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Comparing the Effect of Flipped Teaching versus Multimedia-based Teaching on Postoperative Physical Activity in Patients Undergoing Open-Heart Surgery

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Abstract

Background: Multimedia learning can be recommended for cardiopulmonary rehabilitation to reduce respiratory complications following open-heart surgery (OHS). Furthermore, flipped learning may reinforce the effects of education via further feedback.

Aim: This study aimed to compare the effects of flipped teaching versus multimedia-based teaching on postoperative physical activity in patients undergoing OHS.

Method: This controlled randomized clinical trial was conducted on a total of 60 patients admitted to an intensive care unit and a cardiac-surgical ward in northeastern Iran in 2019. In the multimedia learning group, a tutorial video was displayed three times a day at different stages, namely preoperation, 1-2 days after the surgery, and 2-3 days postsurgery. The flipped learning group was also subjected to the same tutorial with the potential to be displayed on smartphones. Then, the 6-Clicks instrument was completed to assess the basic mobility function. The data were analyzed in the IBM SPSS Statistics software (version 25) using the Mann-Whitney U and Friedman tests.

Results: The groups were homogenous in terms of demographic characteristics. Based on the inter-group comparison, the mean duration of physical activity was not significantly different in the study groups at the preoperative stage (P=0.87), 2 days postoperation (P=0.09), and 5-6 days after surgery (P=0.10). However, the mean score of physical activity, on the second and fifth days until the sixth day at the postoperative stage, was significantly different in flipped (p<0.001) and multimedia (p<0.001) groups.

Implications for Practice: Same as multimedia-based teaching, flipped teaching is able to improve physical activity in patients following OHS.

Keywords: Flipped learning, Heart surgery, Multimedia learning, Physical activity

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Introduction

Open-heart surgery (OHS) is one of the important therapeutic approaches for cardiovascular diseases (CVDs) (4); however, it is sometimes accompanied by a number of complications. In this regard, this approach results in about 5-33% respiratory complications at the postoperative stage. Respiratory failure can be considered one of the morbidity factors resulting from this surgery (5, 6). However, early mobilization can result in a rise in pulmonary residual remains, quality of breath, and alveolar ventilation, which can prevent or moderate such side effects if combined with cardiopulmonary rehabilitation (7, 8). Numerous factors, including the non-provision of associated education for patients and unawareness about the importance of mobilization, can even cause immobility in patients after surgery (9, 10).

Accordingly, pre- and postoperative education is one of the basic nursing care services (11). The verbal method is the most common mode of education delivery the main barriers to which are inadequate educational equipment and time (12). Another traditional method is the use of writing tools, the disadvantages of which are their dependence on patient literacy and limited abilities to demonstrate some movements (e.g., effective coughing) (13, 14). Multimedia learning is one of the most recent educational methods, which can be effective, especially for teaching about the appropriate actions and movements (15). This approach has been employed to fulfill patient education in various fields. For instance, Saleh-Moghaddam et al. (2016) used multimedia to improve the functions of the respiratory system in patients following off-pump OHS (15).

The use of multiple senses to learn in multimedia learning and the affordability and flexibility of this method to meet learners' needs are among the benefits of this approach (16). However, the elimination of the presence of the instructors and their replacement with some tutorial videos are considered the limitations of this method (17). Therefore, there is a need for an educational method that facilitates patient interaction with instructors (i.e., nurses) and patient feedback.

Flipped learning is a new learner-centered educational approach, which has received much attention in recent years in the field of medical science education (18). In this method, the instructor provides a learning content that is to be taught to the learners in advance. Accordingly, the learners have to gain the knowledge of the content presented in the form of video, text, or audio files, in an environment apart from an educational classroom. Afterward, a classroom can be held to discuss issues, raise questions and answers, and fix learners' problems (19). Activities performed before this educational program can also focus on supports for low cognitive levels (e.g., perceptions), and classroom time can be further spent on gaining access to higher levels of e.g., applications and analyses (20, 21). Lee (2018), comparing flipped learning with the traditional method of instructing surgical nursing skills, introduced flipped learning as an effective method in terms of control and problem-solving (22).

Flipped learning is accessible and low-cost; moreover, it does not need any special equipment. However, studies on flipped learning are limited to learners in educational classrooms. To the best of our knowledge, the utilization of this method in patient education, including individuals undergoing OHS, has remained underreported. Moreover, it does not seem logical to generalize the results of the studies conducted on healthy learners in classrooms to inpatients, with regard to the difference in educational conditions. On the other hand, training about physical activity requires higher levels of education, such as applications and analyses, in addition to improved cognitive levels, which is emphasized in flipped learning. As multimedia learning is a good option for patient education, the present study aimed to compare the effects of flipped teaching versus multimedia-based teaching on postoperative physical activity in patients undergoing OHS.

Methods

This two-group randomized clinical trial was conducted on 60 patients admitted to the intensive care unit (ICU) and cardiac surgical ward of a hospital located in northeastern Iran from November 20 to January 10, 2019. The sample size was determined based on a pilot study on 10 patients from each group and the formula of "comparison of two independent population means". Based on the physical status variable, the sample size was calculated as 30 cases in each group, with the confidence interval of 95% and test power of 80%. However, 33 patients were included in each group considering 10% sample attrition. Three patients from each group were ultimately excluded from the study, and data analysis was finally performed on 30 individuals in each group.

In order to prevent information dissemination between the two groups, the convenience sampling method was employed, and the subjects were divided into two groups via random allocation with time blocks. Using the IBM SPSS Statistics software (version 25), random sequence for 8 weeks (each week with a time block) with two codes of A and B were written on indistinguishable small pieces of paper and kept in a sealed envelope. At the beginning of each week, the envelope was opened, and it could be determined based on the relevant code whether all the patients in that week were assigned to the flipped learning group (code A) or the multimedia learning group (code B). Until the end of patient discharge in each block, a new case was not allowed to enter the study in order to minimize the possibility of information dissemination. Sampling was discontinued after completing the sample size in each group.

The inclusion criteria in this study were: 1) a minimum level of literacy and ability to receive education, 2) age range of 18-75 years, 3) possession of a smartphone with the capability to display tutorial videos (in the flipped learning group), 4) no previous education in this field, 5) coronary artery bypass surgery of two or three vessels, 6) ejection fraction of > 30%, 7) body mass index (BMI) of < 35, 8) no physical disabilities, and 9) no history of lung diseases. On the other hand, the exclusion criteria included: 1) lowered level of consciousness after admission to the ICU, 2) long stay in the ICU (i.e., > 3 days), and 3) incidence of postsurgery complications (e.g., tachycardia, ventricular fibrillation, cardiogenic pulmonary edema, pleural effusion, and pulmonary embolism).

The data collection instruments administered in this study included a demographic characteristic form and the 6-Clicks instrument derived from the Activity Measure for Post-Acute Care (AM-PAC) to assess physical activity. The validity of the mentioned instrument was confirmed by the content validity method using the opinions of seven university professors. Given the objectivity and frequent use of this tool in previous research, its reliability has been also confirmed.

This scale is a standard tool for the measurement of activity at the post-acute care stage and consists of six items, including bed mobility, sit to stand/stand to sit, supine to sit, sitted transfers, ambulation, and ascending the stairs. Each item is also comprised of four problem severities (i.e., unable or complete, high, low, and none), receiving a score of 1-4, respectively, wherein a higher score indicates better physical activity (23, 24). Accordingly, the raw score obtained from this instrument is between 6 and 24, which can be reported based on the percentages between 0 and 100, where a higher percentage suggests more physical activity limitations.

In addition, based on the percentage of physical activity, seven levels of physical activity limitations (including no, very low, low, moderate, high, very high, and complete limitation) are considered in this tool (25). As this instrument has not been so far translated into Persian or implemented in Iran, it was initially translated by a fluent English and Farsi speaking person, re-translated into English, and then compared with the original version to obtain homogeneity. Then, the given instrument was submitted to seven university professors in both Persian and English languages, and the final version was employed after making the necessary corrections.

The reliability of the English version of this instrument was reported as 0.849 for the total score and 0.581 for basic mobility by Diana et al. (2014), using intraclass correlation coefficients. Based on the test-retest method, the mean difference between the assessment scores was close to zero (26). In the present study, the reliability of the Persian version of this instrument in the domains of basic mobility was also confirmed once again by performing a test-retest method on 10 individuals within a 30-min interval, rendering a correlation coefficient of 0.93.

This research was conducted in three stages. The sampling process started from 11 a.m. to 2 p.m. the day before the surgery. The subjects were recruited if meeting the eligibility criteria based on the assessment of their medical records and implementation of interviews. After the implementation of the interviews, provision of some oral explanations for patient companions, and achievement of patient consent to participate in the study, the medical records were reviewed, and the demographic characteristic questionnaire was completed by the researcher. The 6-Clicks instrument was also filled out with the help of the researcher assistant. Then, based on the random sequences in the sealed envelope, it was determined which educational method could be used in that week, and the patients were included in the relevant group.

At the intervention stage, the group receiving multimedia learning was provided with the tutorial video containing audio, video, text, and music files in three sessions, namely at the preoperative stage (for a group of 2-4 individuals), 1-2 days after the surgery (individually and in the ICU), and 2-3 days after the surgery (for a group of 2-4 individuals, in the cardiac surgical ward). If there were any questions or ambiguities, they were responded at the same time. All three sessions lasted about 15-20 min, and the content of the sessions included the same or new parts. The tutorial video was developed by the researcher and with the help of experts in media based on related educational rehabilitation contents notified by the Ministry of Health and Medical Education and then approved by the given specialists (i.e., faculty members of nursing, medicine, and medical education). The content of this tutorial video included respiratory complications and their effects on the functions of the respiratory system, deep breathing technique, how to use a spirometer, correct coughing techniques and its importance, and an exercise program and how to do it in supine, sitting, and upright positions.

In the flipped learning group, the same video with the capability to be displayed on smartphones was presented to the patients or their companions within 11 a.m. to 2 p.m., the day before the surgery, along with the instruction explanations. They were asked to watch the video of each session before the onset of the educational classroom. On the evening of the same day, a session was held with the presence of 2-4 people and the researcher for 20-15 min to talk about the video (which had been already seen by the patients). Then, the patients raised their problems regarding how to properly practice breathing and physical activity techniques, and the researcher demonstrated the correct movements if necessary. Moreover, the important points were highlighted. The second session was held individually 1-2 days after the surgery in the ICU (due to the equipment connected to the patients and no possibility to have a group session). In addition, the third session was held 2-3 days after the surgery in the cardiac-surgical ward for a group of 2-4 individuals. All three sessions were held between 6 p.m. and 10 p.m., using the same time and presentation methods.

At the post-intervention stage, patients' physical activity was measured using the 6-Clicks instrument before patient transfer to the cardiac surgical ward (i.e., the 2^{nd} day after the surgery in the ICU) and prior to discharge from this ward (i.e., 5-6 days after OHS), similar to that in the pre-intervention stage.

The study was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran (code no. IR.MUMS.NURSE.REC.1398.036). As soon as the formal letter of introduction from the School of Nursing and Midwifery was presented to the hospital officials, the researcher entered the study context. The data were analyzed in the IBM SPSS Statistics software (version 25) using the Mann-Whitney U test, independent-sample t-test, Chi-square test, Fisher's exact test, Wilcoxon signed-rank test, and Friedman test at the significance level of 0.05. The Kolmogorov-Smirnov and Shapiro-Wilk tests were also employed to examine the normality distribution of the quantitative variables.

Results

The mean ages of the patients in the groups receiving flipped and multimedia learning were 57.8±11.0 and 55.3±11.4 years, respectively. The results of Mann-Whitney U test showed no significant difference between the study groups in terms of the mean age (P=0.19). Furthermore, the results revealed no statistically significant difference between the two groups considering demographic characteristics and disease status; accordingly, they were homogeneous in this regard (P≥0.05; Table 1).

At the pre-intervention stage, the mean score of physical activity (based on percentages) between the patients in the flipped and multimedia learning groups was not significantly different (P=0.87), and both groups were homogeneous with regard to these variables. In addition, 2 days after OHS, the mean score of physical activity showed no significant difference in the two study groups (P=0.09). Likewise, 5-6 days after the surgery, there was no significant difference between the patients in the flipped and multimedia learning groups in terms of the mean scores of physical activity (P=0.10). Additionally, there was no significant difference in the mean scores of patient physical activity 2 days after the surgery, compared with those at the preoperative stage in the two study groups (P=0.87). Similarly, no significant difference was observed between the mean scores of physical activity of the two groups 5-6 days after OHS, compared with those estimated at the preoperative stage (P=0.22). This mean score was not also significantly different 5-6 days after OHS, compared with those obtained 2 days postsurgery, in the two research groups (P=0.99).

The mean scores of physical activity were compared at three time points in each group. Based on the results of the Friedman and related post-hoc tests, the mean score of physical activity underwent a significant increase in the flipped learning group 2 days after the surgery, compared with that at the preoperative stage (P<0.001). The given value, however, was declined in a significant manner 5-6 days after OHS (P<0.001) and 2 days after this period (P<0.001), compared with the value estimated at the preoperative stage. In the group with multimedia learning, the mean score was significantly dropped 2 days after the surgery, compared to that at the preoperative stage (P<0.001). However, it was significantly increased 5-6 days after OHS, compared with those at the preoperative stage (P<0.001) and 3 days postsurgery (P<0.001; Table 2).

In addition to the mean score of physical activity, its modified score was evaluated based on the categories (i.e., levels) of physical activity (including seven categories from 0 to 100%) and compared in the two groups. The results revealed that before the intervention, the patients in the flipped learning (n=20, 66.7%) and multimedia learning (n=16, 63.3%) groups had a low level of physical activity limitation. However, these results were not significant based on the Mann-Whitney U test (P=0.805); therefore, both groups were homogeneous in this regard.

Two days postsurgery, the flipped learning group (n=18, 60.0%) had a moderate level of physical activity limitation, while the multimedia learning group (n=16, 53.3%) had a high level of physical activity limitation. These findings were found to be statistically significant based on the results of Mann-Whitney U test (P=0.305). In addition, 5-6 days after OHS, the patients in the flipped learning group (n=14, 46.7%) had no physical activity limitation, whereas those in the multimedia learning group (n=12, 40.0%) had a very low level of limitation. The results of the Mann-Whitney U test revealed that these findings were statistically significant (P=0.113). The intragroup comparison using the Friedman test and the related post-hoc test showed that physical activity limitation was significantly augmented in both study groups 2 days after OHS, compared with that at the preoperative stage (P<0.001). However, the levels of physical activity limitations were significantly declined 5-6 days after the surgery as compared to those estimated at the preoperative stage (P<0.001) and 2 days after this period (P<0.001; Table 3).

Table 1. Demographic characteristics and disease status of patients undergoing open-heart surgery in each study group

Variables		Groups		Test results
		Flipped learning (n=30)	Multimedia learning (n=30)	
Age (year) Mean±Standard deviation		57.8±11.0	55.3±11.4	*P=0.19
Gender n (Percentage)	Male	20 (66.7)	23 (76.6)	***P=0.39
	Female	10 (33.3)	7 (23.3)	
Level of education n (Percentage)	Illiterate	5 (16.7)	12 (23.3)	*P=0.56
	Primary school	10 (33.3)	20 (33.3)	
	High school diploma	12 (40.0)	22 (33.3)	
	Bachelor's degree	3 (10.0)	6 (10.0)	
Type of surgery n (Percentage)	Off-pump	26 (86.7)	25 (83.3)	***P=0.718
	On-pump	4 (13.3)	5 (16.7)	
Number of blocked coronary arteries n (Percentage)	Two	15 (50.0)	17 (56.7)	*P=0.60
	Three	15 (50.0)	13 (43.3)	
Body mass index (kg/m^2) Mean±Standard deviation		24.7±3.5	23.7±2.5	**P=0.76
Ejection fraction Mean±Standard deviation		49.4±8.2	49.4±9.4	*P=0.95
Intubation duration (h) Mean±Standard deviation		346.4±155.5	358.3±157.5	**P=0.76

*Mann-Whitney U test
**Independent-samples t-test
***Chi-square test

Table 2. Comparison of physical activity mean scores, at preoperative stage (i.e., one day before the surgery), 2 days postsurgery, and 5-6 days after open-heart surgery in the study groups

Physical activity mean scores (based on percentages)	Groups: Flipped learning	Groups: Multimedia learning	Statistical test results for inter-group comparison
	Mean±Standard deviation	Mean±Standard deviation	
Preoperative stage (One day before surgery)	21.1±10.0	21.4±11.1	*P=0.87
Two days after OHS	56.8±10.5	61.6±9.7	**P=0.09
Five or six days after OHS	9.3±10.2	13.7±10.3	*P=0.10
Difference between preoperative stage and two days after it	-35.8±15.0	-39.9±0.7 -39.9±12.0	*P=0.87
Difference between preoperative stage and five-six days after it	11.7±11.5	7.7±6.9	*P=0.22
Difference between two days after OHS and five-six days after it	47.5±11.1	47.6±11.1	*P=0.99
Intra-group comparison	***P<0.001	***P<0.001	

OHS: open-heart surgery
*Mann-Whitney U test
**Independent-samples t-test
***Friedman test

Table 3. Frequency distribution of patients according to the levels of physical activity limitation at the preoperative stage, 2 days postoperation, and 5-6 days after the surgery in the study groups

Level of physical activity limitation	Category (level)	Group: Flipped learning	Group: Multimedia learning	Statistical test results for inter-group comparison
		Mean±Standard deviation	Mean±Standard deviation	
Preoperative stage (One day before surgery)	No	2 (6.7)	2 (67.0)	*P=0.80
	Very low	8 (26.7)	9 (30.0)	
	Low	20 (66.7)	19 (63.3)	
Two days after OHS	Moderate	18 (60.0)	14 (46.7)	*P=0.30
	High	12 (40.0)	16 (53.3)	
Five-six days after OHS	No	14 (46.7)	7 (23.3)	*P=0.11
	Very Low	8 (26.7)	12 (40.0)	
	Low	8 (26.7)	11 (36.7)	
Intra-group comparison		**P<0.001	**P<0.001	

OHS: open-heart surgery
*Mann-Whitney U test
**Friedman test

Discussion

The present study aimed to compare the effects of flipped teaching and multimedia-based teaching on postoperative physical activity in patients undergoing OHS. Based on the results, both methods facilitated the improvement of physical activity in patients undergoing OHS 5-6 days after the surgery. In this regard, the effect size values of the flipped and the multimedia learning were 55.6 and 36.0, respectively, at this stage. Flipped learning also left similar effects to those of multimedia learning.

In a study performed by Wang et al. (2016), a multimedia exercise program resulted in the enhancement of physical activity in cardiac surgery patients, compared with the control intervention. In the mentioned study, physical activity was assessed through a walking test in 6 min, and the effect size at the time of hospital discharge was reported as 10.9% (27). Accordingly, their results are consistent with those of the present study in terms of the impact of multimedia learning; however, their effect size was smaller. This difference can be attributed to the type of test employed for the estimation of the effect size, as well as the measurement time, which was 5-6 days after OHS in the present study.

Gholamnia-Shirvani et al. (2018) similarly found that multimedia software could enhance physical activity in a population of healthy women. In this regard, during a period of 3 months, physical activity in the group working with multimedia increased by 325% (28). The results of the mentioned study considering the effect of multimedia are in line with the findings of the present study; however, the effect size was much greater, which could be related to the difference in statistical population and longer follow-up duration. Given the need for the special conditions of postoperative physical activity in patients, especially those undergoing OHS, the difference in multimedia effect size can be justified (29).

On the other hand, the findings of the present study are inconsistent with the results reported by Rajabi Naeeni et al. (2015), examining the effect of multimedia learning on pregnant women's knowledge of risky symptoms during pregnancy and postpartum (30). Among the limitations of this study was the impossibility of observing learners' feedback about the received education, as well as its proper interpretation or amendment, in multimedia learning (17). Therefore, the results might have been affected.

Additionally, Sayadi et al. (2018), reflecting on anxiety and physiological status in patients with cerebral angiography, showed no priority for this educational method over the routine approaches (31), which is inconsistent with our findings. It should be stated that the variables examined in the mentioned research are different from the ones recruited in the present study. This could justify the discrepancy in the results because these variables could be affected by various factors.

Studies conducted on the impacts of flipped learning are mainly related to the teachings presented in general education or higher education courses in non-medical disciplines. In this regard, Vaughn et al. (2019) conducted a study to determine the effect of flipped learning on knowledge, skills, and physical activity in students, with the main objectives of boosting physical activity, decreasing immobility, eliminating not-permitted amounts in BMI, and making changes in psychological-social variables related to physical activity. The results of the mentioned study also demonstrated a statistically significant difference between students' pre-test and post-test scores in 13 sports skills (32). With regard to the positive efficiency of flipped learning, it was concluded that the findings of the mentioned investigation are consistent with those of the present research. Given the differences in the statistical populations between these two studies, the necessary care should be taken in comparing these studies with each other.

In the field of medical science, studies on flipped learning have been so far limited to educational courses for students or graduates. Furthermore, to the best of our knowledge, the effects of this method on patient education have been underreported. In a study carried out by Khoshnoodi Far (2019), flipped learning was reported to improve the level of satisfaction in continuing education for doctors, compared with traditional teaching methods (33). In the mentioned study, the effect size values of flipped learning with regard to satisfaction with teaching and learning were obtained as 5.7% and 20.6%, respectively, which were smaller than the effect size estimated in the present study (55.6%). This could be related to the difference in the statistical populations and the consequences under consideration. In the study by Lee et al. (2018), comparing flipped learning with the traditional method of instruction, lipped learning was introduced as an effective approach in terms of self-efficacy, self-management, and problem-solving for nursing practices (34). Although no significant difference was observed between the two groups in terms of many domains based on the outcomes. In the mentioned research, the effect size of learning in terms of self-efficacy was obtained as 2.4%. Despite the lack of a significant difference between the groups, each method could be alone effective.

The results reported by Harrington et al. (2015), comparing flipped learning and traditional method of instruction in nursing, are not in agreement with the findings of the present study. In this regard, no significant difference was observed between any of the groups in any of the learning cases. Accordingly, both groups were affected in the same manner. The lack of the experience of the School of Nursing and Midwifery in using flipped learning was among the shortcomings and limitations affecting the results of the mentioned study (35). Therefore, this could justify the contradictions with the present study.

In a study performed by Beom et al. (2018), the use of flipped training left no effects on the skills and satisfaction of medical students with advanced cardiopulmonary resuscitation education (36). The findings of the mentioned investigation did not support the results of the present study. The difference in the statistical populations and investigated variables could be the cause of this discrepancy. Tune et al. (2013) also assessed the effectiveness of a lecture-based curriculum versus flipped learning associated with cardiovascular, respiratory, and renal physiology in students. They demonstrated that flipped learning could have positive effects on the overall performance of students and their scores. Accordingly, they introduced flipped learning as a highly efficient educational method (37).

Among the limitations of the present study was the lack of access to patients at a good time before the start of the educational sessions. Accordingly, attempts were made to divide the educational content into three sessions to reduce the volume of the first session to have 6 h of education. Moreover, the individual differences of the patients and their prior knowledge of pain control, complication management, and effective techniques for breathing and coughing could influence patients' respiratory status and performance. However, these factors were controlled though the random allocation of the subjects and removal of those who had previously received education in this domain. The short-term follow-up of the indicators associated with the functions of the respiratory system and physical activity in the patients (up to one week after OHS) was another limitation of this study. If the follow-up was longer, it was more likely to obtain generalizable results. However, this was not feasible due to the lack of access to patients after this period, as well as time and resource constraints. Therefore, it is recommended to conduct a study with an extended follow-up period (e.g., 4 weeks after discharge).

Implications for Practice

The use of technology in education is on a growing trend. Technology is utilized in flipped learning to provide education and facilitate learning; therefore, it is possible to observe feedback originated from education. Multimedia learning only involves the use of tutorial videos for the delivery of educational contents; therefore, it requires equipment and skills. However, any contents, such as films, PowerPoint presentations, and educational booklets, can be employed in flipped learning. Accordingly, the latter method can be concluded to be more convenient, cost-effective, and applicable, compared to the former one. Based on the statistical results of the present study, flipped learning had the same efficiency as that of multimedia learning.

Considering the positive effects of flipped learning in patient education, including enhanced physical activity after OHS, it is recommended to employ this new method in patient education programs. Due to the limitations of the present study, there is a need to conduct further research with a longer follow-up duration (e.g., 4 weeks after discharge).

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Conflicts of Interest

No conflict of interest with any individuals or organizations was declared in this study.

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