

Pediatric Pharmacists' Participation in Cardiopulmonary Resuscitation Events

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The Pediatric Pharmacy Advocacy Group (PPAG) understands the dilemma and varying factors that many institutions face concerning the routine participation of pharmacists in emergency resuscitation events. Acknowledging these obstacles, the PPAG encourages all institutions to strongly consider creating, adopting, and upholding policies to address pharmacists' participation in cardiopulmonary resuscitation (CPR) as evidenced by the impact pharmacist participation has shown on the reduction of hospital medication error and mortality rates in children. The PPAG advocates that pharmacists be actively involved in the institution's CPR, medical emergency team committees, and preparation of emergency drug kits and resuscitation trays. The PPAG advocates that all institutions requiring a pharmacist's participation in CPR events consider adoption of preparatory training programs. Although the PPAG does not advocate any one specific program, consideration should be taken to ensure that pharmacists are educated on the pharmacotherapy of drugs used in the CPR process, including but not limited to basic life support, Advanced Cardiac Life Support, and Pediatric Advanced Life Support algorithms; medication preparation and administration guidelines; medication compatibility; recommended dosing for emergency medications; and familiarity with the institutional emergency cart.

ABBREVIATIONS ACLS, Advanced Cardiac Life Support; CPR, cardiopulmonary resuscitation; PALS, Pediatric Advanced Life Support; PEA, pulseless electrical activity; PICU, pediatric intensive care unit; PPAG, Pediatric Pharmacy Advocacy Group

KEYWORDS cardiopulmonary resuscitation; pediatric advanced life support; pediatrics; pharmacist

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Background

During the last two decades, there has been a significant improvement in overall survival of cardiac arrest in children.¹ Current data suggest that 5000 to 10,000 children per year require cardiopulmonary resuscitation (CPR) during their hospital stay and that half of these children will not survive to discharge regardless of age or precipitating cardiac arrest rhythm.^{1,2} A number of interventions have been recommended to improve CPR outcomes, including depth and quality of compressions, development of rapid response teams, and establishment of postarrest targets (e.g., temperature, oxygenation and ventilation, blood pressure).¹ However, the portion of cardiac arrests caused by non-shockable rhythms, such as pulseless electrical activity, has more than doubled between 2000 and 2009.³ Therefore, for patients with pulseless electrical activity and other cardiac arrest events, medications are still an important component of CPR interventions.

The role of pharmacists in the provision of medication therapy recommendations and preparations of medications during CPR events in a hospital setting has been described during the past 45 years.^{4,5} Most data have been obtained from surveys conducted at

academic and non-academic health systems. The first report of pharmacist participation was in the 1970s,⁶ and by 1992 Bond et al⁷ reported participation in these events at 30% of responding institutions. In 1991 and 1995, surveys were conducted and results published by Raehl et al⁴ and Shimp et al,⁸ respectively. These surveys concluded that pharmacist attendance at CPR events only occurred in about 30% to 35% of hospitals represented and did not differentiate between adult and pediatric CPR events. Currently, there are limited studies evaluating the impact of pediatric pharmacists in CPR events. The purpose of this position statement is to discuss an overview of CPR events in children, establish the position of the Pediatric Pharmacy Advocacy Group (PPAG) in support of pediatric pharmacists responding to all CPR events in children, and provide recommendations for implementation.

Controversy

Only 1 study has documented the frequency of pediatric pharmacists responding to CPR events. Hahn et al⁹ conducted a survey of children's hospitals and found that only 63% of institutions surveyed had pharmacists that responded to CPR events. To our knowledge, there

are no studies documenting the impact of pediatric pharmacists on the outcomes of codes. However, there is sufficient literature demonstrating pharmacists in the pediatric intensive care unit (PICU) have a positive impact on patient care and outcomes, including reduction and prevention of medication errors.^{10,11} Given that pharmacists have such a significant impact on care of patients in the PICU, one can presume the expertise of the pediatric pharmacist would have a similar positive impact on the ordering, preparation, and administration of medications during CPR events. Nevertheless, several challenges exist in expanding pharmacy services to resuscitation teams that are frequently cited, including inadequate staffing within the pharmacy department, a lack of advanced formal resuscitation training for pharmacists, apprehension, and a lack of perception of the pharmacist's role on the resuscitation team. CPR is a very complex process, and there is considerable variability regarding pharmacists' participation and baseline expertise in CPR events.

Recommendations

Participation in CPR Oversight Committees. The PPAG advocates that pediatric pharmacists participate in CPR and rapid response committees. Pharmacist participation on these committees is essential given that these committees are responsible for review of CPR events for individual patients to determine areas for quality improvement and are responsible for the development of policies and procedures for CPR events. Another essential activity that pharmacists may carry out on these committees is oversight of emergency carts and kits for CPR and rapid response events, rapid sequence intubation episodes, and trauma emergencies. A lack of standardization and organization of emergency carts, especially the emergency medications, can have a negative impact on the outcomes of these events because response time is critical to patient survival, and disorganization creates delays.^{12,13} Pharmacists are essential to this process, as noted by the American Society of Health-System Pharmacists and The Joint Commission, to ensure that medications in the emergency carts are organized and stored appropriately.^{14,15} This has become especially essential in light of drug shortages.

In addition to these activities, pharmacists may also participate in the development of institutional-specific protocols and dosing tools for CPR events. Institutions would benefit from a pharmacist's expertise in the development of protocols for emergency situations, like hyperkalemia, sepsis, and status epilepticus, that are not explicitly addressed in the 2015 Pediatric Advanced Life Support (PALS) guidelines.¹⁶ These protocols are meant to help clinicians anticipate potential medication therapies that would be specific to the institution's formulary. Pharmacist participation in the development of dosing tools for emergency medications is also vital

to preventing medication errors during CPR events, especially because children require weight-based dosing.

Participation in Individual Patient CPR and Rapid Response Events. The PPAG recommends that children's hospitals have pediatric pharmacists respond to all neonatal and pediatric CPR events. The infrequent occurrences of pediatric CPR events underscore the importance of having an expert in drug therapy immediately available for clinical pharmacotherapeutic consultation. Further, the PPAG also suggests that institutions also consider placing a pediatric pharmacist on rapid response teams. Pharmacists can assist in providing medication therapy recommendations consistent with PALS guidelines and can ensure medication safety. Draper and Eppert¹⁷ conducted a retrospective study evaluating 74 CPR events in adults to determine compliance with American Heart Association Advanced Cardiac Life Support (ACLS) guidelines and found that compliance with ACLS guidelines was more likely when a pharmacist was present (59.3% versus 31.9%, $p = 0.03$). Although this study did not focus on pediatric patients, it would seem reasonable that pediatric pharmacists could also ensure that medication regimens were compliant with PALS recommendations.

Pharmacists can also work to minimize medication errors during CPR events. The most prevalent category of medical errors, particularly in children, is medication errors made during the ordering process.^{11,18} During a review of simulated CPR events, Porter et al¹⁹ found that the presence of a pediatric pharmacist significantly reduced medication errors made by pediatric resident physician trainees. In the age of emergency medication shortages, emergency carts are filled with alternatives to the expected medications. Whether this is an alternative packaging or necessitates a pharmacy-generated kit, medication errors are more probable when unfamiliar medications need preparation. Pediatric pharmacists help clinicians anticipate these changes and ensure that the most appropriate medication is drawn up and administered correctly.

Training of Pediatric Pharmacists. The PPAG recommends that pharmacy leadership develop a training competency program for all staff to participate in CPR events that may include "hands-on" training, such as multidisciplinary mock codes and simulation labs, as well as written competencies with sample patient cases. In addition, the PPAG recommends that pediatric pharmacists responding to CPR and rapid response events maintain appropriate certifications through the American Heart Association, including basic life support and PALS, with consideration for obtaining the Neonatal Resuscitation Program for pharmacists in the Neonatal Intensive Care Unit and the ACLS for pharmacists responding to adult codes. Machado et al²⁰ found that pharmacists had a more favorable attitude toward participation in CPR events if they felt that they had adequate training, including basic life support, ACLS,

Table. Recommendations for Education and Training for Pediatric Pharmacists for Cardiopulmonary Resuscitation Events

Recommendation	Description
Credentialing	
Basic life support	Require for all pharmacy staff
Pediatric Advanced Life Support (PALS)	Require for all pharmacy staff
Neonatal Resuscitation Program (NRP)	Consider requiring for pharmacists whose practice setting is in the neonatal ICU and/or respond to deliveries
Advanced Cardiac Life Support (ACLS)	Consider requiring for pharmacists who may respond to adult codes
Education and training	
Mock codes/simulation	Require pharmacists to participate in 1 mock code per year Require pharmacy residents to participate in 1 mock code per quarter Activities during simulation/mock codes: Calculate doses and draw up medications Identify potential medication incompatibilities and admixture concerns Familiarization with the code cart Practice closed-loop communication with other health care professionals Learn how to administer medications (depending on pharmacy practice laws) Become familiar with treatment algorithms and guidelines
Mentorship activities	New pharmacists and residents must respond to codes, along with other experienced pharmacists
Additional educational activities beyond PALS	
Code sheets	Hands-on activities and patient case examples
Additional pharmacology lectures	Focus on the non-PALS emergency situations, such as hyperkalemia, sepsis, and status epilepticus
Completion of workbook	Means of documentation of training on annual review
Drug shortages	Develop a communication tool for drug shortage communication/substitutions
Emergency drug processes	All pharmacists must demonstrate an understanding of the general process so they can respond to requests for more medications during a code, correctly refill emergency carts, etc.
Ongoing continuous quality improvement and evaluation	
Formative and summative feedback	Participate in debrief sessions for mock codes as well as real-life codes Documentation of participation in real-life codes and mock codes in annual review

ICU, intensive care unit

self-study programs, continuing education programs, and institution-specific training programs.

Despite the rigor of ACLS, PALS, and the Neonatal Resuscitation Program, there is limited information available in the programs related to certain aspects of pharmacotherapy, including but not limited to medication doses, compatibility concerns with intravenous medications, and medication reconstitution. All of these programs require participation in simulated CPR events, but they may not have specific roles defined for various health care disciplines. In addition, these experiences alone may not prepare the pharmacist for routine participation in hospital CPR events. Some institutions may consider adopting their own training programs to prepare pharmacists for participation in

resuscitation events. Marlowe et al²¹ prepared a training program that included instruction on various aspects of pharmacotherapy for advanced cardiac support and some additional hands-on training time to familiarize themselves with code trays and intravenous admixtures. They conducted their study with 28 full-time and part-time pharmacists and found a significant improvement in written posttests and pharmacist comfort levels following didactic and hands-on training. Additionally, Small et al²² developed a pediatric emergencies training program for pharmacists at a pediatric teaching hospital and found that after training was completed, confidence levels increased by an average of 14.5% and competency increased by an average of 11%. These studies demonstrate how training programs for

pharmacists participating in CPR events help to improve comfort levels and competency through the assistance of educational interventions, written examinations and certification, and hands-on training.

Pharmacist training sessions for pediatric emergencies within simulation laboratories and monthly multidisciplinary mock codes are also an additional training opportunity that allows pharmacists to identify different patterns of medication use, practice communication skills in a critical setting, and participate in postsimulation debriefing exercises to address errors and successes.^{23,24} For pharmacy resident training, Thompson Bastin et al²⁴ evaluated the use of simulation exercises used to prepare residents for a 24-hour in-house on-call program. The investigators found that self-perceived preparedness was increased following the sepsis ($p = 0.001$), stroke, and status epilepticus exercises ($p = 0.042$). These findings demonstrate that simulation-training exercises implemented in pharmacy residency programs can increase medical emergency preparedness.

Prior to the implementation of an institution-specific training program, hospital pharmacy leadership should analyze data and review patient safety guidelines to determine the specific training needs of their pharmacists. Pharmacists should be part of institutional patient safety committees and quality assurance programs. Recommendations to help prepare pharmacists for pediatric CPR events are listed in the Table. Institutions should incorporate pharmacists in the development and implementation of appropriate tools, such as standardization of pediatric and neonatal medication code algorithms and weight-based reference cards for emergency code medications, to assist with medication preparation.

Conclusion

The PPAG encourages all institutions to create, adopt, and uphold policies to address pediatric pharmacists' participation in CPR events and emergency cart preparedness. Evidence supports a positive impact of pharmacist participation in reducing hospital medication error and improved mortality rates in children. The PPAG further advocates that all institutions require a pharmacist's participation in emergency situations and consider adoption of preparatory training and competency programs for resuscitation using nationally accepted guidelines. Although the PPAG does not advocate any one specific program, consideration should be taken to ensure that pharmacists are educated on the pharmacotherapy of drugs used in the CPR process, including but not limited to basic life support and PALS algorithms; medication preparation and administration guidelines; medication compatibility; recommended dosing for emergency medications; and familiarity with the institutional emergency cart.

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