



Department of Pediatrics and Child Health

Assessment of Knowledge and Skill of Cardiopulmonary Resuscitation among Health Professionals in St. Paul's Hospital Millennium Medical College Pediatrics and Child Health Department

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A Thesis Submitted to Department of Pediatrics and Child Health, St. Paul's Hospital Millennium Medical College in Partial Fulfillment for the Requirement of the Certificate in Pediatrics and Child Health

NOVEMBER, 2021

ADDIS ABABA, ETHIOPIA

St. Paul's Hospital Millennium Medical College
Department of Pediatrics and Child Health

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Health Professionals in St. Paul's Hospital Millennium Medical College
Pediatrics and Child Health Department**

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Acknowledgement

I would like to express my heartfelt gratitude to my advisor, Dr Abate Yeshidinber (MD, Pediatric Pulmonologist & Critical Care Physician), for his innumerable guidance from the beginning to the end of this study.

I would also like to extend my gratitude to Dr Tigist Bacha (MD, Pediatric Critical Care Intensivist) for her support and guidance during the development of the proposal.

I am extremely grateful to Mr. James Gibson (MHA, EMT-P, AHA Ethiopia Resuscitation Training President) for all his support and contribution without which this study couldn't have been completed.

Last but not least, I would like to thank my husband Yared Ayalew for his understanding, encouragement and continuous support.

Abstract

Background: Cardiopulmonary resuscitation is an emergency lifesaving procedure done on a patient having cardiac arrest in order to keep blood flowing to preserve intact brain function until an advanced life support can be given or return of spontaneous circulation can be achieved. The knowledge and skill of health professionals involved in the care of patients with cardiac arrest has an effect on the quality of Cardiopulmonary resuscitation provided to the patients; thus affecting patient outcome after cardiac arrest.

Objective: This study is aimed to assess the knowledge and skill of Cardiopulmonary resuscitation among health professionals working in St. Paul's Hospital Millennium Medical College Pediatrics and Child health department.

Methods: Institution based descriptive cross sectional study was conducted from February 1, 2021 to June 30, 2021. The data was collected using a structured and pretested questionnaire prepared according to the content of the recent American Heart Association guideline. The skill assessment was done using the AHA CPR skill assessment checklist to evaluate a demonstration of CPR on high fidelity manikin. The data was inserted to EpiData version 3.1 and was analyzed using SPSS version 26.

Results: 202 participants participated with a final sample size of 190 after exclusion of incomplete data. The age of study participants ranged from 22-40 years with a median of 27 years (IQR 25-28). 91 (47.9%) were nurses, 34 (17.9%) interns, 63 (33.1%) were pediatric residents, and 2 pediatricians (1.1%). The mean knowledge assessment score was 38.51% (SD=14.68) and median 35.29% (IQR = 29.41-47.06) with no participant scoring above 84%. Nurses had the lowest score on the written test. The mean skill assessment score was 22.01% (SD=14.25) with the highest scored by pediatricians. Participants working at pediatric intensive care unit scored the highest on skill assessment while those working at neonatal intensive care unit scored the lowest.

Conclusion: This study has shown that the knowledge and skill of CPR among the health professionals working at SPHMMC pediatrics department is poor. Being a nurse is associated with less knowledge and being a pediatrician and working at PICU was associated with better skill of CPR while working at NICU was associated with lesser skill of CPR.

Key terms: Assessment, Knowledge, Skill, Cardiopulmonary resuscitation

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Acronyms

AHA – American Heart Association

ALS – Advanced Life Support

BLS – Basic Life Support

CPR –Cardiopulmonary Resuscitation

ECC – Emergency Cardiovascular Care

ERC – European Resuscitation Council

GWTG-R – Get With the Guidelines®-Resuscitation

HCP – Health Care Professional

HOW – Hematology Oncology Ward

IHCA – In Hospital Cardiac Arrest

NICU – Neonatal Intensive Care Unit

OHCA – Out of Hospital Cardiac Arrest

PEOPD – Pediatric Emergency Outpatient Department

PICU – Pediatric Intensive Care Unit

PROPD – Pediatric Regular Outpatient Department

ROSC – Return of Spontaneous Circulation

SPHMMC – St. Paul’s Hospital Millennium Medical College

1. Introduction

1.1. Background to the Study

Cardiopulmonary resuscitation (CPR) is an emergency lifesaving procedure which is performed for a patient who has cardiac arrest, often involving chest compressions and artificial ventilation, to keep blood flowing in the body, in an effort of preservation of intact brain function, until advanced life support can be given to achieve spontaneous blood circulation or breathing (1). CPR done immediately after cardiac arrest can double or triple the chance of survival after cardiac arrest (1).

The American Heart Association (AHA) states that efforts of resuscitation date as old as the healing arts, progressing from primitive resuscitative efforts that have been abandoned to the ones that continue to be used to this day. The first clinical documentation of a successful mouth to mouth resuscitation was in 1732 (2). Chest compression was successfully used first in 1891 by a German surgeon, on two occasions, on a 9 years old boy and on an 18 years old boy, although the technique didn't continue to be practiced for half a century afterwards (3). Despite the fact that some physicians continued to apply mouth to mouth resuscitation and other methods of delivering lung ventilation, and even open heart massage or closed chest cardiac massage, it was not until 1960 that mouth-to-mouth breathing was combined with chest compressions to create cardiopulmonary resuscitation (2). At the same time the AHA started programs to familiarize physicians with closed-chest cardiac resuscitation, and 3 years later, formally endorsed CPR (2). In 1983 the AHA assembled a national conference on pediatric resuscitation to develop CPR and Emergency Cardiovascular Care (ECC) guidelines for pediatric and neonatal patients (2). The International Liaison Committee on Resuscitation (ILCOR) was established in 1992 to provide an opportunity for the major organizations in resuscitation to work together on CPR and emergency cardiovascular care protocols. The member organizations in the ILCOR are the AHA, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian and New Zealand Committee on Resuscitation, the Resuscitation Councils of Asia, the Inter-American Heart Foundation and the Resuscitation Councils of Southern Africa. The ILCOR provides an evaluation process by which the international science and knowledge relevant to CPR and ECC is identified and reviewed. It also provides recommendations and each member council reviews these recommendations and updates their respective guidelines (4).

In its standard form CPR consists of Chest compression, Airway and Breathing, usually performed in this order, although Chest compression only CPR is recommended for bystander CPR in the out of hospital setting in adults, and in infants and children if the rescuer is unable or unwilling to deliver breaths (1, 5).

In an effort to improve the post cardiac arrest outcome, there are a chains of survival proposed for management of In Hospital Cardiac Arrest (IHCA) & Out of Hospital Cardiac Arrest (OHCA), both for Pediatrics and Adults. The recently updated AHA pediatric in hospital chain of survival consists of six components: Early recognition and prevention, Activation of emergency response, High quality CPR, Advanced resuscitation, Post Cardiac Arrest Care, and Recovery (5).

The third step of the pediatric IHCA chain of survival, High quality CPR, is an integral part of the management of IHCA because it provides blood flow to vital organs and increases the likelihood of return of spontaneous circulation (5). High quality CPR has five components: adequate chest compression depth, optimal chest compression rate, minimizing interruptions in CPR, allowing full chest recoil between compressions, and avoiding excessive ventilation (5).

As it has been previously stated, outcome of cardiac arrest depends on the quality of the resuscitative care provided. Important components of cardiac arrest care like immediate recognition of cardiac arrest, early initiation of CPR, and high-quality chest compressions can vary depending on the knowledge and skills of health professionals providing care for IHCA. These variables can be targeted by resuscitation training programs to improve patient outcomes (6).

1.2.Statement of the Problem

The incidence of in hospital cardiac arrest is rarely reported in literatures because of lack of standard definitions. Although the data cannot represent the worldwide picture because of the differences in the epidemiology of diseases in different countries, communities and even different hospitals, studies done in the USA show that the incidence of IHCA ranges from 1-5 events per 1000 hospital admissions among all age groups (7). A 5 year retrospective study done in a tertiary hospital in New Zealand has found the incidence of cardiac arrest in pediatric patients to be 0.7% of all hospital admissions and 5.5% of Pediatric Intensive Care Unit admissions (8). Another prospective study done over a one year period in a tertiary hospital in Brazil showed an incidence of cardiac arrest and bradycardia with poor perfusion to be 3% among all pediatric admissions (9).

Although there are only few studies which compared the outcome of IHCA in different hospitals, there are plenty of patient related and non-patient related factors that account for the differences in the outcome of IHCA. Patient related factors affecting outcome after cardiac arrest include age, sex, cardiac arrest rhythm, location of arrest, mechanical ventilation, acute non-stroke neurologic event, major trauma, hypotension, metabolic or electrolyte abnormalities, renal insufficiency, sepsis, illness category, and need for intravenous vasoactive agents prior to the arrest (10). Overall survival after cardiac arrest is better in children than adults with rate of survival to hospital discharge 27% versus 18% (11). Infants have shown better post cardiac arrest survival to discharge than other age group children (12).

There are myriads of non-patient related factors associated with outcome after cardiac arrest. One such association is that survival rates from in hospital cardiac arrest occurring during nights and weekends are lower than that of working hours and weekdays, which could be because of lower surveillance levels; less availability of trained medical staffing, ancillary personnel, important medical services, and common urgent procedures; and reduced psychophysical performance (13, 14).

Many studies have shown that patient survival depends on quality of CPR. In a prospective cohort study done on adult patients with OHCA, chest compression at a depth of <38mm was associated with a reduction in survival to discharge rates by 30% and increased depth of chest compression was overall associated with better outcomes in Return Of Spontaneous Circulation (ROSC), 1-

day survival, and discharge (15). Similarly slower chest compression was associated with a drop of the rate of ROSC from 75% to 42% (16).

The outcomes from IHCA have shown improvement within hospitals participating in the AHA's Get With The Guidelines®-Resuscitation program (GWTG-R), a data registry and quality improvement program for IHCA provided by the AHA, with risk adjusted rates of survival to discharge in adults increasing from 13.7% in 2000 to 22.3% in 2009. The rate of clinically significant neurologic disability among survivors has also shown improvement from 32.9% to 28.1% over the same period (17). Similarly, assessment of the trends in the outcome of in hospital cardiac arrest in pediatric patients in hospitals participating in GWTG-R program has shown an improvement, with risk adjusted survival to discharge increasing from 14.3% in 2000 to 43.4% in 2009. It was also found that improvement in survival is largely driven by an improvement in acute resuscitation survival, with risk adjusted rates increasing from 42.9% to 81.2% over the same period. Besides, this improvement in survival is not accompanied by an increase in neurological disability among survivors (18).

Moreover, a prospective cohort study done in a tertiary hospital has found that patients whose cardiopulmonary arrest was discovered by a nurse who has Advanced Life Support (ALS) training are about 4 times more likely to survive to discharge than those patients discovered by a non-trained nurse (19). This study has clearly revealed that the ALS training, and thus the knowledge & skill of the nurses about CPR has an impact on patient survival after cardiac arrest.

The presence of gaps in the quality of CPR provided to patients and its association with difference in patient outcome presents an important opportunity to improve the survival rates after cardiac arrest. Accordingly, this descriptive study is intended to inquire on the knowledge of health professionals working in St. Paul's Hospital Millennium Medical College (SPHMMC) pediatric department and identify the factors associated with their level of knowledge, thus will provide an insight for actions to improve the gaps and improve patient survival.

1.3. Significance of the study

The study is aimed to assess the knowledge and skills of cardiopulmonary resuscitation among health professionals working SPHMMC pediatrics and child health department. The findings from this study can be used as a baseline to improve the gaps in the knowledge of health professionals, pointing on the factors that resulted in the deficits or differences. Furthermore, given the paucity of studies done on this area, this study can be used as a baseline for further studies.

2. Literature Review

There are many studies worldwide which were done to assess the knowledge of health professionals about CPR, with a few among them assessing both knowledge and skills of CPR. Some selected literatures are reviewed as follows.

An observational study done in Kist Medical College Hospital, in Nepal, assessed the knowledge of the medical and paramedical staff based on the 2005 BLS Guidelines of European Resuscitation Council. Data was collected using a questionnaire consisting of 3 parts: demography and professional qualification of the participants; experience in and attitude to BLS/CPR; and their theoretical and practical knowledge about CPR, using MCQs prepared based on 2005 ERC BLS Guidelines. 150 questionnaires were distributed and 127 were filled of which 6 were incomplete and thus excluded. Data from 121 responders (27 clinical faculty members, 21 dental and basic sciences faculty members, 29 house officers (Residents) and 44 nurses and health assistants) were analyzed. The overall mean score was 6.6 out of 15 questions with a median score of 7. The clinical faculty members, house officers and nurses/health assistants (together) had a mean score of 7.4 ± 3.15 , 7.37 ± 2.02 and 6.63 ± 2.16 respectively, while dental/basic sciences faculty members had the least mean score of 4.52 ± 2.13 ($P < 0.001$). Those who had received CPR training within 5 years prior to the study period scored the highest, with a mean of 8.62 ± 2.49 , whereas those who had the training more than 5 years back or no training at all got a mean score of 5.54 ± 2.38 and 6.1 ± 2.29 respectively ($P = 0.001$). The study has also found that participants who were involved in resuscitation frequently had a higher median score of 8 compared to those who were seldom involved or not involved at all, who scored a median of 5 ($P < 0.001$). There was no statistically significant correlation found between work experience & knowledge of CPR. This study has shown that there is a significant gap in the knowledge of CPR, and has demonstrated that differences in professional background were related to differences in knowledge of CPR; additionally recent training, and frequent participation in resuscitation were independently associated with better knowledge of CPR. There was a significant non-responder rate of 16% which may affect the generalizability of the result. It was mentioned that frequent participation in resuscitation was associated with better knowledge of CPR, but there is no clear statement of what frequent involvement means, thus creating ambiguity. Moreover, the study didn't use a standard cut off point to compare the score of the participants, thus making interpretation difficult. (20).

A descriptive, quantitative study conducted in five hospitals in Athens, Greece assessed the knowledge of nurses and doctors according to the 2005 European Resuscitation Council BLS and ALS guidelines. The data was collected using a questionnaire having three parts to assess the demographic data, training and experience with a cardiac arrest victim; questions to evaluate familiarity with the 2005 ERC guidelines; and a survey of confidence in being part of a cardiac arrest team and in performing practical resuscitation skills. Data was collected from a total of 82 nurses and 134 doctors who agreed to respond to the questionnaire out of 470 randomly selected nurses and doctors who were asked to participate with a response rate of 45.5% (54.6% among nurses, 46.6% among trainee doctors and 37.6% among specialized doctors). The study found no statistically significant difference in the total theoretical knowledge score between doctors and nurses (Doctors: 9.1 ± 1.2 , Nurses: 8.5 ± 1.7 out of 15 questions, $p = \text{NS}$). Respondents who had attended BLS courses gave correct answers in significantly more BLS questions than those with no previous BLS training ($p < 0.0001$; T-test). Similarly, respondents who reported having ALS training, scored significantly better in all ALS questions compared to those with no previous ALS training ($p < 0.0001$; T-test). Nurses and doctors who worked in high-risk areas for cardiac arrest (emergency departments, anesthesiology departments and intensive care units), had a significantly higher frequency to provide the correct answers in BLS ($P = 0.0114$; T-test) and ALS ($p = 0.0077$; T-test) questions, than those working in low-risk areas. Nurses and doctors who had encountered more than 5 cardiac arrests the preceding year, scored significantly better in BLS ($p = 0.0072$; T-test) and ALS questions ($p < 0.0001$; T-test) than those who had dealt with less. This study has revealed that the knowledge of the nurses & doctors was suboptimal. It has also shown that having BLS or ALS training, working in high risk areas for cardiac arrest, and recent experience with cardiac arrest were independently associated with a higher score & therefore a better knowledge on CPR. However it has only assessed the theoretical knowledge and the score might not represent how the health professionals would respond in resuscitation. There is also a significant non-responder rate which may reflect that nurses & doctors who were not willing to participate in the study refused because they didn't know the answers, thus leading to underestimation of the knowledge gap (21).

A multi-center cross-sectional study was conducted in five institutions of Karachi, Pakistan from January to March 2018. Data was collected using a questionnaire having two parts: demographics and knowledge part which was according to the AHA/ERC guidelines of 2015. The questionnaire

was administered to the concerned staff (doctors, dentists & nurses) on duty in different departments of the hospital based on non-probability convenience sampling. In total, 58.3% of the individuals who answered the questionnaire answered less than 50% of the questions. The average scores of doctors, dentists and nurses were 53.5 ± 14.2 , 43.3 ± 13.4 and 38.4 ± 15.0 respectively, (p value < 0.001) reflecting the inadequacy of knowledge on CPR. Furthermore, less than 2% of the participants were able to exceed the 84% mark set by the AHA. In this study, being a doctor (OR 5.89, 95% CI: (2.91 to 11.89), a faculty member (OR 3.49, 95% CI: (1.51 to 8.05), and having attended a BLS course (OR 2.19, 95% CI: (1.34 to 3.56), was significantly associated with greater knowledge. As happened with other studies, this study also assessed only theoretical knowledge and the response might not reflect the skill set and improvising capabilities of the health professionals. The data was collected using nonprobability sampling, which might have affected the representativeness of the sample (22).

A descriptive cross-sectional study was conducted in a South African tertiary hospital. Convenience sampling was used and 100 doctors (interns, medical officers and residents) working in different departments were included. A closed ended questionnaire was administered. The questionnaire had two parts, the first contained demographic characteristics and the second covered general resuscitation (evaluation and identification of a patient requiring assistance and decisions and actions taken), as well as adult CPR (decisions and actions) and pediatric CPR (decisions and actions). A minimum score of 84% defined adequate knowledge as outlined in the AHA BLS courses. None of the participants had adequate knowledge with a mean score of 35.1% (95% CI: 31.7; 38.6). The mean total score was highest among doctors from the departments of Emergency medicine 55% (95%CI: 45.6; 64.4) Anesthesia 48.9% (95% CI: 40.1; 57.6), Internal medicine 36.7% (95%CI: 28.2; 45.2) followed by Interns and doctors from surgery department. Doctors from pediatrics department had a 5th mean score, 25.6 (95%CI: 13.8; 37.3). The score in the pediatric resuscitation part of the questionnaire was highest among doctors from Anesthesia 60% (95% CI: 44.6; 75.4), Emergency medicine 50% (95%CI: 34.2; 65.8) and Pediatrics 40% (95%CI: 16.9; 63.1), which is only a few points above the mean score 36.6% (95% CI: 37.0; 41.6). The study has shown that there is a significant lack of knowledge among the participants. Although the differences in the scores of doctors from different departments can be observed, there is an overlap of the confidence interval and the p value might not be significant. This might

be because of the small sample size used in the study. Furthermore, convenience sampling was used, which may affect the representativeness of the participants (23).

A quasi experimental study was done in two referral hospitals in Botswana to assess CPR knowledge and skills of registered nurses using a pre-test, an intervention, post-test, and re-test after three months. Non-probability convenience sampling was utilized to select 102 participants, all of whom participated in the pretest, the intervention (CPR training) and immediate posttest, but only 70 participants took the retest. A questionnaire having demographic characteristics was filled, skill was assessed with a 3 minutes activity and the participants completed MCQs assessing their knowledge. A 4hr BLS training session based on AHA guidelines was given and knowledge and skill assessment was repeated immediately after the session. The nurses' mean score on the knowledge assessment part was 55.09%, 80.63%, and 70.75% on the pretest, posttest and retest respectively indicating overall poor knowledge compared with the AHA cut off point of 84%, and some improvement of knowledge after the training which has deteriorated after 3 months. The participants' mean score on skill assessment was 9.42%, indicating poor performance. The post-test mean score increased to 78.31% after training, but it decreased to 67.82% after 3 months. This study has demonstrated a significant deficit in the knowledge and skill of the participants and has shown that the 4hr training resulted in an improvement of the scores, even though there was decline after 3 months. There was a significant drop out rate which might have affected the accuracy of the results (24).

A descriptive cross sectional study was done in an urban tertiary hospital in Dar es Salaam, Tanzania from October 2015 to March 2016 to assess CPR knowledge and skills of healthcare professionals. A randomly selected 350 health care professionals including health attendants, nurses, interns, general practitioners, residents, specialists, and supporting clinical staff, which represented 15% of all staffs, participated in the study. Data was collected using a questionnaire involving demographic and other information about training and experience; MCQ and fill-in-the-blank test derived from the AHA guideline; and videotaped skill assessment part done on manikin. Overall 80% of the participants scored <50% in the written test, with only 4% of the participants having a score of >75%. On the skill assessment part 66% of the participants scored <50% with only 9% scoring >75%. The combined total score (written and practical) on initial approach, compressions and ventilation among doctors was significantly higher than the other HCPs with no significant difference between the subgroups of doctors. When comparison was

done by department the Emergency department had the highest combined score of written & practical parts on initial approach, compression & ventilation. Participants with prior experience on CPR had a better overall score with a median of 40 % (IQR 28–54) than those who had not performed CPR, median score of 26 % (IQR 16–42) $p= 0.001$. Prior training on CPR was also associated with a better overall score with a median of 46% (IQR 36–58) than no training, 26% (IQR 18–40), $p= 0.001$. The study has indicated the inadequacy of knowledge and skills among the HCPs and has indicated the factors associated with the differences in the scores of the participants. Although the study has identified a significant gap of knowledge of the HCPs, it hasn't compared the results with a standard cut off point, and thus may have underestimated the knowledge deficit (25).

An institution based cross sectional study was conducted in Gondar University Hospital and Bahirdar Referral Hospital in 2016 to assess the knowledge and attitude towards BLS among the nurses working in these hospitals. 397 nurses were given questionnaires and 388 participated in the study with a response rate of 97.7%. More than two thirds (68.6%) of the nurses never had BLS training. Of the remaining 31.4% participants who had BLS training, 7.7% had training before graduation and 23.7% of the participant had in service training. The mean score of the participants was 9.17 with a median of 9 out of 22 knowledge assessing questions. Only 38.6% of the participants had good knowledge of BLS. The study has also revealed that 71.6% of the participants had poor BLS practice. Those nurses who had first degree were 6.96 times more likely to have good knowledge as compared to diploma holders [AOR=6.96, 95%CI (3.36, 14.42)]. Longer period of clinical experience (5-10 years) was associated with better knowledge than fewer years' experience [AOR=6.82, 95%CI (1.93, 24.12)]. Nurses who were working in medical ICU were about 5 times more likely to have good knowledge of BLS as compared to nurses working in OPD [AOR=4.67, 95%CI (1.09, 19.86)]. Nurses who had BLS training were 5.63 times more likely to have better knowledge than those who hadn't [AOR=5.63, 95% CI (2.9, 10.92)]. The study has identified the gap in the knowledge of nurses working at 2 referral hospitals in Ethiopia. It has also assessed the factors associated with the differences in knowledge and practice of CPR. This study is one of the few studies done in Ethiopia to assess the knowledge and practice of CPR among nurses. The study was done at 2 hospitals, and was done with a larger sample size than the other studies done in our country. However, the sample size determination and sampling technique were not mentioned in the study. The questionnaire used in the study was

not validated, nor pretested, thus making the evaluating capacity of the test questionable. Furthermore, the knowledge assessment was not done with a standard cutoff point and has thus resulted in underestimation of the knowledge deficit; on top of that, the tool used to assess the practice part was not clearly stated making interpretation of the results difficult (26).

3. Objectives of the Study

3.1.General Objective

The study aimed to assess the knowledge and skill of cardiopulmonary resuscitation among health professionals working in St. Paul's Hospital Millennium Medical College, Department of Pediatrics and Child Health, from February 1, 2021 to June 30, 2021.

3.2.Specific Objectives

- To assess the level of knowledge of CPR among health professionals working in SPHMMC Pediatrics and Child health Department
- To assess the skill of CPR among health professionals working in SPHMMC Pediatrics and Child health Department
- To assess the factors affecting CPR knowledge of the health professionals
- To assess the factors affecting CPR skill of the health professionals
- To assess the correlation between knowledge and skill of CPR

4. Methods and materials

4.1.Study Area

The study was conducted in SPHMMC Pediatrics department. SPHMMC is the leading teaching and tertiary referral hospital under the federal ministry of health of Ethiopia. It was established in 1968 by Emperor Haile Selassie. Currently it serves patients with more than 700 beds and gives service for more than 1200 emergency and outpatient visitors daily (27). The Pediatric Department has 4 Pediatric Intensive Care Unit beds, 41 ward beds, 40 Neonatal Intensive Care Unit beds, Emergency and regular outpatient departments and follow up clinics. There are more than 20 Pediatricians, more than 74 residents, and more than 160 nurses working in the pediatrics department.

4.2.Study design and period

Institution based descriptive cross sectional study was conducted from February 1, 2021 to June 30, 2021.

4.3.Source population

All health professionals working in St. Paul's Hospital Millennium Medical College, Department of Pediatrics and Child Health

4.4.Study population

All nurses, interns, residents, pediatricians and consultants working in St. Paul's Hospital Millennium Medical College, Department of Pediatrics and Child Health, from February 1, 2021 to June 30, 2021.

4.5.Inclusion criteria

All nurses, interns and residents, pediatricians and consultants working in SPHMMC, Pediatric and child health department and working during the study period at one of PEOPD (Pediatric Emergency Outpatient Department), Ward, HOW (Hematology Oncology Ward), NICU (Neonatal Intensive Care Unit) and PICU (Pediatric Intensive Care Unit), Pediatric regular outpatient department (PROPD) follow up clinics and those rotating at subspecialty attachments

and detachment at other departments were included in the study to ensure that the possible associated factors could be adequately assessed.

4.6.Exclusion criteria

Participants who were unable to participate in both the knowledge & skill assessment were excluded from the study.

4.7.Sample size Determination & Sampling Technique

4.7.1. Sample size

All health professionals working at SPHMMC Pediatrics and Child health department during the study period were involved in the study.

4.7.2. Sampling technique

Sampling was not needed because all the health professionals working at SPHMMC Pediatrics and Child health department were planned to be involved in the study.

4.8.Data Collection method, tool and personnel

The data was collected by trained general practitioners using a structured and pretested questionnaire adapted from previously done similar researches and the AHA BLS skill assessment checklist filled by observation of CPR demonstration on infant manikin. Both the skill assessment checklist and the questionnaire were coded for each participant. The principal investigator re-checked the filled questionnaires and checklists and to ensure their completeness and accuracy.

The questionnaire has two parts, the first part inquiring on relevant demographic data, CPR related experience and CPR training and the second part having 17 multiple choice questions extracted from content of the recent AHA CPR and ECC guideline.

The skill assessment was done through observation of study participants' demonstration on high fidelity infant manikin and the activity was assessed based on the information displayed by the manikin. The skill assessment checklist has 4 check boxes for assessment and activation, 3 for compressions performed with proper hand placement, correct rate and depth of compression allowing complete recoil of the chest, 3 for ventilations performed with each breath given over 1 second with visible chest rise and resumption of compression within 10 seconds and 1 check box

for resumption of compression within 10 seconds by itself. The assessment and activation assessed whether the participant checked for responsiveness and breathing, shouted for help and did proper pulse check. For the assessment of compression, participants performed two cycles of compression as a single rescuer and one cycle of 2 rescuers CPR. Each cycle of compression was assessed for proper hand placement, recommended rate, adequate depth and complete recoil after compression. Ventilation was assessed with three cycles, the first two performed by a single rescuer and the last with two rescuers. Each cycle of ventilation was assessed for two breaths delivered by bag mask device, each breath given over one second with adequate chest rise and resumption of chest compression within 10 seconds.

4.9. Study Variables

4.9.1. Dependent variables

- Adequate knowledge of CPR
- Adequate skill of CPR

4.9.2. Independent variables

- Age
- Educational background
- Work place
- Work experience
- Duration of stay in the department
- BLS/ALS training
- Length of time after training
- Recent exposure with a patient in need of CPR

4.10. Data Processing & Analysis

After data collection, each data set was checked for completeness and coding. The data was entered to EpiData version 3.1, checked for completeness and consistency and exported to SPSS version 26 for analysis.

Descriptive statistics was used to describe the independent variables. Multiple logistic regression was used to see the association between dependent and independent variables. Pearson's

correlation was done to assess the correlation between the two outcome variables. The knowledge part of the questionnaire was graded out of 100% and the 84% set by the AHA was used to evaluate the adequacy of knowledge. A confidence limit of 95% and p value less than 0.05 was considered statistically significant. A draft of the results will be submitted to the advisors for approval.

4.11. Data Quality Assurance

The data was collected using a questionnaire adapted from similar researches and the AHA BLS skill assessment checklist. The data collectors checked their individual filled tools for completeness and consistency and the principal investigator was providing supportive supervision. The collected data was checked by the PI before data processing.

4.12. Ethical Consideration

Before data collection, permission and ethical clearance was obtained from SPHMMC Institutional Review Board and Department of pediatrics and child health. There was also a written consent prepared with the questionnaire explaining the aim of the study and that the data will be used solely for this study.

4.13 Operational Definition

Adequate Knowledge of CPR – Score of 84% or more on a test prepared according to the AHA BLS course content

Adequate Skill of CPR – Demonstration of every step of the AHA CPR skill assessment successfully with a score of 100% on the AHA BLS skill assessment.

5 Result

During the study period 232 nurses and physicians were working at the department of pediatrics and child health. However, only 202 of them consented to participate in the study (response rate of 87.1%). Among the 202 participants 12 were excluded because of incomplete data giving a final sample size of 190.

The age of study participants ranged from 22-40 years with a median of 27 years (IQR 25-28).

Among the participants 91 (47.9%) were nurses, 34 (17.9%) interns, 26 (13.7%) first year pediatric residents, 17 (8.9%) second year pediatric residents, 20 (10.5%) third year pediatric residents and 2 pediatricians (1.1%).

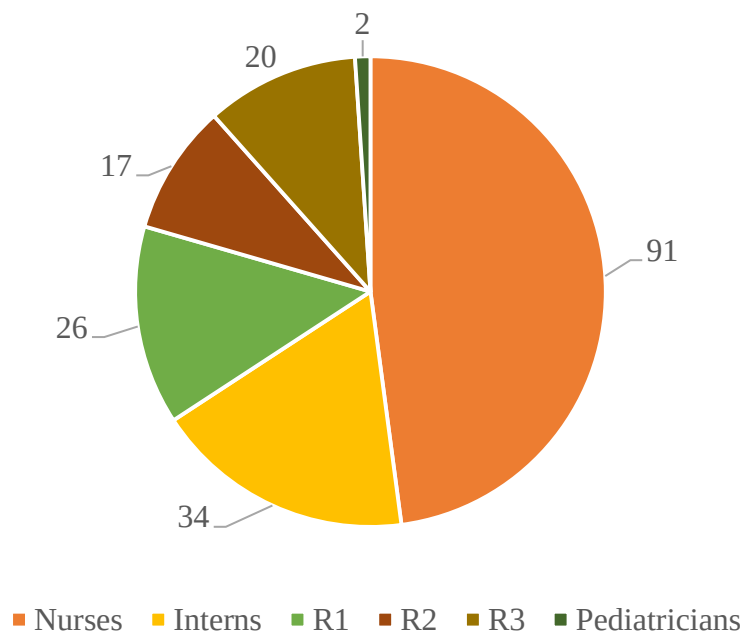


Figure 1 Professional rank of participants in SPHMMC Pediatrics Department, 2021

A quarter of the participants (26.3%) were working at the pediatric emergency OPD followed by NICU and Ward (each 22.6%) and PICU (11.6%) (Table 1).

Majority (81.1%) have clinical experience of less than 5 years, 16.8% had experience of 5-10 years and only four (2.1%) had clinical practice for more than 10 years. Furthermore, 178 (93.7%) worked in the pediatrics department for less than 5 years (Table 2).

One hundred forty (73.3%) had some form of formal or informal training on BLS or ALS either before or after graduation, while 26.3% of them never had any training at all.

More than a third (36.8%) did not receive any form of training on BLS during their undergraduate education, and 54.7% didn't have any form of education on ALS during their undergraduate education

Excluding the interns, only 35.9% of participants had BLS training after graduation and 21.8% had ALS training after graduation.

About 172(90.5%) had performed CPR of whom 82(43.2%) did CPR 1-5 times in the past one year, 14(7.4%) did 6-8 times, 74(38.9%) more than 10 times and 2 participants didn't perform CPR in the past 1 year.

About 57.8% providers got their knowledge of CPR from formal education, 44.9% from reading, 38.4% from training, 10.3% from internet or YouTube videos and 1.1% from other sources like from colleagues and from clinical experience of CPR. Five participants did not specify their source of knowledge.

Table 1 Professional rank and work place of participants at SPHMMC Pediatrics Department, 2021

		Work place							Total
		PICU	PEOPD	NICU	Ward	PROPD	HOW	Other units*	
Professional rank	Nurse (BSc)	15	24	26	17	6	2	0	90
	Nurse (MSc)	0	0	1	0	0	0	0	1
	Intern	0	13	7	12	2	0	0	34
	R1	4	10	2	7	3	0	0	26
	R2	3	1	5	5	2	0	1	17
	R3	0	2	1	1	0	0	16	20
	Pediatrician	0	0	1	1	0	0	0	2
Total		22	50	43	43	13	2	17	190

* Other units - those temporarily working at follow up clinics, subspecialty attachments and detachments at other departments

Table 2 Demographic data, Clinical and CPR related experience of health professionals at SPHMMC Pediatrics Department, 2021

	Frequency	Percentage
Age		
20-25	63	33.2
26-30	112	59.5
30-35	10	5.3
36-40	4	2.1
Years of Clinical Practice		
Less than 5 years	154	81.1
5-10 years	32	16.8
More than 10 years	4	2.1
Years of practice in the Pediatrics department		
Less than 1 year	56	29.5
1-5 years	122	64.2
5-10 years	12	6.3
Had any form of CPR related education or training		
Yes	140	73.7
No	50	26.3
BLS education before graduation		
Yes	120	63.2
No	70	36.8
ALS education before graduation		
Yes	86	45.3
No	104	54.7
BLS training after graduation (N=156)		
Yes	56	35.9
No	100	64.1
ALS training after graduation (N=156)		
Yes	34	21.79
No	122	78.21
Performed CPR in a lifetime		
Yes	172	90.5
No	18	9.5
Number of CPR performed in the past 1 year		
None	20	10.5
1-5 times	82	43.2
6-10 times	14	7.4
More than 10 times	74	38.9

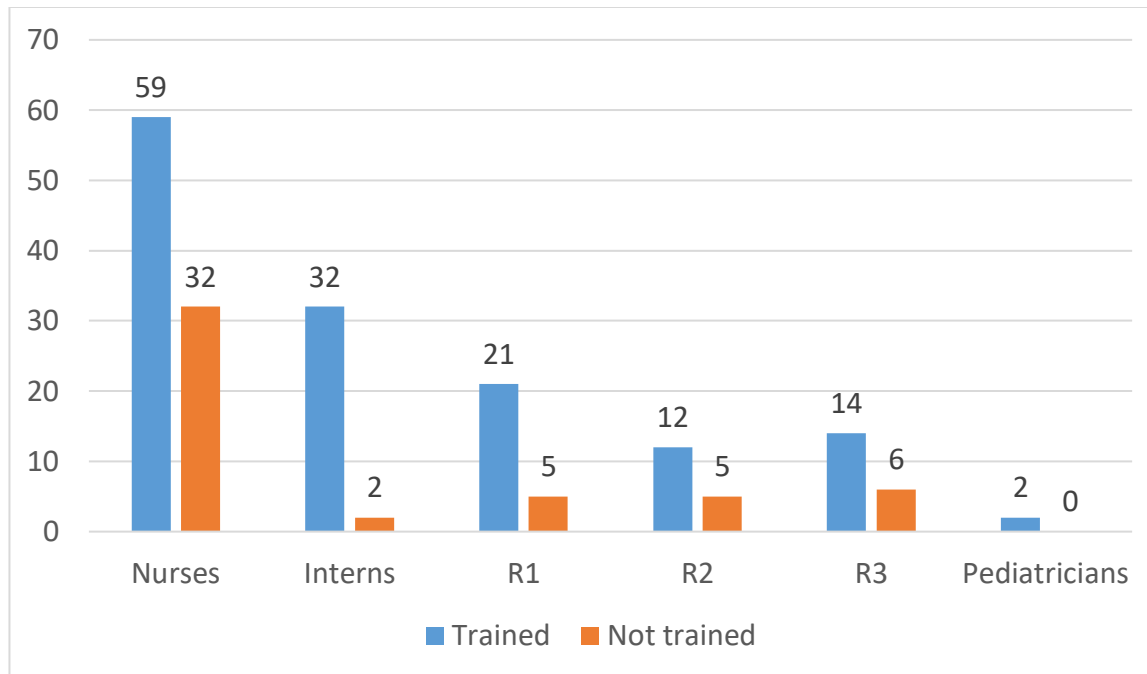


Figure 2 Training Status with professional rank among health professionals in SPHMMC Pediatrics Department, 2021

5.1. Knowledge assessment

The participants were provided with 17 multiple choice questions and the score was converted to 100%. The lowest score was 5.88% (two participants) while the highest was 82.35% (two participants), with an overall mean score of 38.51% (SD=14.68) and median 35.29% (IQR = 29.41-47.06). Furthermore, 80% of the participants scored less than 50%.

Table 3 Performance of participants on CPR related knowledge assessment questions at SPHMMC Pediatrics Department, 2021

Questions	Correct response (percent)	Incorrect response (percent)
1. The current order of updated CPR intervention for all age groups after neonatal age is	39 (20.5)	151 (79.5)
2. How long should a pulse check last?	53 (27.9)	137 (72.1)
3. You are alone and find a patient who is possibly in cardiac arrest. What is your first step?	33 (17.4)	157 (82.6)
4. You are certain of the above answer. What is your next step?	33 (17.4)	157 (82.6)
5. When do you start Chest compression?	157(82.6)	33 (17.4)

6. The recommended rate of chest compression during CPR	83 (43.7)	107 (56.3)
7. If you believe there is risk of a C-spine injury, the best way to open the airway is using	125 (65.8)	65 (34.2)
8. The correct hand placement/position in CPR is:	114 (60)	76 (40)
9. The recommended depth of chest compressions in child aged 1 to puberty	18 (9.5)	172 (90.5)
10. For the best ventilation of infants, the head position should be:	78 (41.1)	112 (58.9)
11. Incorrect chest compression to ventilation ratio	70 (36.8)	120 (63.2)
12. Suppose you are doing CPR on 3 years old child with an advanced airway; what is the appropriate rate of breath per minute to be provided?	66 (34.7)	124 (65.3)
13. Which way of chest compression is preferable in neonatal resuscitation?	102(53.7)	88 (46.3)
14. Which is not characteristic of high quality CPR?	92 (48.4)	98 (51.6)
15. The initial intervention in a newborn with HR of <100/ minute?	84 (44.2)	106 (55.8)
16. Which is not true regarding Epinephrine administration?	42 (22.1)	148 (77.9)
17. What do you do immediately after delivering a shock to a person with an AED?	52 (27.4)	138 (72.6)

Table 4 Factors associated with CPR related knowledge of health professionals at SPHMMC Pediatrics Department, 2021

	Number of participants	Test score mean % (SD)	Difference between groups
Professional rank	N=190		<i>p<0.01</i>
Nurse	91	31.35 (11.80)*	
Intern	34	42.04 (14.78)	
R1	26	43.21 (13.09)	
R2	17	48.44 (10.71)	
R3	20	48.53 (15.25)	
Pediatrician	2	58.82 (16.64)	
Current work placement	N=190		<i>p<0.05</i>
PICU	22	36.90(14.66)	

PEOPD	50	39.41(13.87)	
NICU	43	34.06(16.11)*	
Ward	43	39.95(13.67)	
PROPD	13	36.65(11.05)	
Hematology-Oncology	2	29.41(8.32)	
Other units**	17	48.10(15.17)*	
Time in Clinical Practice	N=190		p=0.704
Less than 5 years	154	38.35(14.29)	
5-10 years	32	39.89(17.08)	
More than 10 years	4	33.82(10.05)	
Time in pediatrics department	N=190		p=0.113
Less than 1 year	56	40.86(14.30)	
1-5 years	122	38.14(14.25)	
5-10 years	12	31.37(18.99)	
Had any training	N=190		p=0.495
Yes	140	38.95(15.09)	
No	50	37.29(13.53)	
BLS education before graduation	N=190		p=0.424
Yes	120	39.17(15.03)	
No	70	37.40(14.09)	
ALS education before graduation	N=190		p=0.080
Yes	86	40.56(13.98)	
No	104	36.82(15.09)	
BLS training after graduation	N=156		p=0.172
Yes	56	35.61(14.90)	
No	100	38.94(14.35)	
ALS training after graduation	N=156		p=0.135
Yes	34	34.43(14.78)	
No	122	38.67(14.47)	
Last training after graduation	N=156		p<0.05
Less than 1 year back	11	42.78(14.19)	

1-5 years back	43	33.38(14.28)*	
More than 5 years back	3	49.02(20.66)	
Not trained	99	38.74(14.28)*	
Performance of CPR	N=190		p=0.703
Performed CPR in lifetime	172	38.65(14.92)	
Never performed CPR	18	37.25(12.44)	
Number of CPR performed in the past 1 year	N=190		p=0.885
None	20	37.06(11.78)	
1-5 times	82	39.45(14.89)	
6-10 times	14	37.82(7.90)	
More than 10 times	74	38.00(16.21)	

* Groups with statistically significant difference

** Other units - those temporarily rotating at follow up clinics, subspecialty attachments and detachments at other departments

Nurses had significantly lower mean scores (M=31.35%, SD=11.80) on the CPR knowledge questions than interns (M=42.04%, SD=14.78), first year residents (M=43.21%, SD=13.09), second year residents (M=48.44%, SD=10.71), third year residents (M=48.53%, SD=15.25) and pediatricians (M=58.82%, SD=16.64). The mean differences were significant at p value of <0.01. However there were no significant differences between the other health professionals.

The participants working at NICU at the time of the study scored lower (M=34.06%, SD=16.11) than those working at “Other units” which was assigned to those temporarily rotating at follow up clinics, subspecialty attachments and detachments at other departments (M=48.10%, SD=15.17) with a significant difference at a p value of 0.017. There were no significant differences between other areas of placement.

Participants who had their last training 1-5 years before the study scored significantly lower (M=33.38%, SD=14.28) than those who had no training after graduation (M=38.74, SD=14.28) with a p value of <0.05. There were no statistically significant differences between other groups.

Based on this finding, the independent variables with significant mean difference were dummy coded and standard stepwise multiple regression analysis was done to analyze for explanatory

variables for MCQ score. Being a nurse was found to be a significant predictor of score on the multiple choice questions ($B = -13.747$, $SE=1.888$, $p<0.001$). Otherwise work place and length of time after training were not significant predictors.

5.2. Skill Assessment

The American Heart Association (AHA) infant BLS checklist was used to assess the skill of the participants. The checklist has 11 check boxes for one or more correctly performed skills. The score out of 11 was converted to percentages out of 100. The mean score of the participants was 22.01% ($SD=14.25$) with a minimum score of 0% (5 participants) and a maximum of 100% (one participant). Furthermore, 94.7% of the participants scored $<50\%$.

Pediatricians scored significantly higher ($M=90.91\%$, $SD=12.86$) than first year residents ($M=25.17\%$, $SD=13.19$), third year residents ($M=24.55\%$, $SD=12.55$), interns ($M=21.12\%$, $SD=10.43$), nurses ($M=19.98\%$, $SD=13.29$) and second year residents ($M=18.72\%$, $SD=7.52$) with a p value <0.01 (Table 5). However there was no statistically significant difference between the others.

Participants from the PICU performed significantly higher ($M=30.17\%$, $SD=14.41$) than those at NICU ($M=16.91\%$, $SD=14.92$) with a p value of <0.01 , but there was no statistically significant difference with the other groups. Further analysis was done to compare the means of the nurses working at PICU and NICU and there was a statistically significant difference with nurses from PICU scoring higher ($M=31.52\%$, $SD=16.43$) than nurses from NICU ($M=13.45\%$, $SD=7.72$) with a p value < 0.01 .

Performance of participants with experience of more than 10 years ($M=43.18\%$, $SD=35.11$) is significantly higher than those with experience of 5-10 years ($M=24.43\%$, $SD=18.25$) and less than 5 years ($M=20.96\%$, $SD=12.05$) with a p value of 0.012 and 0.002 respectively. There is a very low positive correlation between length of clinical experience and skill assessment score ($r=0.194$, $p<0.01$).

The analysis of variance shows that significantly higher score was achieved by participants who had their last BLS or ALS training 5-10 years back ($M=66.67\%$, $SD=42.96$) than those who had their last training 1-5 years back ($M=22.83\%$, $SD=15.16$), those who had no training after graduation ($M=21.12\%$, $SD=12.10$) and those who had training less than a year before the study was conducted ($M=17.36\%$, $SD=8.58$) with a p value <0.01 .

Based on this finding the independent variables with significant mean difference were dummy coded and multiple regression analysis was done to analyze for explanatory variables for skill score. The significant predictors from the model were being pediatrician (B=74.343, SE=14.773, $p<0.001$), working at PICU (B=8.278, SE=2.727, $p<0.01$) and working at NICU (B= -6.546, SE=2.083, $p<0.01$). The other variables were not significant predictors.

Table 5 Factors associated with CPR skill performance of participants at SPHMMC Pediatrics Department, 2021

	Number of participants	Skill score mean % (SD)	Initial approach mean (SD)	Compression skill mean (SD)	Ventilation skill mean (SD)
Professional rank	N=190	$p<0.01$	$p<0.01$	$p<0.01$	$p<0.01$
Nurse	91	19.98(13.29)	1.08(0.87)	0.18(0.59)	0.23(0.73)
Intern	34	21.12(10.43)	1.29(0.80)	0.03(0.17)	0.18(0.58)
R1	26	25.17(13.19)	1.27(0.78)	0.15(0.46)	0.54(1.10)
R2	17	18.72(7.52)	1.18(0.64)	0.12(0.33)	0.12(0.33)
R3	20	24.55(12.55)	1.40(0.82)	0(0)	0.6(1.05)
Pediatrician	2	90.91(12.86)*	4.00(0)*	2(1.41)*	3(0)*
Work place	N=190	$p<0.01$		$p<0.01$	
PICU	22	30.17(14.41)*	1.45(0.86)	0.5(0.96)*	0.55(1.10)
PEOPD	50	22.72(13.65)	1.30(0.89)	0.08(0.34)	0.34(0.85)
NICU	43	16.91(14.92)*	1.12(0.82)	0.09(0.48)	0.12(0.50)
Ward	43	21.14(14.81)	1.09(0.97)	0.14(0.41)	0.28(0.80)
PROPD	13	21.68(6.98)	1.08(0.64)	0.15(0.56)	0.23(0.83)
HOW	2	27.27(12.86)	1.50(0.71)	0(0)	0.5(0.71)
Other units	17	24.06(13.23)	1.29(0.85)	0(0)	0.65(1.12)
Time in Clinical Practice	N=190	$p<0.05$	$p<0.05$	$p<0.05$	
Less than 5 years	154	20.96(12.05)	1.18(0.80)	0.10(0.38)	0.27(0.75)
5-10 years	32	24.43(18.25)	1.22(1.04)	0.25(0.76)	0.53(1.08)
More than 10 years	4	43.18(35.11)*	2.5(1.29)*	1.0(1.41)*	0.75(1.5)
Time in pediatrics department	N=190	$p=0.185$		$p<0.05$	
Less than 1 year	56	20.45(9.84)	1.23(0.79)	0.04(0.19)	0.16(0.6)
1-5 years	122	22.06(13.63)	1.19(0.85)	0.16(0.55)	0.38(0.88)
5-10 years	12	28.79(29.98)	1.42(1.38)	0.42(0.9)*	0.5(1.17)
Had any training	N=190	$p=0.171$			
Yes	140	22.86(14.49)	1.27(0.82)	0.16(0.53)	0.35(0.86)
No	50	19.64(13.42)	1.06(0.98)	0.08(0.44)	0.24(0.74)
BLS education before graduation	N=190	$p=0.475$			
Yes	120	22.58(14.39)	1.27(0.83)	0.18(0.56)	0.33(0.83)

No	70	21.04(14.06)	1.13(0.93)	0.09(0.41)	0.31(0.84)
ALS education before graduation	N=190	p=0.364			
Yes	86	23.04(15.76)	1.24(0.84)	0.22(0.62)	0.34(0.86)
No	104	21.15(12.88)	1.19(0.89)	0.08(0.39)	0.31(0.81)
BLS training after graduation	N=156	p=0.276			
Yes	56	24.18(19.09)	1.3(0.97)	0.2(0.64)	0.46(1.04)
No	100	21.09(12.04)	1.14(0.83)	0.15(0.5)	0.29(0.77)
ALS training after graduation	N=156	p=0.074			
Yes	34	27.81(21.81)	1.38(1.05)	0.29(0.80)	0.59(1.18)
No	122	20.64(12.09)	1.15(0.83)	0.13(0.51)	0.29(0.77)
Last training after graduation	N=156	p<0.01	p<0.01	p<0.01	p<0.01
<1 year back	11	17.36(8.58)	1.18(0.75)	0.09(0.30)	0.09(0.30)
1-5 years back	43	22.83(15.16)	1.21(0.86)	0.14(0.56)	0.44(1.03)
> 5 years back	3	66.67(42.96)*	3(1.73)*	1.33(1.53) *	2(1.73)*
Not trained	99	21.12(12.10)	1.14(0.83)	0.14(0.51)	0.29(0.77)
Performance of CPR	N=190	p=0.685			p<0.01
Performed CPR in lifetime	172	22.15(14.65)	1.21(0.86)	0.15(0.52)	0.35(0.87)*
Never performed	18	20.71(9.76)	1.28(0.96)	0.11(0.47)	0(0)
Number of CPR performed in the past 1 year	N=190	p=0.956			
None	20	20.91(9.37)	1.3(0.92)	0.1(0.45)	0(0)
1-5 times	82	21.73(21.73)	1.13(0.95)	0.11(0.45)	0.38(0.95)
6-10 times	14	23.38(11.67)	1(0.88)	0.36(0.63)	0.36(0.84)
More than 10 times	74	22.36(12.70)	1.32(0.74)	0.15(0.57)	0.34(0.80)

* Groups with statistically significant difference

** Other units - those temporarily rotating at follow up clinics, subspecialty attachments and detachments at other departments

5.2.1. Initial approach

The initial approach of assessment and activation was assessed using 4 activities and the overall mean score of the participants on this part was 1.22(SD=0.87) out of 4 with a minimum score of 0 scored by 39 (20.5%) participants and a maximum of 4 by 3 participants. Only 19 participants

(10%) checked for responsiveness, 122(64.2%) checked for breathing, 68(35.8%) shouted for help and 22(11.6%) did proper pulse check (Table 6).

Pediatricians performed significantly better ($M=4.00$, $SD=0$) than third year residents ($M=1.40$, $SD=0.82$), interns ($M=1.29$, $SD=0.80$), first year residents ($M=1.27$, $SD=0.78$), second year residents ($M=1.18$, $SD=0.64$) and nurses ($M=1.08$, $SD=0.87$), p value <0.01 .

Participants with more than 10 year experience scored better ($M=2.50$, $SD=1.29$) than those with experience of 5-10 years ($M=1.22$, $SD=1.04$) and less than 5 years ($M=1.18$, $SD=0.80$) with p value of <0.05 .

Participants who had their last training more than 5 years back scored significantly higher ($M=3$, $SD=1.73$) than those who had their last training 1-5 years back ($M=1.21$, $SD=0.86$), those who had training less than a year before the study was conducted ($M=1.18$, $SD=0.75$) and those that had no training after graduation ($M=1.14$, $SD=0.83$) with a p value <0.01 .

Table 6 Performance of Participants on CPR skill assessment at SPHMMC Pediatrics Department, 2021

Steps	Correct number (percent)	Incorrect number (percent)
Assessment and activation		
Checking for responsiveness	19(10)	171(90)
Checking for breathing	122(64.2)	68(35.8)
Shouting for help	68(35.8)	122(64.2)
Checking for pulse	22(11.6)	168(88.4)
Cycle 1 of CPR (Single rescuer)		
Performing high quality compressions	5(2.6)	185(97.4)
Placement of 2 fingers or 2 thumbs in correct position	79(41.6)	111(58.4)
30 compressions in 15-18 seconds	11(5.8)	179(94.2)
Compression of adequate depth	142(74.7)	48(25.3)
Complete recoil after compression	143(75.3)	47(24.7)
Gives 2 breaths properly	17(8.9)	173(91.1)

Each breath given over 1 second	165(86.8)	25(13.2)
Visible chest rise with each breath	20(10.5)	170(89.5)
Resumes chest compression within 10 seconds	144(75.8)	46(24.2)
Cycle 2 of CPR (Single rescuer)		
Cycle 2 compressions	8(4.2)	182(95.8)
Cycle 2 ventilation	16(8.4)	174(91.6)
Resumes compression within 10 seconds	144(75.8)	46(24.2)
Cycle 3 of CPR (Two rescuers)		
Performs high quality compressions	14(7.4)	176(92.6)
15 compressions with 2 thumbs	51(26.8)	139(73.2)
15 compressions in 7-9 seconds	24(12.6)	166(87.4)
Compression of adequate depth	164(86.3)	26(13.7)
Complete recoil after chest compression	167(87.9)	23(12.1)
Cycle 4 of CPR (Two rescuers)		
Gives 2 breaths properly	26(13.7)	164(86.3)
Each breath given over 1 second	177(93.2)	13(6.8)
Visible chest rise with each breath	29(15.3)	161(84.7)
Resumes compression within 10 seconds	178(93.7)	12(6.3)

5.2.2. Compressions

The participants performed two cycles of compression as a single rescuer and one cycle of 2 rescuer CPR. Each cycle of compression was assessed for proper hand placement, recommended rate, adequate depth and complete recoil after compression and marked as correctly done if all of these 4 criteria are met. The majority 173(91.1%) of the participants did none of the compressions correctly, while 10(5.3%) participants did one correct compression, 4(2.1%) and 3(1.6%) performed 2 and 3 correct compressions respectively (Table 6).

Pediatricians scored better ($M=2$, $SD=1.41$) than nurses ($M=0.18$, $SD=0.59$), first year residents ($M=0.15$, $SD=0.46$), second year residents ($M=0.12$, $SD=0.33$), interns ($M=0.03$, $SD=0.17$) and third year residents ($M=0$), p value <0.01 .

Participants working at PICU during the study period scored significantly higher ($M=0.5$, $SD=0.96$) than those working at PROPD ($M=0.15$, $SD=0.56$), ward ($M=0.14$, $SD=0.41$), NICU ($M=0.09$, $SD=0.48$), PEOPD ($M=0.08$, $SD=0.34$) and those working at “Other units” ($M=0$) at a p value of <0.05 .

Participants with more than 10 years of clinical experience scored better ($M=1$, $SD=1.41$) than those with clinical experience of 5-10 years ($M=0.25$, $SD=0.76$) and less than 5 years ($M=0.1$, $SD=0.38$) with a p value of <0.01 .

There is a significant difference between the score of participants who have worked in the pediatric department for 5-10 years ($M=0.42$, $SD=0.9$) versus those who have worked for less than a year ($M=0.04$, $SD=0.187$), p value <0.05 .

The participants who had their last BLS or ALS training 5-10 years back scored higher ($M=1.33$, $SD=1.53$) than those who had their last training 1-5 years back ($M=0.14$, $SD=0.56$), those who had no training after graduation ($M=0.14$, $SD=0.51$) and those who had training less than a year before the study was conducted ($M=0.09$, $SD=0.03$) with a p value <0.01 .

More participants performed high quality compressions (7.4%) with two rescuers CPR than both the first (2.6%) and the second (4.2%) cycles of single rescuer CPR.

On further evaluation of the quality of CPR, More participants (41.6%) did compressions with proper hand placement on the first cycle of single rescuer CPR than on two rescuers CPR (26.8%). The rate of compression was better on two rescuer CPR (12.6%) than single rescuer CPR (5.8%). Greater number of participants performed compressions of adequate depth on the two rescuer CPR (86.3%) than on single rescuer CPR (74.7%). One hundred sixty seven participants (87.9%) performed compressions with complete recoil in the two rescuer CPR and one hundred forty three participants (75.3%) did so on single rescuer CPR.

5.2.3. Ventilation

Majority of the participants (160(84.2%)) did not perform any of the ventilation cycles properly, while 13 participants (6.8%) performed one cycle of compression correctly, 3(1.6%) and 14(7.4%) correctly performed two and three cycles respectively (Table 6).

Pediatricians performed higher (M=3, SD=0) than third year residents (M=0.6, SD=1.05), first year residents (M=0.54, SD=1.1), nurses (M=0.23, SD=0.73), interns (M=0.18, SD=0.58) and second year residents (M=0.12, SD=0.33), p value < 0.01.

The participants who had their last BLS or ALS training 5-10 years back scored higher (M=2, SD=1.73) than those who had their last training 1-5 years back (M=0.44, SD=1.03), those who had no training after graduation (M=0.29, SD=0.77) and those who had training less than a year before the study was conducted (M=0.09, SD=0.03) with a p value <0.01.

There is a significant difference in the ventilation scores of participants who had an experience of performing CPR (M=0.35, SD=0.87) and those who had never performed CPR (M=0), p value <0.01.

5.3. Correlation between knowledge and skill of CPR

There is a very low positive correlation between the participants' score of knowledge assessment questions and skill assessment, but it is not statistically significant (r=0.134, p=0.065).

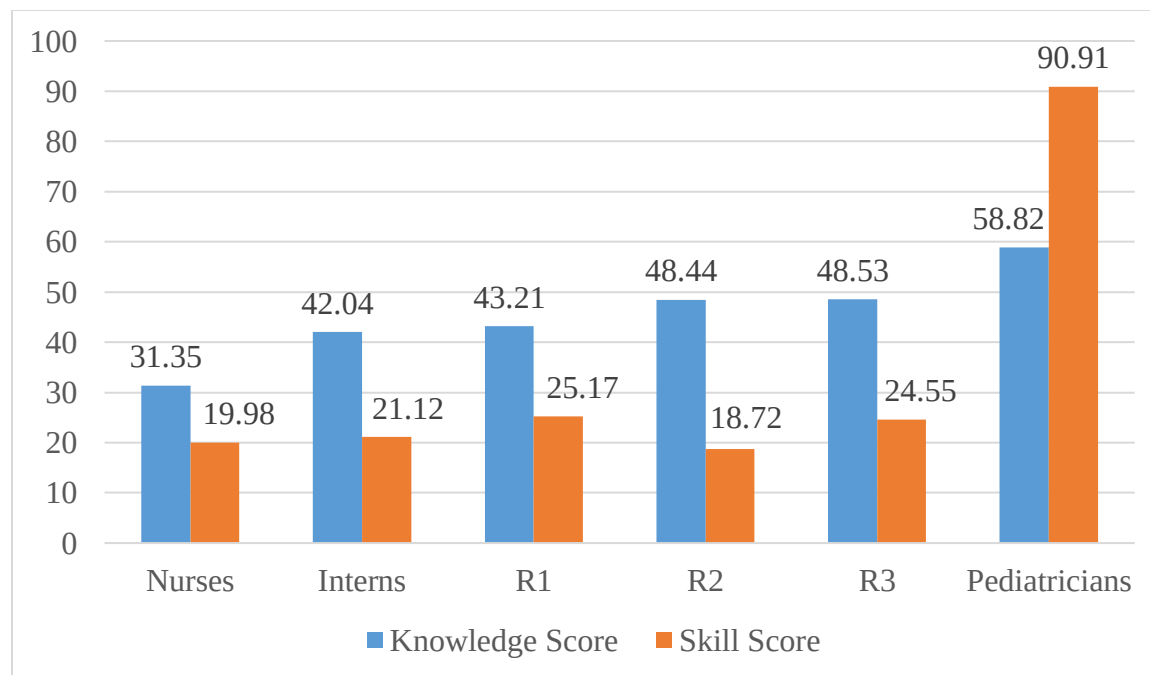


Figure 3 Mean knowledge and Skill score of participants with Professional rank at SPHMMC Pediatrics Department, 2021

6. Discussion

As the first study of its kind in Ethiopia, this research was done with an objective of gaining an insight into the level of knowledge and skill of CPR among health professionals working in one of the leading teaching hospitals in the country. A total of 202 health professionals participated in the study with a response rate of 87.1%. After exclusion of 12 participants with incomplete data, 190 participants including nurses, interns, residents and pediatricians were analyzed.

The mean score of the participants on knowledge assessment question was 38.51% which is way below the standard score of 84% set by the AHA to pass the BLS certification exam. Moreover, none of the participants scored above this passing mark and 80% of the participants scored below 50%. This shows that the knowledge of the health professionals working at SPHMMC pediatrics department about CPR is poor. This also goes with other studies (20, 23, 25, 26) done in Ethiopia and in other countries. This may be due to the fact that CPR related education is not universally given in medical schools (36.8% of the participants reported not having BLS education in their undergraduate program) and the fact that there is low coverage of BLS/ALS training after graduation with more than a quarter of the participants (26.3%) not having any form of CPR related training at all. This result is even better than another study done in 2 referral hospital in Amhara region with more than 2/3rd of the nurses having no training on CPR (26).

On further assessment of the factors associated with knowledge of CPR, it was found that nurses have significantly lower scores than the other professionals. This result is similar to researches done in other countries (22, 25). The reason behind lesser knowledge scores of nurses may be the difference of curriculum between nurses' education and that of medical degree. This result is more concerning considering the fact that nurses are at the frontlines of the clinical practice. The study has also shown that participants working at NICU scored lower than those working at follow up clinics, subspecialty attachments and detachments at other departments, but this can be because the majority of the participants at NICU (62.79%) were nurses and all of the participants from the other units were residents. Furthermore multiple regression analysis didn't show significant prediction of knowledge assessment score from work place.

Surprisingly, participants who had their last training 1-5 years before the study scored significantly lower than those who never had any form of training on CPR. This result may be confounded by other factors since multiple regression analysis didn't show significant prediction from length of

time after training. The result may also be because of the effect of time on retention of knowledge (24, 28) and the fact that the resuscitation guidelines have been updated since these trainings took place. This finding is in contrast to a similar study done in Nepal which demonstrated that participants with CPR training within 5 years have better knowledge than those trained more than 5 years back and not trained at all (20).

In this study the length of clinical experience and time in pediatrics department did not result in any statistically significant difference in the knowledge scores and this was similar to other studies (25)

There was no statistically significant difference between the scores of participants who had an experience of performing CPR and those who hadn't.

There was no statistically significant difference between participants who had CPR training and those who hadn't although it is expected that training would improve the knowledge of CPR. This is in contrast to previous studies (21, 22, 25, 26).

The mean score of the participants was 22.01% (SD=14.25) on the skill assessment with only one person scoring 100% and 94.7% of the participants scoring <50%. Health professionals skill on CPR is said to have an impact on survival of patients with cardiac arrest (5, 6), making us question the quality of CPR provided to the patients. This result shows significantly poor skill performance of the health professionals and the finding is similar to the finding in other studies done in Africa (24, 25).

Pediatricians scored significantly higher than first year residents, third year residents, interns, nurses and second year residents) with a p value<0.01. However this result cannot be generalized because less than 10% of the pediatricians working in the department participated in the study.

Participants working at PICU during the study period scored significantly better than those working at NICU. This may be because participants at NICU have less experience with infant resuscitation since they are involved in the care of neonates only. Participants at PICU and PEOPD are expected to have more encounter with critically ill children who may be in need of CPR than participants at other places, but there was no statistically significant difference in their scores (21, 25, 26).

Clinical experience of more than 10 years as associated with better performance in skill assessment than experience of less than 10 years. Although longer time in clinical practice may mean better experience in CPR and thus better skill, this result may be confounded by other factors since

multiple regression analysis doesn't show statistically significant prediction from having an experience of more than 10 years.

Although the mean score of participants who had training 5-10 years back is higher than the others, this result may be confounded by other factors and multiple regression analysis doesn't show statistically significant prediction from having training 5-10 years prior to the study.

In this study having CPR training, and the frequency of involvement in CPR were not related to a significant change in skill assessment score.

This study showed that the participants have poor skill on assessment and activation part of the skill assessment with only 3 participants properly doing the assessment and activation. This result might lead to a question about the competence to promptly detect the need for CPR intervention in patients. This finding of significantly low skill score on the initial approach is in line with a similar study done in Tanzania (25).

Majority of the participants (91.1%) did not perform a single correct chest compression out of three attempts. This result shows a poor chest compression performance among the participants. Furthermore, most of the participants performed compressions with improper hand placement and incorrect rate of compression. The findings were better on the depth of compressions and chest recoil with more than three quarters of the participants compressing at adequate depth and with complete chest recoil. However, the overall results of the quality of compression may be worrisome since studies show that the quality of CPR affects the rate of ROSC and specifically lower depth and slower rate of compression are associated with poor patient outcome (6, 16). This finding is in line with a similar study done in Tanzania (25).

Most of the participants (84.2%) did not perform a single ventilation correctly out of three attempts with majority of them unable to attain visible chest rise on their ventilation attempt.

There is a relatively better performance on resumption of compression within 10 seconds with more than three quarters of the participants resuming compression within 10 seconds on all of the three evaluations.

There was no statistically significant correlation between knowledge and skill of CPR on this study.

7. Conclusion and Recommendations

7.1. Conclusion

This study has shown that the knowledge and skill of CPR of the health professionals working at SPHMMC pediatrics department is poor. Being a nurse is associated with less knowledge and being a pediatrician and working at PICU was associated with better skill of CPR while working at NICU was associated with lesser skill of CPR.

7.2. Recommendations

Since the quality of CPR provided affects the chance of survival of patients, measures that can improve the knowledge and skill of CPR should be undertaken. The MOH and MOSHE should work towards improvement in provision of CPR education in the undergraduate medical education and BLS and ALS training after graduation including timely refresher trainings if possible with certification. Further studies may also be needed to assess the quality of CPR trainings given in our country considering the fact that there was no difference in knowledge and skill of trained and untrained health professionals.

8. Strengths and Limitations

8.1. Strengths

- To the author's knowledge this is the first study that assessed both the knowledge and skill of health professionals in Ethiopia, so this will serve as a baseline for further studies.
- Skill assessment was done using high fidelity manikin which made a reliable assessment of the rate and depth of compression possible.

8.2. Limitations

- Most of the pediatricians did not participate in the study which might affect the generalizability of the result.
- The study was done in one tertiary center and might not reflect the knowledge and skill of the health professionals in other set ups.
- Skill assessment with a manikin might not reflect what happens in a real patient scenario.

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Annex 1: Questionnaire

Information Sheet

Greetings!

I am Dr Chaltu Nemomsa, a final year Pediatrics and Child health resident at St. Paul's Hospital Millennium Medical College. I am conducting a research for the partial fulfillment of the requirements for the certificate of Pediatrics and Child health. The study will assess the knowledge and skill of Cardiopulmonary resuscitation among the health professionals working in the SPHMMC pediatric department. It will also identify the associated factors and help guide future interventions to improve the health professionals' knowledge and skill on CPR.

Participation in this study is entirely voluntary and you may refuse to complete the study at any point during the survey. Your personal information will not be revealed or shared. The data from this survey will be accessible only to those working on the project.

The information gathered is solely for academic use, and all the responses will be kept confidential and anonymous. It would be appreciated if you would take a few minutes of your time to complete this survey. If you have any questions or concerns, please contact me at 0941034506 or email:chaltukf@gmail.com. Thank you!

Consent Form

I the undersigned have read and understood that my response will be confidential and the information I provide will only be used for research purpose. I have also been informed that I can refuse to participate in the study. Based on the above information I am willing to participate in the study voluntarily.

Signature of the participant:_____

Date: _____

Part 1: Demographic Data

1. Age_____
2. Sex M____F_____
3. Mark in the space that meets your job title
Nurse____Intern____Resident R1____R2____R3____Pediatrician____
____Other (mention)_____
Please specify if you have any specific specialty _____
4. Current Work placement PICU__PEOPD____NICU____Ward ____PROPD_____
5. How long have you been in clinical practice? (Since graduation/Since qualification for interns)Years_____Months_____
6. How long have you worked in the pediatric department? Years_____Months_____
7. Did you have any formal or informal education or training on Basic Life support/Advanced Life Support during the time of your undergraduate education? Yes_____No_____
8. If your answer is yes to the above question, please specify the type of training you received

9. Have you ever had Basic Life support/Advanced Life Support Training after graduation?
Yes_____No_____
10. If your answer to the above question is yes, how many times did you have the training?_____
11. When was the last time you had BLS/ALS training?_____
12. Where did you get your knowledge about CPR from? Training____Reading____
Formal Education____Internet/YouTube videos____other (mention)_____
13. Have you ever done CPR? Yes__ No __
14. If your answer to the above question is yes, then how many times have you done CPR in the past 1 year? 1-5 times_____ 6-10 times_____ >10 times_____

Part 2: Knowledge assessment

1. The current order of updated cardiopulmonary resuscitation (CPR) intervention for all age groups after neonatal age is
 - A. Airway, Breathing, Chest compressions (ABC)
 - B. Chest compressions, Airway, Breathing (CAB)
 - C. Airway, Chest compressions, Breathing (ACB)
 - D. Breathing, Chest compressions, Airway (BCA)
2. How long should a pulse check last?
 - A. As long as it takes to find a pulse
 - B. No more than 2 seconds
 - C. No more than 5 seconds
 - D. No more than 10 seconds
3. You are alone and find a patient who is possibly in cardiac arrest. What is your first step?
 - A. Check for responsiveness
 - B. Ensure scene safety
 - C. Begin Chest Compressions
 - D. Open the airway and give 2 breaths
4. You are certain of the above answer. What is your next step?
 - A. Begin chest compressions
 - B. Check for responsiveness
 - C. Call the patient's doctor
 - D. Provide rescue breathing
5. When do you start Chest compression?
 - A. There is no pulse and patient is not breathing

- B. There is a pulse and the patient is not breathing
 - C. There is a pulse and the patient is unconscious
 - D. All of above
6. What is the recommended rate of chest compression during CPR?
- A. 80-100 per minute
 - B. 100-120 per minute
 - C. At least 120 per minute
 - D. None of the above
7. If you believe there is risk of a C-spine injury, the best way to open the airway is using
- A. Flexion technique
 - B. Hyperextension technique
 - C. Head tilt, chin lift technique
 - D. Jaw thrust technique
8. The correct hand placement/position in CPR is:
- A. At the lower end of the chest and upper abdomen
 - B. At the apex of the left part of the chest (On top of the heart)
 - C. Centre of the sternum just below the intermammary line
 - D. Upper part of the sternum above the nipples
9. What is the recommended depth of chest compressions in child aged 1 to puberty
- A. $\frac{1}{3}$ to $\frac{1}{2}$ of the depth of the chest
 - B. At least $\frac{1}{4}$ of the depth of the chest
 - C. 5cm or more
 - D. 1cm or more
10. For the best ventilation of infants, the head should be:

- A. Hyper extended
 - B. Neutral position
 - C. Flexed position
 - D. Turned to left lateral position
11. Which of the following is **incorrect** chest compression to ventilation ratio?
- A. 30:2 for children and infant if only a single rescuer is present
 - B. 15:2 in children and infants if at least 2 rescuers are present
 - C. 3:1 in newborns unless a cardiac cause is known
 - D. None of the above
12. Suppose you are doing CPR on 3 years old child with an advanced airway; what is the appropriate rate of breath per minute to be provided?
- A. 4-10 breaths per minute
 - B. 10-20 breaths per minute
 - C. 20-30 breaths per minute
 - D. 30-40 breaths per minute
13. Which of the following ways of chest compression is preferable in neonatal resuscitation?
- A. Two finger technique
 - B. Two thumb–encircling hands technique
 - C. Using the heel of 1 hand
14. Which of the following is not characteristic of high quality CPR?
- A. Adequate chest compression depth
 - B. Optimal chest compression rate
 - C. Frequent evaluation of cardiac activity every 1 minute
 - D. Allowing full chest recoil between compressions

- E. Avoiding excessive ventilation
15. Which of the following should be the initial intervention in a newborn with HR of <100 per minute?
- A. Chest compression
 - B. Positive pressure ventilation
 - C. IV Adrenaline administration
 - D. Fluid bolus administration
16. Which of the following is not true regarding Epinephrine administration?
- A. IV/IO is preferable to endotracheal tube (ETT) for Epinephrine administration.
 - B. The initial dose of epinephrine should be administered within 5 min from the start of chest compressions.
 - C. Epinephrine should be given every 3–5 min until return of spontaneous circulation is achieved.
 - D. The dose of Epinephrine to be used in cardiac arrest is 0.1mg/kg
17. What do you do immediately after delivering a shock to a person with an AED?
- A. Reassess for a pulse
 - B. Do chest compressions only
 - C. Resume CPR
 - D. Do ventilation only

Annex 2: Skill Assessment Checklist

BLS: Infant CPR Skills Testing Checklist Basic Life Support

Participant Code: _____

Hospital Scenario: “You are working in a hospital or clinic when a woman runs through the door, carrying an infant. She shouts, ‘Help me! My baby’s not breathing.’ You have gloves and a bag mask device. You send your coworker to activate the emergency response system and to get the emergency equipment.” How would you assess the infant and how would you intervene?

Assessment and Activation

- | | |
|--|--|
| ☐ Checks responsiveness | ☐ Shouts for help/Activates emergency response system |
| ☐ Checks breathing | ☐ Checks pulse |

Once student shouts for help, instructor says, “Here’s the barrier device.”

Cycle 1 of CPR (30:2) **CPR feedback devices are preferred for accuracy*

Infant Compressions

- ☐ Performs high-quality compressions*:
 - Placement of 2 fingers or 2 thumbs in the center of the chest, just below the nipple line
 - 30 compressions in no less than 15 and no more than 18 seconds
 - Compresses at least one third the depth of the chest, approximately 1½ inches (4 cm)
 - Complete recoil after each compression

Infant Breaths

- ☐ Gives 2 breaths with a barrier device:
 - Each breath given over 1 second
 - Visible chest rise with each breath
 - Resumes compressions in less than 10 seconds

Cycle 2 of CPR (repeats steps in Cycle 1) *Only check box if step is successfully performed*

- | | | |
|---------------------------------------|----------------------------------|---|
| ☐ Compressions | ☐ Breaths | ☐ Resumes compressions in less than 10 seconds |
|---------------------------------------|----------------------------------|---|

Rescuer 2 arrives with bag-mask device and begins ventilation while Rescuer 1 continues compressions with 2 thumb–encircling hands technique.

Cycle 3 of CPR

Rescuer 1: Infant Compressions

- ☐ Performs high-quality compressions*:
 - 15 compressions with 2 thumb–encircling hands technique
 - 15 compressions in no less than 7 and no more than 9 seconds
 - Compresses at least one third the depth of the chest, approximately 1½ inches (4 cm)
 - Complete recoil after each compression

Rescuer 2: Infant Breaths

This rescuer is not evaluated.

Cycle 4 of CPR**Rescuer 2: Infant Compressions**

This rescuer is not evaluated.

Rescuer 1: Infant Breaths

- ☐ Gives 2 breaths with a bag-mask device:
 - Each breath given over 1 second
 - Visible chest rise with each breath
 - Resumes compressions in less than 10 seconds