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Effect of a Training Module in Cardiopulmonary Resuscitation on the Knowledge and Skills of Pediatric Nursing Personnel

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Abstract

Objective: To evaluate the impact of an informal training program on the knowledge and skills of nursing personnel posted in pediatric acute care areas at pre-specified time points.

Methods: This repeated measures quasi-experimental study design was conducted in a tertiary care teaching hospital between March and April 2011. In the first phase, the knowledge and skills of the participants were assessed using a validated questionnaire and a skill checklist. This was followed by an informal training program on pediatric cardio pulmonary resuscitation (CPR) and retest immediately following the training and again at 6 weeks.

Results: A total of 65 nursing personnel were enrolled in the study. Of these 22 (34%) were staff nurses and 43 (66%) were final year nursing students. All of them had been trained 6 weeks earlier in an informal training and evaluation program carried out in the department. The mean knowledge score of the participating nurses increased from 9.7 before training to 13 while the mean skill score increased from 8.9 before training to 10.7 immediately following the training. At 6 weeks, the participants seemed to retain the knowledge acquired but not the skills with the mean knowledge score remaining at 13 while the mean skill score dropped to 9.8, the difference between the immediate post-test and 6 weeks skill re-test being statistically significant. Also greater proportion of participants passed the 6 weeks knowledge test (62%) in comparison to skills (26%), the difference in scores between immediate and 6 weeks re-test being statistically significant ($p < 0.03$) only in skills.

Conclusion: Knowledge and skills of pediatric nursing personnel posted in acute care areas improved with the new teaching program. However, knowledge seemed to be retained with time in comparison to skills.

Keywords*:* CPR; Cardiopulmonary resuscitation; Nursing personnel; Nursing staff; Nursing students; Knowledge; Skills.

Background

Cardiac arrest defined as the sudden cessation of cardiac activity- is associated with very high morbidity and mortality in adults as well as children (1). Nearly 40% of cardiac arrests occur in hospital (2) of which only 27% are reported to survive (3, 4). Providing high quality CPR is one of the most important factors documented to influence these survival rates (5, 6). The cornerstone of providing high quality CPR therefore, lies in the education and training of healthcare professionals involved in the care of sick children (7, 8).

Of all healthcare professionals' nurses are often the first to discover a patient of cardiac arrest in most emergency wards owing to the nature of their duties (time bound administration of medications or monitoring vitals). Therefore it is needless to say that their competency in CPR is a critical factor in determining successful outcomes in patients with cardiac arrests (9, 10). A key factor determining CPR competence is the retention of CPR knowledge and skills (11). However, evidence is compelling to show that CPR knowledge and skills are poorly retained across populations (11-13). Three decades of research on competency of nurses in CPR (registered

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nurses or students) across the world has shown that knowledge and skills of nurses in CPR *are not retained* following training although they may improve transiently immediately post training (9-15). A review of studies on CPR retention over a 9 year period revealed poor CPR skills retention (2).

Several factors such as lack of motivation, lack of institutional guidance, method of instruction, poor outcome after CPR (may prevent them from doing CPR), and too many steps of CPR have been implicated as barriers to acquisition and/or poor retention of knowledge and skills in CPR among nurses (16). Of these, the method of instruction is one of the most critical factors associated with CPR competency (10). Several kinds of teaching methods such as video self-instruction, peer tuition, cardiac arrest simulation, computer aided learning tools and use of action cards have been evaluated in the literature (17-22). All of them have shown improvement in either knowledge or skills or both (14). However what works best for a particular institute or a group may not be applicable in another setting, and the best way forward is to develop a set of indigenous teaching/ training methods in accordance with the standard recommendations suitable to that particular institute. Rosemary Hamilton in 2005(14) in her meta-analysis on 'knowledge and skill retention in nurses' following training in CPR' made the following observations that; resuscitation knowledge and skills declined from 3 to 6 months following lecture style training only and, video self-instruction, peer tuition and computer based teaching tools seemed to improve the performance. The author concluded that resuscitation education for nurses should be based on evidence based guidelines, using simulation of in-hospital cardiac arrest scenarios and formal assessment should be carried out to ensure retention of the same.

Knowledge and skills of CPR in children: There is only one published study till date (16) which addressed this issue in nurses involved in the care of children. In a previous study from our institute *(in press)* we found that the knowledge and skills of nurses and nursing students posted in acute care areas of pediatrics improved significantly immediately following an informal training program in pediatric CPR. However this acquisition in knowledge and skills was poorly retained at 6 weeks with most participants failing both tests and decline in mean scores to pre-training levels at 6 weeks. In this study we had used videos, lectures and hands on demonstrations using manikins as per 2005 Pediatric Advanced Life Support (PALS) guidelines (23, 24) and had also distributed resource material 2 weeks in advance of the pretest. Such poor performance was a cause for concern as these nurses were all posted in acute care areas such as emergency and pediatric intensive care unit of our hospital and therefore they could directly impact the outcomes of children admitted in these areas. In view of these concerns we decided to modify our training methods keeping in mind the peculiarities of our study participants and reevaluate them after 6 weeks of such training.

We aimed to evaluate the performance of the study participants immediately and after 6 weeks of the new training method in comparison to their pre-training scores. Our ultimate goal was to identify an appropriate educational strategy that will ensure that nurses retain their knowledge and skills in infant and child CPR for longer periods and, to decide, the optimal frequency for update or retraining so that they continue to perform good quality CPR confidently in real life situations.

Material and Methods

Design and setting

A prospective, repeated- measures, quasi-experimental design was selected to test participants at 3 pre-specified time points (initial, post training and at 6 weeks). The study was conducted in the department of pediatrics of a tertiary care teaching hospital in North India between March and April 2011.

Participants

The study participants were 65 nurses from the previous study who had already received

informal training in CPR 6 weeks prior to this study and comprised of 22 staff nurses and 43 final year nursing students posted in pediatrics.

A formal protocol was submitted and approved by the Institutional ethics committee. The head of the nursing division was also informed and informed, written consent was obtained from all the nurses before starting the study.

Objectives

Our primary objective was to evaluate the impact of an informal teaching method in infant/child CPR on knowledge and skills of nursing personnel – at various time points after training. Our secondary objective was to decide the frequency of retraining/updates, the content of these updates *and* to compare the performance of the two nursing subgroups.

Assessment tools (Pre/post intervention)

Knowledge was assessed by a structured questionnaire containing 15 knowledge and practice questions (each given 1 mark for correct answer and 0 for wrong answer) validated by 2 national level PALS instructors independently. Multiple choice questions on airway, chest compressions (rate, depth, and site), order of resuscitation, drug administration, and one rescuer-two rescuer recommendations were used. The order of the questions was changed at every time point so that sheer familiarity with the order of questions did not affect the results. The set of questions used in this study was different from the previous study.

Skills were assessed on infant manikin by a national level PALS instructor not involved in the training phase. Case simulations were provided to maintain reliability. Skills checklist containing 12 skills in the recommended order (1 mark for correct and 0.5 for partially correct performance) were used (25). No marks were awarded for not attempting the skill and for incorrect performance. The manikin was equipped with a skill meter which helped in evaluating correct and incorrect performances. Only infant case simulations were provided to maintain reliability.

Intervention/training

In the first study intervention was in the form of distribution of resource material, lectures, video demonstrations, instructor led discussions and case simulation as per IAP PALS recommendations. In addition demonstration of CPR skills (one rescuer and 2 rescuer scenarios) using manikin (batches of 6/session; 2 sessions per day) were carried out. In this study we used a teaching method in which all the participants were required to sit together in groups and read the entire resource material provided to them in the classroom. The instructor would then ask one member from each team to summarize what has been learnt in each section of the resource material and question other members of the group on important issues described in the section. In this way we made sure that participants not only read through the entire material but also understood critical components of life support skills. This was in addition to video demonstrations and lectures. Demonstration of CPR skills (one rescuer and 2 rescuer scenarios) using pediatric and infant manikin (batches of 6 students/session; 4 sessions per day) were carried out by the principal investigator similar to the previous study. However, in addition we used practice while watching (PWW) videos for each candidate so that the participants were confident in performing the skills. Relief of foreign body airway obstruction in infant and child, use of airway adjuncts, providing bag mask ventilation one rescuer and 2 rescuer methods and insertion of intra-osseous lines were also demonstrated as part of intervention/training in CPR. In addition, we also trained them on how to use the manual and automatic external defibrillator this time.

Methodology

The study was carried out in 3 phases. In the pre-intervention phase informed consent of the

participants was obtained and the participant's knowledge was tested using a validated questionnaire. Assessment of their skills was performed in isolation of their peers except for the 2 rescuer scenarios wherein the next participant was called in to assist the student being assessed. Each participant was provided with single rescuer and two rescuer case simulations. The process of evaluation of each participant took 3 minutes duration. This was followed by the interventions as described above *(see training*). In the post intervention phase the participant's knowledge and skills were reassessed using the same questionnaire and skills assessment method as in the pre-intervention phase at various time points such as immediately following the training and at 6 weeks following the training. For ensuring greater reliability the same scenarios, test sheet and questionnaire were used throughout the study.

Statistical analysis

The demographic variables such as age of the nurses, years of experience, previous training in CPR and no of resuscitations assisted were recorded in a proforma. Data was entered into MS Excel 2007 and analyzed using STATA 11.0. Paired t-test was used for continuous variables and McNemar test for categorical variables.

Results

Baseline characteristics

A total of 65 nurses from the previous study participated in this study of which 22 were staff nurses and 43 were students. The baseline characteristics of the participating nurses are described in *table 1*. As we can see from the table almost all the nurses had actively participated in drug administration during CPR as compared to performing other essential skills such as airway or chest compressions.

None of the nurses dropped out at any stage of the study. Thus the final data set comprised of all the 65 nurses enrolled. The study flow chart is depicted in *figure 1* (see below).

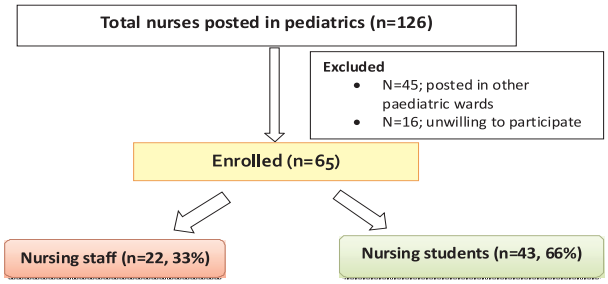
Table 1: Baseline characteristics of participating nurses

Variables	N (%)
Profile	
Nursing staff	22(34%)
Nursing student	43 (66%)
Mean (SD) age in years	
Nursing staff	36 (7)
Nursing students	22 (2)
Years of experience in pediatrics (staff nurses)	
<1 year	7 (32%)
1-3 years	10 (45%)
>3 years	5 (22.7%)
No of resuscitations assisted in last 6 months (staff nurses)	
>10	18 (22%)
Actively involved in which part of resuscitation	
Airway	16 (45%)
Chest compression	18 (81%)
Drug administration	**22 (100%)**
Defibrillation	1 (4.5%)

Data is expressed as number (%) unless specified otherwise; SD, Standard Deviation

Figure 2 shows mean knowledge scores of the study population at different time points. As we can see the scores of the participating nurses improved from a mean of 9.2 to 13 immediate post- test the difference being statistically significant ($p<0.001$). However, the nurses seemed to retain the knowledge gained at 6 weeks re-test as their mean scores remained at 13 (*table 2*). The differences in means between the 6 weeks re-test and immediate post- test was therefore statistically insignificant ($p=0.1$). Similarly, the proportion of nurses scoring pass marks improved to almost 6 times the pretest numbers immediately following the training and this performance continued even after 6 weeks of training (*table 3*) with only a marginal decline in the proportion passing at 6 weeks in comparison to immediate post-test. Thus

Figure 1: Study flow chart



Pretest –post -test CPR knowledge scores

knowledge seemed to be well retained in this study population.

Pretest –post -test CPR skill scores

Figure 2 shows mean skill scores of the study population at different time points. The mean skill scores of the participating nurses improved from 8.9 before training to 10.7 immediately following training and this difference was statistically significant (*table 2*). Although the mean skill scores at 6 weeks was higher than the baseline scores (9.8 vs. 8.9) there was a significant fall in the 6 weeks scores as compared to the immediate post-test scores (9.8 vs. 10.7) the difference between the two scores being statistically significant (p=0.01). Although majority of the participating nurses passed the skill test.

Immmediately post-training (*Table 3*) only one fourth seemed to retain the same at 6 weeks re-test. Thus knowledge seemed to be better retained than skills in the study population.

Figure 2: Mean knowledge and skill scores- of the study population at different time points

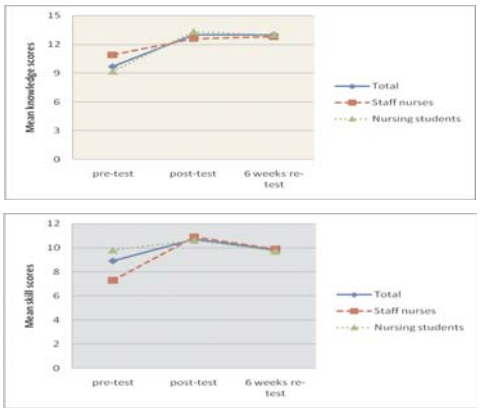


Table 2: CPR knowledge and skill evaluation- comparison of scores at different time points

Variables compared	Pretest Mean (SD)	Post-test Mean (SD)	6 weeks Mean (SD)	Pretest vs. post- test MD (95% CI)	Post- test vs. 6 weeks re-test MD (95% CI)	Pretest vs. 6 weeks re-test MD (95% CI)
Knowledge*	9.7 (2.1)	13 (1.3)	13 (1)	-3.4 (-4.1, -2.7)	0.15 (-0.03, 0.34)	-3.2 (-3.8 – 2.5)
Skills#	8.9 (2.3)	10.7 (1.1)	9.8(1)	-1.7 (-2.4, -1.1)	0.94 (0.76, 1.13)	-0.8 (-1.5, -0.2)

** P value <0.001 on all time points except post-test knowledge vs.6 weeks re-test where p=0.1; # the p value was <0.001 on all time points except pretest skill vs.6 weeks re-test where p=0.01; SD, Standard Deviation; MD, Mean Difference; CI, Confidence Interval*

Staff nurses vs. student nurses

We also compared the baseline and re-test performances in the two nursing subgroups of the study (*table 4*). We observed that there was significant difference in the baseline scores between thetwo groups with staff nurses having higher knowledge score means in comparison to students (10.9 vs. 9.2). Paradoxically, the students seemed to fare better skill wise before the training (9.8 vs. 7.3). With training however, the differences between the two groups started to blur as the difference in scores was no longer significant between the two immediate post-test or after 6 weeks (*table 4*). In fact at 6 weeks the students' mean knowledge scores were higher than that of the staff nurses (13 vs. 12.9) and the staff nurses seemed to have improved in their skill performance dramatically with mean scores being marginally higher than that of the students' (9.9 vs. 9.7). These findings also reflected in the proportion passing the two tests at different time points (*Table 5*).

What went wrong?

Most of them went wrong even after the training (post- test and re-test numbers combined) in 'calling for help' (n=97, 75%), in

Table 3: Proportion of participants who passed the evaluation at different time points

variable	Pretest	Post test	6 weeks	P (pretest vs. post- test)	P (post-test vs. 6 weeks re-test
Knowledge	7 (11.3%)	46 (71%)	40 (62%)	<0.001	0.84
Skills	18 (27.7%)	46 (71%)	17 (26.2%)	<0.001	0.03

the 'technique of chest compressions when changing over from 1 rescuer to 2 rescuer scenario in infant CPR (n=78, 60%), in the depth of chest compressions' (n=86, 66%) and in the 'order of resuscitation' (n=64, 49%).

Discussion

In this repeated post- test study we found that the knowledge and skills of nurses posted in emergency and ICU improved following the new teaching method and the nurses seemed to retain the knowledge acquired even at 6 weeks after training. Our findings are in stark contrast to our previous study comprising the same cohort of nurses (*in press*). In our previous study we had found that both knowledge and skills declined significantly at 6 weeks re-test with performance in knowledge domain lagging behind that of skills. As previously described the poor performance of this cohort in the previous study prompted us to change our teaching module to suit the needs of the study participants so that we could improve the overall competence of these nurses in performing infant/child. We succeeded to a certain extent with our experiment as the participants seemed to retain the knowledge acquired after training at 6 weeks and this was despite the fact an entirely different set of questions was used in this study and not the same questionnaire as was used in the previous one. However, despite the mean skill score of the study participants being more than 84% there was a significant decline in the proportion of nurses passing the skills re-test at 6 weeks.

Table 4: CPR knowledge and skill scores - differences between nursing staff and students

Variable	Nursing staff Mean (SD) score	Students Mean (SD) score	Mean Diff	95% CI of the difference Upper	Lower	P value (2-tailed)
Pretest knowledge	10.9 (2.3)	9.2 (1.8)	1.8	0.67	2.84	0.001
Posttest knowledge	12.6 (1.9)	13.3 (0.9)	-0.7	-1.38	0.002	0.05
6 weeks re-test Knowledge	12.8 (1)	13 (0.9)	-0.25	0.75	-0.25	0.32
Pretest skill	7.3 (2.7)	9.8 (1.6)	-2.5	-3.5	-1.39	<0.001
Posttest skill	10.9 (0.6)	10.6 (1.3)	0.29	-0.31	0.89	0.33
6 weeks re-test skill	9.9 (0.7)	9.7 (1.2)	0.28	-0.28	-0.84	0.32

SD, Standard Definition; CI, Confidence Interval

Table 5: Proportion of nurses vs. nursing students who passed the knowledge and skill evaluation at different time points

Variable	Nurses (n=22)	Nursing students (n=43)	P value
Pretest knowledge	5 (26%)	2 (5%)	**0.02**
Posttest knowledge	13 (59%)	33 (76.7%)	0.13
6 weeks re-test knowledge	12(54.6%)	28(65%)	0.40
Pretest skill	2 (9%)	16 (37.2)	**0.02**
Posttest skill	17 (77%)	29 (67.4%)	0.56
6 weeks re-test skill	6(27%)	11 (25.6%)	1.00

Irrespective of the status of baseline training of the participant, studies have identified considerable decrease in knowledge recall and skill performance even after short periods of time following completion of the courses (2, 5, 9, 12, 26-29). However, the findings have been dichotomous in some of them with participants faring better in a particular domain as compared to the other. In most instances knowledge was better retained than skills with time similar to what we found in our study (2, 5, 12, 30). Our findings are also in agreement with the only published pediatric study on this subject by Hayley west (26) in which the author observed that the participating nurses' knowledge was retained at 6 weeks but the order in which the nurses were performing the skills was beginning to change by 6 weeks.

The probable reasons behind why our study participants retained knowledge better than skills in contrast to our previous study in which the skills were better retained could be *firstly*, the teaching method that we used in this study (all the participants were made to read the entire resource material in the classroom and discuss and clarify any issues thereby improving their understanding of the same). In the earlier study the participants were asked to read the resource material by themselves 2 weeks prior to the study.

Several kinds of teaching methods have been evaluated in the context of improving knowledge and skills of health care professionals in performing CPR in adults. Some of the frequently tested methods include video self- instruction, peer tuition, cardiac arrest simulation (CAS) or Mega- codes using specialized CPR manikins, computer aided learning, lecture style teaching, gaming and use of action cards (17-22). In a meta-analysis on the teaching methods in CPR training Hamilton R (14) observed that among all the methods listed above video self-instruction, peer tuition and computer based teaching tools improved the performance and retention of CPR skills and knowledge in nurses. In our previous study we had used peer tuition, computer based teaching methods and hands on demonstration using CPR manikin to train the participants. As this strategy failed to retain their performance with time, in addition to the methods used in the previous study we introduced the group discussion activity with reinforcement by the instructor on the critical components of CPR to improve their knowledge, and, added video – self instruction with instructor feedback to improve their skill performance. To a great extent this model of training succeeded in improving their competency in CPR knowledge but not in skills. *Secondly*, unlike the previous study in which only 10% had received some sort of informal training prior to participating in the study, all the 65 nurses participating in this study were already trained through the previous study 6 weeks before the start of this study. Thus similar to figures from developed countries (60-100%) (16, 31-33), the nurses participating in this study were all trained this time and probably this contributed to their overall improvement in knowledge and skill acquisition in comparison to the previous study. *Thirdly*, the nurses were probably more motivated this time to improve their performance in knowledge as they had been given a feedback about their poor performance in knowledge as compared to skills after the previous study, and *finally*, lack of self – confidence as noted in previous studies or probably over confidence in the study participants in performing skills could have resulted in this discrepancy in their performance.

We also compared the performance of the nursing staff with that of the students to see if there was any difference between the two. In our previous study we found that whichever group had performed well in a particular domain in comparison to the other at baseline, continued to perform similarly at 6 weeks. For example, the nursing staff had higher mean knowledge scores at baseline compared to the nursing students, while the latter group was better at skills. Both groups continued to perform similarly at 6 weeks. Thus baseline scores seemed to influence the retaining capacity of the two groups with time. Interestingly, in this study we observed that even though there were significant differences in the baseline scores between the two groups (with the staff nurses having higher mean knowledge scores and the nursing students having higher skill scores), there was no difference in their performance with time. Thus the training program seemed to improve the overall competence of the nursing subgroups irrespective of their clinical experience or their baseline performance with knowledge outperforming skill in both subgroups at 6 weeks. We could not find any other studies which had compared these two subgroups in the two domains.

Thus from the above discussion the following points emerge – i*)* a combination of teaching methods suited to the attributes of the study population improved the overall performance of the study cohort ii*)* knowledge was better

retained with time in comparison to skills iii) motivation to learn and/or self-confidence may play a major role in acquisition and retention of knowledge and skills in infant/child CPR and iv) there was no difference in the performance of the two nursing subgroups with time despite having differences in baseline scores.

The strengths of our study are *1)* we used a combination of teaching methods and devised a new method which improved the overall competence of the nurses in infant/ child CPR and *2)* we included defibrillation in the course curriculum unlike the previous study so that the nurses were familiar with the procedure. However, our study has several limitations such as *a)* in the skill assessment we had only tested infant 1 rescuer and 2 rescuer case scenarios and did not evaluate child 1 rescuer/ 2 rescuer, foreign body airway obstruction or defibrillation. We plan to evaluate the same at a later stage *b)* the time duration required for training in the knowledge domain is long (8-10 hours) and needs high level of commitment from the instructors/ trainers and motivation of the participants to learn. In most setups the participants may not be willing to spend so much time or may not be so motivated. Therefore the training program should be tailored to the needs of the study population to get the best results.

Recommendations

Based on the findings of ours study we have decided to use this method of teaching in new recruitments as and when they are posted and conduct update/retraining program for the trained nurses once in every 2 months with reevaluation and feedback after each update.

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Conflict of Interest: *None*

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