., 2011). The evaluation of training programs and their importance is increasing gradually day by day. One of the most well-known models for the evaluation of training is the "Kirkpatrick Training Evaluation Model", which was published by Donald Kirkpatrick in 1954. Although it has been sixty years then, Kirkpatrick's Training Evaluation Model is still valid today and is used in many areas (Gunderman & Chan, 2015). It consists of four levels respectively. Reactions/Responses, Learning, Behavior, and Results. Kirkpatrick also stated that each level is highly important and all levels are associated. The aim of "Reactions/Responses" level is to assess the reactions of individuals who participate in training for the relevant training. The words, reaction or response used here refer to satisfaction and content the participants feel with the training (Kirkpatrick, 2009; Pardue, 2015). The second level is "Learning" and it is defined as a change in participants' attitudes and an increase in their theoretical knowledge and practical skills by participation in the training. The examination of the literature shows that there are some studies conducted using Kirkpatrick Training Evaluation Model. Clark et al. (2014) addressed the third level of the Kirkpatrick Training Evaluation Model (Behavior) with 18 nurses in the sample (Clark et al., 2014). Similarly, the first two levels of the Kirkpatrick's Model were used in our study. To evaluate the "Reactions/Responses" level, the nurses ' satisfaction was questioned; to evaluate the "Learning" level, the nurses' information was questioned.

Objective: There are several published studies conducted on the effectiveness of the training method in decreasing peripheral blood culture contamination (Park et al., 2015; Ramirez et al., 2015; Hopkins et al., 2013; Al-Hamad et al., 2016; Bowen et al., 2016; O'Connor et al., 2016). In this context, the aim of this study is to evaluate the training approach given to nurses in reducing false positive blood cultures that have many negative effects on patient safety and health system through Kirkpatrick's model. The aim of the study is also to increase the awareness of nurses on the subject, to improve peripheral blood culture collection process and indirectly reduce false positive blood culture rates. The questions expected to be answered in this research are as follows;

- Does the training activity have an impact on the level of knowledge of nurses?

- Does the quality of training activity affect the satisfaction of nurses?

Methodology

This study has quasi-experimental single group pre-posttest design. The study sample consisted of nurses working in the Pediatric Emergency Department (ED) and the Pediatric Gastroenterology Department (GD) of a university hospital who voluntarily agreed to participate in the study.

The reason for choosing these two clinics was that they were the most frequently used peripheral blood culture clinics of the hospital.

A power analysis method was used to determine the sample to be 16 nurses for at least a 5% margin of error and an 80% statistical testing power. The number of nurses was 14 in the ED and 6 in the GD. Because one of the nurses in the ED resigned from her job, the sample was regarded as consisting of 19 nurses during the training and in all stages after the training. The data were collected between April 2016 and September 2016.

Data Collection Tools
<u>Evaluation of Taking Blood Culture Performed with ANTT Information Questionnaire:</u> This questionnaire was developed by the researchers in accordance with

the relevant literature (Park et al., 2015; Ramirez et al., 2015; Hopkins et al., 2013; Al-Hamad et al., 2016; Bowen et al., 2016; O'Connor et al., 2016) and the training program. The first part included questions about the demographic characteristics of nurses. The second part of the questionnaire consisted of questions about the definitions of ANTT and its practice stages. The evaluation form included 20 questions, some of which were multiple-choice and some of which were true-false questions. The opinions of the experts were asked about the form.

The Nurse Satisfaction Evaluation Form: This form prepared by the researcher based on the literature (Cömert, 2015) consisted of questions to determine nurses' age, sex, professional experience, and their opinions about ANTT. The nurses were asked to mark one of the options ranging from 1 (Disagree) to 3 (Agree) for their agreement level on each statement included in the questionnaire. The second part of the form was developed by the researcher based on the relevant literature. It is a 5-point Likert type questionnaire consisting of questions about the adequacy of training in terms of theoretical and practical knowledge, its contribution to nursing knowledge and professional development, and the duration of training and its flow. The questionnaire also included questions about the satisfaction of nurses with the knowledge and practice competency, skill of managing time, command of the subject, presentation skill and communication skills of educator providing the training.

Data Collection Procedure

In the first stage on the study, an "Information Questionnaire" that was developed in accordance with the literature (Park et al., 2015; Ramirez et al., 2015; Hopkins et al., 2013; Al-Hamad et al., 2016; Bowen et al., 2016; O'Connor et al., 2016) to assess the nurses' knowledge level about ANTT and taking blood culture was administered to 20 nurses as pre-test. Moreover, a training program included details about taking a blood culture using the ANTT was provided to 19 nurses (one of the nurses quit from her job) in groups consisting of 1 to 5 individuals as eleven sessions. Each session lasted approximately one hour. The ANTT training presentation was prepared in accordance with the current literature (ANTT, 2015; Rowley & Clare, 2011) using the ANTT Clinical Guideline based on documents sent by the Association for Safe Aseptic Practice to the researchers. The content of training included topics such as the definition of circulatory system infections; the definition of false positive blood culture; the causes of a false positive blood culture; the definition, and the principles and practice stages of ANTT. The training consisted of a PowerPoint (Microsoft, Redmond, WA) presentation and a video explaining the process of taking peripheral blood culture by using the ANTT.Finally, in the first stage of the study, the information questionnaire was administered as the post-test to determine the effect of the training program. In the second stage of the study, satisfaction form about ANTT technique and training provided was administered to all of the nurses to implement the first level of Kirkpatrick's Model. The nurses' opinions and thoughts about the and training were determined.

Figure 1: Research steps

Data Analysis: The data were assessed in the Statistical Package for Social Science (SPSS) 22.0 program. The descriptive data related to patients were presented as number and percentage in the data analysis. A Wilcoxon test was performed to assess the significant difference between the nurses' pre-test and post-test results. McNemar's test was performed to assess the difference between each of the questions to discern whether they were answered correctly before and after the training. A correlation analysis was performed to examine the relationship between the pre-test/post-test and the answers given for the satisfaction questionnaires.

Ethical Considerations: For the application of the research; written consent was obtained from the Faculty of Medicine Children's Hospital (273-3559). Verbal consent was obtained from nurses. Ethics committee approval was obtained from the Faculty of Nursing Scientific Ethics Committee (2016-128).

Results

Participant Characteristics: Of the nurses who participated in the study, 95% (n:19) were female and their mean age was 30.35±5.98 years. This study found that 42.1% (n:8) of the nurses had been working for 6–10 years and 70% (n:14) were working in the ED. This study also found that 36.8% (n:7) of the nurses were working in their department for 0–1 year. Of the nurses, 85% (n:17) had a bachelor's degree and 70% (n:14) had received asepsis training previously. Also, 95% of nurses (n:19) had the opinion that contaminated blood culture is the nurse's fault.

Participant Knowledge: Overall statistical significance was found between the numbers of questions answered correctly before and after the training (Table 1).

Table 1. Change in participants' knowledge levels

Variables	Pre-Test	Post-Test	Analysis Value (Z)	P
Number of correctly answered question	7.9±2.5 *Min:4* *Max:14*	13.89±2.86 *Min:7* *Max:17*	-3.792	.000

Table 2. Participant Satisfaction (n:19)	Disagreed		Hesitant		Agreed	
	n	%	n	%	n	%
I think that I create more effective skin antisepsis by using the ANTT	-	-	-	-	19	100
I think that ANTT is not useful in term of time management	7	36.8	6	31.6	6	31.6
I think that taking blood culture using ANTT is more useful in reducing workload compared to the conventional method	7	36.8	3	15.8	9	47.4
I think I can protect both myself and patients to whom I provide health care more effectively with the help of ANTT	-	-	3	15.8	16	84.2
I think I should follow the Application Instructions for ANTT for each patient while working in the unit	-	-	-	-	19	100

I think that more than one hand-washing practices are not practical while following the ANTT	4	21.2	7	36.8	8	42.1
I think that more than one hand-washing practices performed while following the ANTT Instructions will irritate my hands	2	10.5	7	36.8	10	52.6
The training was adequate in terms of theoretical information	-	-	2	10.5	17	89.5
The training was adequate in terms of practical information	2	10.5	1	5.3	16	84.2
The training increased my awareness about the topic	2	10.5	-	-	17	89.5
I want such trainings to be provided again	3	15.8	2	10.5	14	73.7
I liked the training in general	-	-	2	10.5	17	89.5
The knowledge and practice level of educator was adequate	-	-	1	5..3	18	94.8

Participant Satisfaction: For the question in the last part of the form, "*What are the causes that hinder you from using ANTT when taking blood culture?*", the answers, working in a Pediatric ED (n:5), the high number of patients (n:4), lack of personnel (n:6), inadequate materials (n:5), time limitation (n:4), patients having central venous catheter generally (n:1), and heavy workload (n:2) were given.

The study also examined the relationship between reaction and learning levels. The Pearson correlation analysis was used to examine these relationships. The results of the analysis showed that there was a weakly positive correlation between the answers for the statement, "*I think that the Application Instructions for ANTT can be easily followed*" and the post-training scores" (r=.409, p=.033). The study also found that there was a moderately positive correlation between the statement, "*The content of the training was closely related to my working field*" and the pre-training scores (r=.470, p=.011). Moreover, there was a moderately positive correlation between the statement, "*The duration of training was adequate*" and the pre-training scores (r=.512, p=.025). The study also found a moderately positive correlation between the statement, "*I liked the training in general*" and the pre-training scores (r=.555, p=.014).

Discussion

Obtaining accurate results in peripheral blood culture tests is one of the factors vital to providing effective nursing care. One of the most effective interventions for the prevention of false positive blood cultures in hospitalized children and applying the asepsis/antisepsis rules effectively is to provide nurses with education (Al-Hamad et al., 2016; Bowen et al., 2016; O'Connor et al., 2016). The present study found that the nurses' knowledge level of false positive blood cultures and preventing them increased and they answered the questions accurately at higher levels. Similarly, a study by Al-Hamad et al. (2016) assessed the effectiveness of training provided for false positive blood cultures and contamination; the authors found that there was a significant difference between pre- and post-training knowledge scores and that the training increased the knowledge level. The same study reported that the training which was provided to nurses to reduce contamination in peripheral blood cultures made improvements in patient care and the prevention of infections (Al-Hamad et al., 2016;). The nurses included in another study stated that they found the training provided to them about peripheral blood culture contamination useful and that the training motivated them (Bowen et al., 2016).

According to the examination of findings related to the level of reaction, which were obtained from the administered to the nurses who participated in the training, the highest percentages were found in the reactions with 100% participation rate. In the present study, 42.1% of the nurses agreed with the statement, "*I think that more than one hand-washing practices are not practical while following the ANTT*". Similarly, in the study by Maraş, 2.94 out of 4 nurses stated that that they did not found washing hands after each patient contact practical. Of the nurses in the present study, 52.6% gave the answer, "*I think that more than one hand-washing practices performed while following the ANTT Instructions will irritate my hands*", whereas 2.34 out of 4 nurses stated that their hands may get irritated (Maraş, 2007).The examination of data obtained from The Nurse Satisfaction Evaluation Form showed that the highest percentages were found in the items related to the educator with a 100% participation rate. Like the present study, a study conducted by Cömert in 2015 evaluated a Mid-Level Leadership Training provided to 54 officers in the Turkish Land Forces Command according to Kirkpatrick's 4-Level Training Evaluation Model; the general examination of findings of the Reaction level showed that the highest values belonged to the educators (Cömert, 2015).

In the final step, the present study examined the relationship between the findings of reaction level and of learning levels. A significant relationship was found between the reactions of nurses who participated in the training and their learning levels in some statements. There is an order among the levels according to the Kirkpatrick's 4-Level Training Evaluation Model. It is based on the principle of "without reactions learning would be impossible". If nurses participating in training react positively to the training, it can be asserted that learning occurs. However, if nurses react negatively to the training, it can be asserted that learning did not occur (Pardue, 2015). Based on that principle, there should be a positive and significant relationship between reactions and learning levels. This study found a weakly positive correlation between the answers to the statement, "*I think that the instructions for ANTT can be easily followed*" and the post-training scores (r=.409, p=.033). The study also found a moderately positive correlation between the statement, "*The content of the training was closely related to my working field*" and the pre-training scores (r=.470, p=.011). Moreover, a moderately positive correlation between the statement, "*The duration of training was adequate*" and the pre-training scores (r=.512, p=.025) was found in this study. The study also found a moderately positive correlation between the statement, "*I liked the training in general*" and the pre-training scores (r=.555, p=.014). Unlike the present study, a study conducted by Cömert (2015) evaluated the reaction levels of individuals who participated in the training by administering a pre-test before the training and a post-test after the training. It was stated that there was no significant and positive relationship between the learning levels of participants and their reaction levels (Cömert, 2015). Kirkpatrick's 4-Level Training Evaluation Model is a technique used in various studies as used in the present study. Like the present study, a study by Masood and Usmani (2015) used Kirkpatrick's 4-Level Training Evaluation Model, and pre/posttest design was followed in the second stage, namely the level of learning. There was a statistically significant difference between pretest and posttest scores after the training (p: .001) (Masood & Usmani, 2015).

Conclusion: Despite today's technology, which is being renewed easy passing day in the field of health, the detection and treatment of infections is still one of the most challenging topics for health professionals. It is very important for nurses and other health professionals to increase their level of knowledge about infection management. This study found that the nurses' levels of knowledge and awareness about false positive blood cultures, and the use of aseptic technique and its principles, increased. Thus, it is thought that this increase will make positive contributions to children's health by improving the quality of nursing care, decreasing the rates of contamination in the long term, and increasing patient safety.

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