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Effect of RCDP Training Method on Quality Assessment of Cardiopulmonary Resuscitation in Nursing Undergraduates Using SimpadPlus Feedback: A Randomized and Controlled Trial

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Abstract: The Rapid Cycle Deliberate Practice (RCDP) is a simulation-based training approach that gradually enhances muscle memory through repeated practice and targeted feedback in real-life situations. This article aims to investigate the RCDP training method's effectiveness based on feedback in assessing nursing students' cardiopulmonary resuscitation (CPR) quality. The study included 48 nursing students from a particular school's 2020 cohort. The students were randomly divided into two groups using computerized randomization. The experimental group (Group A, n=24) used the RCDP method to simulate CPR under the guidance of a teacher, while the control group (Group B, n=24) used traditional methods for practice. The students received one hour of theoretical training and two hours of practical training. Knowledge questionnaires were distributed before and after the theoretical training, and the SimPad Plus was used to collect student assessment data after the practical training. The quality of the skills assessment of the two groups was compared, including the number of compressions, average compression depth, compression recoil pass rate, compression depth pass rate, compression frequency, number of ventilations, ventilation volume, and student satisfaction with teaching. The results showed statistically significant differences in the pass rates between the two groups in terms of total compressions, compression frequency, ventilations, and total ventilations ($P<0.01$). The experimental group had a higher pass rate of compression recoil than the control group ($P<0.01$), a shorter average interrupt time during compression ($P<0.01$), and a higher pass rate of compression depth ($P<0.01$). The CPR quality of nursing students was improved, enabling them to perform CPR more accurately and effectively. Learner feedback was positive, indicating that they believed the experience would improve their clinical performance. In conclusion, the RCDP training method based on SimPad Plus feedback, through expert feedback, repeated practice, and real-time feedback from simulated patients, is beneficial in improving the quality of CPR among nursing students.r of 60-point.

1. Introduction

Sudden cardiac arrest is a critical medical emergency that poses a significant threat to human health. The survival and prognosis of cardiac arrest patients are closely linked to the prompt detection and initiation of first aid response, and the importance of high-quality cardiopulmonary resuscitation (CPR) cannot be overstated. However, in clinical practice, the quality of CPR training for first aid personnel is often inadequate, which hinders their ability to provide high-quality CPR in emergency situations[1, 2]. The 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care advocate the use of deliberate practice and mastery learning in resuscitation training to improve skill acquisition and retention[3]. Rapid cycle deliberate practice (RCDP) is a simulation-based medical education model that integrates deliberate practice and mastery learning. It involves rapidly cycling between deliberate practice and targeted feedback until mastery is achieved[4]. This training method entails challenging, goal-oriented work under the supervision of a teacher, with high expectations of achievement, providing feedback and correction, and making adjustments and enhancements to ensure that participants acquire knowledge through comprehensive learning, perfecting details, and creating muscle memory[5, 6].

RCDP has been widely used in the training of instructors, pediatric emergency physicians, anesthesia residents, nurses, and interdisciplinary CPR teaching teams, but research on the content of care is currently lacking. Therefore, this study aims to explore the training effects of RCDP in nursing CPR training.

Data and Methods

Study participants

Forty-eight nursing students from a certain university's class of 2020 were selected as the study subjects, including 18 males and 30 females. The 48 students were randomly divided into an observation group and a control group, with 24 students in each group. Group A (n=24) had an average age of 19.83±0.95 years, while Group B (n=24) had an age of 19.83±0.76 years.

Research Methods

Training Methods

Before the first part of the training, all students in both groups received 1 hour of theoretical CPR training and 2 hours of practical training. Knowledge questionnaires were distributed before the theoretical training and after the practical training. The experimental group used the RCDP training method to break down CPR skills into four parts: initiating CPR (a), external chest compressions (b), opening the airway (c), and post-CPR treatment (d). According to the decomposed operation process, students completed the first part of initiating CPR (a) and then paused for feedback from the instructor, who reinforced correct operations, pointed out deficiencies, and provided improvement suggestions. Students then repeated the cycle from the beginning until completing external chest compressions (b) and then paused again for feedback and demonstration from the instructor (a-b). This process was repeated until mastering the entire CPR operation (a-b-c-d), and then another student from the same group practiced. Each group had 4-5 members, and the total group practice time was 40-50 minutes. If the group time ran out, the practice had to be terminated regardless of whether the student completed it or not. In the control group, after a student completed the entire CPR skill operation process, the instructor provided feedback, reinforced correct operations, pointed out deficiencies, and provided improvement suggestions.

Assessment Methods

The main assessment methods in this study included theoretical test questionnaires and operation evaluation forms. The theoretical test questionnaire contained 28 questions, with 3 points for each question, for a total of 84 points. The operation evaluation form was scored by the teacher based on the evaluation form and feedback from the SimPad PLUS manikin. The evaluation form was developed based on the national CPR competition standards and included assessments of CPR operation steps and operation quality. The SimPad PLUS manikin used was the Resusci Anne QCPR (model 171-01260) produced by Laerdal Medical, equipped with a SkillReporter report instrument that provided real-time feedback, recorded data, calculated overall performance scores during the evaluation, and provided CPR performance evaluation reports (model 206-30015). SimPad PLUS PAD feedback included indicators such as compression count, average compression depth, compression rebound compliance rate, compression depth compliance rate, ventilation count, ventilation rate, etc. The complete step score accounted for 56 points, while the SimPad feedback score accounted for 44 points. The maximum score for the operation evaluation form was 100 points. This assessment followed the AHA CPR guidelines, with five cycles of compression and ventilation. The operation quality score included assessments of compression frequency, compression depth, compression-ventilation ratio, hand placement, ventilation count, ventilation volume, and interruption time of chest compressions of less than 10 seconds.

Control and intervention

There were two Resusci Anne QCPR manikins on-site for the assessment. Before the student operation assessment, a professional experimenter checked and tested the teaching aids to ensure that the manikins were functioning properly and could be used. Three professors with CPR expertise conducted the assessment, with two professors scoring the CPR operation steps for two students, and the third professor scoring the CPR operation quality based on the PAD feedback from the report instrument.

Statistical Analysis

SPSS 26.0 statistical software was used for data analysis. Count data were expressed as rates, and measurement data were expressed as means ± standard deviations. Descriptive statistical analysis, t-tests, chi-square tests, and one-way ANOVA were the main statistical methods used.

2. Results

Comparison of Theoretical Scores before and After Training for Both Groups

The theoretical scores of both groups of students were higher after training than before training (*P*<0.01). The experimental group had higher theoretical scores than the control group after. (See Table 1)

Table 1: Comparison of Theoretical Scores before and After Training for Both Groups

Group	Theoretical Score		*t*	*p*
	Before Training	After Training		
Control	49.62±10.20	67.66±7.82		
Observation	49.41±9.65	65.25±8.67	-7.573	0.000
t	0.079	1.018	-5.688	0.000
p	0.938	0.319		

Table 2: Comparison of the immediate skill scores of the two groups of students and the skill scores of one year after training

Group	Immediate skill score	one year later skill score	
Control	93.62±2.45	78.75±6.78	
Observation	86.33±4.62	77.20±7.51	
t	7.685	0.717	
p	< 0.001		

After the training, the operation scores of the experimental group were higher than those of the control group (P<0.01). However, there was no statistically significant difference in operation scores between the two groups after a one-year training blank period. The results are shown in Table 2.

The experimental group and the control group showed statistically significant differences in the assessment of average compression depth, compression recoil percentage, and average interruption time (P<0.01), as shown in Table 3. The skill operations of both groups also showed statistically significant differences in the quality of compression total count, compression frequency, ventilation volume, and ventilation total count, as shown in Table 4. These differences were based on the feedback provided by the SimPad manikin during the CPR training simulatioans.

Table 3: Comparison of the quality of immediate CPR skills of the two groups of students

Assessment items	Observation	Control	*t*	*p*
Average pressure depth(50-60mm)	50.08±7.87	58.20±2.41	4.958	< 0.001
Press the rebound percentage (100%)	86.08±9.55	96.92±3.95	5.287	< 0.001
Press the interruption time(<10s)	23.25±6.64	14.87±3.57	-5.095	< 0.001

Table 4: Comparison of the quality of skill operation of students in the two groups [example (%)]

Group	Total number of presses	Press frequency	Breathing Total	number of ventilation
	(150times)	(100-120times/min)	(400-700ml)	(10times)
Control(n＝24)	18(75)	22(91.6)	21(87.5)	19(79.1)
Observation (n＝24)	11(45)	17(70.8)	14(58.3)	14(58.3)
x^2	18.75	13.227	22.831	10.219
P	<0.001	<0.001	<0.001	<0.001

3. Discussion

The RCDP curriculum has three principles: psychological safety, expert feedback, and optimizing the number of correct repetitions. In this study, cardiopulmonary resuscitation (CPR) was divided into smaller skill-based practice segments, such as sections a, b, c, and d. After completing Part A, the instructor paused the practice and provided brief feedback to correct any deficiencies. The practice is continued from the beginning to ensure that part a is performed correctly before moving on to parts a-b, a-b-c and finally a-b-c-d, consolidating each skill operation step and achieving the goal of improving the learner's ability to provide high-quality CPR to cardiac arrest patients[7]. SimPad PLUS with SkillReporter feedback device was used in this study to provide real-time feedback, record data, and calculate overall performance during the evaluation period. CPR feedback devices can be used to objectively evaluate the training effect[8].

Improving CPR education for medical students can enhance the knowledge and skills of future healthcare professionals and improve the quality of CPR. Therefore, it is essential to find an appropriate method of teaching CPR to maximize its effectiveness. RCDP, as a teaching method that combines deliberate practice with mastery practice, has been critical to the development of expertise in many fields such as sports, aviation, chess, music, and academia. It has also been shown to be an effective means of improving medical practice skills[9]. RCDP improves teaching effectiveness by maximizing the time available for expert feedback and repetition over a short period of time. Based on the SimPad manikin feedback in this study, which could accurately assess the quality of each step of the learner's operation, it is essential to use performance indicators to implement high-quality CPR, including compressions at a sufficient rate and depth, ensuring chest recoil after each compression, minimizing interruptions, and avoiding overventilation. Real-time feedback can improve compression quality by correcting compression depth and frequency and reducing compression delay.

The results of this study showed that the RCDP group had statistically significant differences compared to the traditional teaching group in average compression depth (50.08±7.87 VS 58.20±2.41) ($P<0.001$), compression recoil rate (86.08±9.55 VS 96.92±3.95) ($P<0.001$), and compression interruption time (23.25±6.64 VS 14.87±3.57) ($P<0.001$). This may be related to the teaching property of RCDP, which effectively reduces the cognitive load by presenting learners with smaller chunks of information to process and memorize periodically throughout the simulation. In Rebecca J's study, learners using traditional teaching methods were not aware of the parts they needed to improve until the lengthy traditional lecture was completed[10]. Also, they may not remember their correct or incorrect actions when taught the entire procedure at once, so RCDP training can improve the quality of CPR implementation by learners. The study also found that theoretical scores improved significantly in both the control and experimental groups after theoretical CPR training and practical exercises, reflecting that effective education can improve learners' perception of cardiac arrest-related content. From the evaluation results of the two groups with different training methods, the theoretical scores of the experimental group are slightly higher than those of the control group. Teaching methods used in this study, such as RCDP training, mainly provide feedback and repetitive practice, which are the most relevant features for effective learning. Continuous improvement and updating of teaching methods are also essential factors in improving the quality of CPR for learners[11].

However, the study also found some problems. First, although the compression outage time in the experimental group was shorter than in the control group, the average time still exceeded the recommended AHA of less than 10 seconds, which is an issue that needs attention and improvement. Second, while RCDP was able to achieve better training outcomes in a shorter period of time, this study found no statistically significant difference in skill scores between the two groups after one year of blank training. This is similar to the results found in Cheng's study, which showed that students' CPR skills declined significantly weeks to months after training[12, 13]. As a result, the American Heart Association RQI program uses an interval training design to perform CPR skill practice at least once every three months. Other scholars have shown that distributed CPR training can be effective in improving CPR performance, and that monthly training is more effective than training every three, six, or twelve months[14]. Future research should focus on how to develop training intervals that can translate improvements in immediate CPR implementation quality into long-term maintenance of CPR implementation quality.

4. Conclusion

In summary, the use of feedback-based deliberate practice of rapid cycling in resuscitation training can promote the acquisition and mastery of high-quality CPR skills. In addition to the use of such methods in classroom instruction, future research may extend feedback-based RCDP training to non-professionals in different populations and communities to see if it can help achieve high-quality CPR. RCDP allows iterative repetition of the same skill, consolidating knowledge and creating lasting muscle memory. It can also improve learners' confidence, which is essential in high-stress situations. In addition, the use of real-time feedback devices can help learners quickly identify and correct errors, leading to better performance. However, the frequency and timing of training intervals needs to be further explored to maintain the effectiveness of CPR training. Overall, the RCDP approach has the potential to improve the quality of CPR education, making it a valuable tool for training future health care professionals.

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