



Mobile app for the accuracy of emergency drug administration in children's cardiovascular resuscitation : a literature review

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ABSTRAK

Latar Belakang: Kesalahan dalam perhitungan titrasi obat merupakan salah satu penyebab kesalahan medis yang berdampak pada pelaksanaan resusitasi kardiopulmoner pada anak. Perhitungan berdasarkan usia, berat badan anak dan data antropometri yang salah inilah yang menyebabkan kesalahan medis dalam pemberian obat darurat pada kasus resusitasi jantung paru. Salah satu strategi dalam memanfaatkan kemajuan teknologi guna meminimalkan terjadinya *medical error* dalam pemberian obat dengan metode titrasi adalah dengan menggunakan aplikasi penghitungan dosis untuk titrasi obat.

Tujuan: Tujuan dari *literature review* ini adalah untuk menganalisis pengaruh penggunaan aplikasi perhitungan pemberian obat untuk pencegahan kesalahan medis pada kasus darurat dan resusitasi kardiopulmoner pediatrik.

Metode: Metode penelitian ini merupakan *literature review* menggunakan PRISMA analisis dengan database PUBMED, Science Direct, Proquest, Springer, Wiley, Taylor, dan Perancis dari tahun 2017-2022.

Hasil: Penggunaan aplikasi seluler untuk pemberian obat atau titrasi pada kasus gawat darurat kardiovaskular anak terbukti efektif dan efisien karena dapat mempercepat waktu persiapan dengan akurasi dosis untuk meminimalkan hipotensi rakitan iskemia ke organ vital dan meningkatkan status hemodinamik serta mempertahankan status neurologis.

Kesimpulan: Aplikasi mobile efektif dan efisien dalam mencegah kesalahan medis dalam pemberian obat dengan metode titrasi pada kasus resusitasi kardiopulmoner pediatrik.

KATA KUNCI : anak; dosis obat; medication error; mobile app; resusitasi jantung paru

ABSTRACT

Background: Errors in the calculation of drug titration are one of the causes of medical errors that have an impact on the implementation of cardiopulmonary resuscitation in children. Calculations based on age, child weight and incorrect anthropometric data are what cause medical errors in the administration of emergency drugs in cases of pulmonary cardio resuscitation. One strategy in utilizing technological advances to minimize the occurrence of medical errors in drug administration with the titration method is to use a dose calculation application for drug titration.

Objectives: The purpose of this *literature review* is to analyze the effect of using drug administration calculation applications for the prevention of medical errors in emergency cases and pediatric cardiopulmonary resuscitation.

Methods: This research method is a *literature review* using PRISMA analysis with a database of PUBMED, Science Direct, Proquest, Springer, Wiley, Taylor, and France from 2017-2022.

Results: The use of mobile apps for drug administration or titration in cases of cardiovascular emergency children has proven to be effective and efficient because it can speed up the preparation time with dose accuracy to minimize ischemia assembled

hypotension to vital organs and improve the hemodynamic status and maintain neurological status.

Conclusions: *Mobile applications is effective and efficient in preventing medical errors in drug administration with the titration method in cases of pediatric cardiopulmonary resuscitation.*

KEYWORDS : *cardiopulmonary resuscitation; drug dosage; medication error; mobile app; pediatric*

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INTRODUCTION

Emergency conditions, especially in the administration of drugs with titration in cases of cardiopulmonary resuscitation of children, require quick and appropriate decision making. Emergency problems in children's cases are a long time in calculating drug titration so that sometimes it causes medical errors that will have an impact on the failure of pulmonary cardio resuscitation (1-4).

Cardiopulmonary Resuscitation (CPR) in a child requires a fast, accurate and safe preparation of intravenous vasoactive drugs (IV). Vasoactive drug administration in children given intravenously because it is complex and requires continuous time so that it requires accuracy in calculating the dosage in order to achieve the effect of the drug given. In some critical situations such as post-cardiac heart attack spontaneous return of circulation (ROSC) or septic shock, it is necessary to prepare appropriate and accurate medications (5).

Lower dose fault tolerance puts children at higher risk than adults for life-threatening errors (6-8) . Treatment errors have been reported in up to 41% of pediatric resuscitations, the most common of which is

the wrong dosage of the drug, found in up to 65% of cases (5,8). Proper preparation and delivery of these drugs can adversely affect the results of pediatric resuscitation.

Errors in drug administration and titration are risks to patient safety that will increase costs in the health care system. Many treatment errors are caused by inaccurate dosages . Some of the mistakes that may occur in the administration of drugs with titration in a child are underdose and overdose. Underdose may occur due to the reduction of the dose of the drug at the time of calculating the titration of drug administration. Overdose may occur when the effect of the drug is not as expected (2,9,10).

Over the past few decades, health information technology (HITs) and communication technologies have been widely adopted in healthcare environments to improve care provision, efficiency, quality, and patient safety while achieving cost savings(5). Supported by the rapid deployment of mobile devices and their innovative features (e.g., connectivity, on-board computing capabilities, small size, and operating systems that enable mobile app

development), mobile health (mHealth) has undergone considerable development to address health concerns by providing medical services and communications within easy reach of the pe nurse.

One strategy in utilizing technological advances to minimize the occurrence of medical errors in drug administration with the titration method is to use a dose calculation application for drug titration. This literature review is expected to identify the application of counting in drug titration can be useful in overcoming the golden crisis period and preventing medical errors in cardiopulmonary resuscitation in children and emergency cases and the administration applications can reduce medical error.

MATERIALS AND METHODS

The design of this article is a literature review with reference to *Preferred Reporting Items for Literature Review and Meta-Analyses* (PRISMA). The author formulated PICO to look for Literatures in the web portal.

Search Strategy

The article search uses electronic databases such as *PROQUEST, Science Direct, Pubmed, Springer, Taylor and France and Wiley Online Library*. Search for articles using predetermined keywords. Keywords in the search for evidence-based research in this Literature review are mobile app or smart application and drug dosage or drug titration and medication error and emergency care and cardiopulmonary resuscitation and Randomized controlled trial.

Eligibility

Lliterature review processes included

inclusion and exclusion criteria. The inclusion criteria in this Literature Review are using a period of time from 2017-2022, with subjects in pediatrics, the type of article is original research and uses the Randomized Controlled Trial design. The exclusion criteria in this Literature review were articles with subjects other than children and the absence of a compared control group.

Data Extraction

Data extraction include checked for duplicate titles, the same title is eliminated from the article search process. The search continues by eliminating articles that have titles that are not relevant to the topic to be reviewed. The selection is then followed by screening abstracts according to predetermined inclusion criteria and inappropriate articles will be eliminated from the search process. Furthermore, articles that have been filtered to this stage will be filtered again through full text screening where articles that have really met the inclusion criteria and there are no problems in terms of research methodology will be involved in the review process for further article assessment.

Quality appraisal

Articles that have been selected are then assessed to see the quality of the article. *Critical appraisal* using Joanna Briggs Institute for Randomized Controlled Trial (RCT). Assessment of article quality is carried out using the JBI method with the results obtained that almost articles used true randomization, using blind treatment in delivery and monitoring outcomes, measure and follow the participants, using statistical

analyzed dan using RCT desain. Based on the article review using JBI for Randomized Controlled Trial above, it was found that the article is valid, important and applicable. So it can be concluded that the article can be used as a reference in Literature reviews

Data Syntesis

Article search sources use electronic databases such as *PROQUEST, Science Direct, Pubmed, Springer, Taylor and France and Wiley Online Library*. Search for articles using predetermined keywords. Keywords in the search for evidence based research in this Literature review are *mobile app*

or smart application and drug dosage or drug titration and medication error and emergency care and cardiopulmonary resuscitation and Randomized controlled trial. Articles obtained from electronic searches through a database of 401 articles. 337 articles were excluded for irrelevance and 38 articles were duplicated. Articles were screened for eligibility obtained a total of 14 articles and those that did not match the inclusion criteria and did not use the application for calculating titration and drug doses 6 articles so that the selected articles were 8 articles.

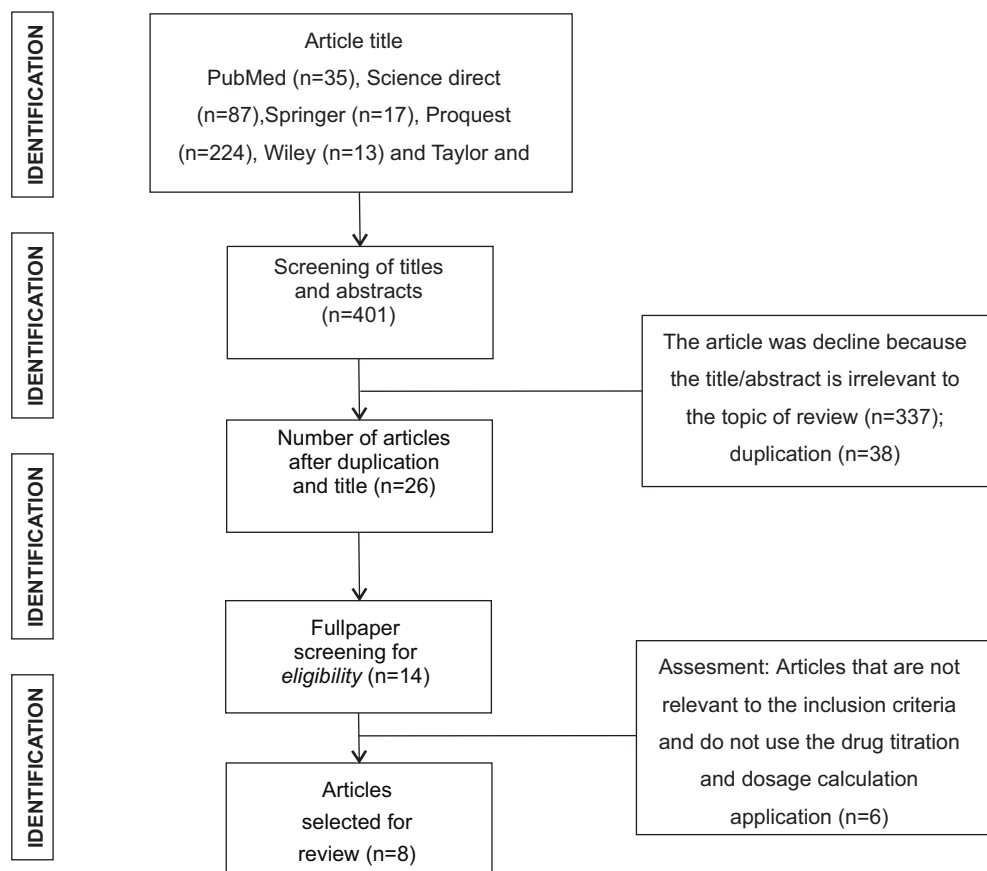


Figure 1. Article processing analysis

The type of research in these 8 articles is a Randomized Controlled Trial. The results of the article assessment using critical appraisal of articles using the correct randomization of respondents as many as 4 articles, using hidden treatments, namely mobile application a number of 2 articles, the use of treatment according to the outline of the purpose of a number of 8 articles, the use of random respondents a number of 7 articles, the provision of random treatment of 8 articles, The use of blinded assessors a number of 8 articles, the existence of a treatment group of 7 articles, the follow-up treatment of 3 articles, the existence of a sample analysis of 7 articles, the treatment results measured in the same method a number of 8 articles, the treatment results measured in a reliable method of 8 articles, the use of statistical analysis a number of 6 articles and the use of RCT a number of 4 articles. The review of the article using JBI for

Randomized Controlled Trial above was found that the article is valid, important and applicable. So it can be concluded that the article can be used as a reference in literature review.

RESULTS AND DISCUSSION

RESULTS

Respondent demographic data

From the results of the article review conducted, data was obtained that in 8 articles involving 823 respondents. The respondent inclusion criteria used in the 8 articles include nurses, doctors and anesthesiologists. The research period in this article is from 1 month to 18 months. The implementation of research for data collection using informed consent in the implementation of drug administration in 11 countries, both Asian, European and American continents. The following are the results in the reviewed article.

Table 1. Article analysis result

Year	Author	Aims	Population and sampel	Method	Result
2017	Johan N Siebert MD et al	The aim of this study was to find out whether the use of PedAMINES in both universities and smaller hospitals reduced drug dosing errors (primary outcome), time to drug preparation (TDP), and time to drug delivery (TDD) (secondary outcome) during pediatric CPR when compared to conventional preparation methods	The study involving 120 certified nurses and takes resuscitation rooms at 3 tertiary pediatric emergency departments and 3 smaller hospitals.	This research used 304 preparations performed using conventional methods with confidence interval 95%, there is 191 were associated with medication errors compared to 17 of the 296 preparations administered using application. In repeated action the proportion of treatment errors decreased 66.5% and it's meaning decreased by 40 seconds and drug delivery decreased 49 seconds.	The PedAMINES application is able to provide a child's weight-based calculation dose on continuous accurately by use of epinephrine and dopamine with a decreased medical error in intravenous titration method rather than konvensional methods.

2022	Johan N Siebert, MD et al	The study aimed to decide the ease of use and adequacy of proof based portable applications while securely getting ready crisis medication at the reason behind care during cardiopulmonary revival inside and outside the clinic	In 2 multicenter randomized controlled parental trials conducted in 6 pediatric emergency departments and 14 emergency medical services for 5 months,	Randomized Controlled Preliminary with assessment among talented pediatric crisis nurture and high level paramedics.	The mobile health app provide nurses and pharmacist to prepare vasoactive drugs intravenously in cases of cardiac arrest quickly and precisely based on the formulation of anthropometric data from children that's include body weight and age.
2018	D. Baumann, et al	This study aims to find out an appropriate method to reduce errors in the treatment process in emergencies where a mobile application has been developed that supports dosage calculation and drug administration.	The study was conducted on 79 respondents, but 3 respondents refused and 2 respondents involved by scenario.	A randomized controlled preliminary at a scholarly medical clinic works out and conveys drugs regulated at target portions into intravenous life sized model cannulas.	Smartphone-based drug administration applications help calculate the dosage of emergency medicines in children according to body weight so as to minimize errors in drug administration which will have an impact on treatment errors and the length of time of patient care.
2020	Mike Wells, et al	The objectives of this study were to evaluate the accuracy of drug dose calculations using the Broselow tape, the PAWPER XL tape plus its companion drug-dosing guide, a custom-designed mobile phone app	This research methods using sample sizes 30 participants and using Fisher Exact test and using confidence interval 95%. The participants are emergency medicine registrars, emergency medicine consultants and senior advanced life.	Randomized controlled trial which was a prospective study in which 30 emergency medicine volunteers participated in eight simulations of common paediatric emergency conditions, using children models. The participants used the three methods to estimate the children's weight and calculate drug doses.	Smartphone-based drug administration applications help calculate the dosage of emergency medicines in children according to body weight so as to minimize errors in drug administration which will have an impact on treatment errors and the length of time of patient care.

2021	Diego Enríquez, et al	The study aimed to compare the frequency of miscalculations in drug prescribing during simulated pediatric emergencies between doctors assisted with smartphone applications and a group of professionals assisted by conventional methods.	Professionals participating in pediatric cardiopulmonary resuscitation (CPR) days with simulated high fidelity are called upon prior enrollment in the group by the institution. The study was conducted by comparing 2 samples that managed emergencies in pediatric cases.	Randomized Controlled Trial with Ambitious, observational, analytical work with historical control. Pediatricians and pediatric residents participate in training sessions in simulated pediatric emergencies.	The use of smartphone applications substantially reduces the occurrence of errors due to miscalculations in pediatric emergency medicine during the implementation of cardiopulmonary resuscitation and 100% no medical error has founded.
2020	Johan N. Siebert, et al	This study aimed to assess the efficacy of evidence-based mobile apps in reducing the occurrence of medication errors compared to conventional preparation methods during simulated cardiac arrest scenarios outside pediatric hospitals.	Participants were randomized (1:1 ratio) to the support of an app designed to assist with pediatric drug preparation, sample size is 74 for intervention group and 76 for controls.	The hisnationwide, open-label, multicenter, randomized clinical trial was conducted at 14 emergency medical service centers.	The use of smartphone applications reduces the occurrence of medical errors during therapy compared to conventional methods, the average drug preparation decreases for 40 seconds and the drug delivery time decreases by 47 seconds and treatment errors decrease by 66.5 from all cases.
2020	Francesco Cavallin et al	This study aims to evaluate the impact of NeoTapAS on HR communication time and resuscitation interventions	Nurses were randomized using a tiered, single, constant 1:1 allocation ratio determined with web-based software.	HR assessment using auscultation plus NeoTapAS compared to auscultation plus mental calculation in a high-fidelity simulated newborn resuscitation scenario.	Mobile application is effective for reducing the time of drug preparation before chest compression and resuscitation where the difference in drug preparation time is found with the initiation of chest compressions by 68 seconds in the administration of epinephrine.

2021	Francesco Corazza et al	This study aims to evaluate the effectiveness of the PediAppRREST application in reducing deviations from the recommendations of PCA management.	The samples in this study were paramedics and medical emergencies at Padua University Hospital, Meyer University Hospital, Maggiore della Carita Hospital, Agostino Gemelli Hospital, and Roman Catholic Hospital for 15 months (September 2020 – December 2021)	New Audio Visual (PediAppRRest) was used in the treatment group while the control group used CtrlPocketPals+ and CtrlPocketPALS - .	This mobile-based application is able to help administer epinephrine drugs and programming in cases of resuscitation according to body weight in children and help in case management after cardiac arrest of children so that epinefrind apat is given exactly according to the dose of the child's needs.
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DISCUSSION

Mobile Application on Drug Preparation

This literature review describes the mobile application that develops by the researchers. Mobile apps for cases in pediatric emergencies in this literature review found several types, namely PedAMINES (Pediatric Accurate Medication in Emergency Situations). This app was designed to support nurses and physicians step-by-step from order to delivery of a wide range of drugs in real time, including those requiring continuous infusion. PedAMINES also dramatically reduced TDP (Time Drug Preparation) and TDD (Time Drug Delivery). Mobile app supporting calculation and administration of intravenous drugs in emergency cases had been developed. The main goal of the app is to combine the advantages of a reference tool to find dosage information and a calculation aid (2-4,11,12). The database contained drugs and their dosage information according to their professional information. The user needs to enter the patients age and weight, choose the

drug and then select the correct dosage. The app will then present all the important information for drug administration in an overview.

Mobile app for patients with heart ejection disorders, heart failure for administration of vasodilator drugs, ISDN and Spironolacton by titration. The results show that the mobile app is faster and more accurate at setup time and monitoring becomes easier because it is already listed in the mobile app (8). Drug administration is based on cardiovascular problems and the setting of administration to patients based on predetermined doses. Mobile Device Tablet used to measure drug dose needs in pediatric cardiopulmonary emergencies by recording emergency drug preparation time, heart-lung compression initiation time, defibrillation needs, time needed to administer medication during the defibrillation period and drug preparation for pediatric patients with shock. This nationwide, open-label, multicenter, randomized clinical trial was conducted at 14 emergency medical services centers in

Switzerland from September 3, 2019, to January 21, 2020. The participants were 150 advanced paramedics with drug preparation autonomy. Each participant was exposed to a 20-minute, standardized, fully video-recorded, realistic pediatric out-of-hospital cardiac arrest cardiopulmonary resuscitation scenario concerning an 18-month-old child. Participants were tested on sequential preparations of 4 intravenous emergency drugs of varying degrees of preparation difficulty (epinephrine, midazolam, 10% dextrose, and sodium bicarbonate). This was a randomised controlled crossover (AB/BA) study evaluating HR assessment using auscultation plus NeoTapAS compared with auscultation plus mental computation in a high-fidelity simulated newborn resuscitation scenario (5,7,13). Almost of all the application that developed by the researchers describe the effectiveness of drug preparation and can monitoring the medical error and presence reducing the number of medical error.

The effect of Mobile Application on drug preparation.

Preparation is required in the administration of emergency medications that have been prescribed based on the needs of the child and body weight. 5 research result find that drug titration preparation, were found that the time decrease was about 45 seconds to 1 minute to prepare the drug administration rather than using conventional method and giving to the patient so it's more efficient from time to saving their live by crisis periods (Baumann et al., 2019; Cavallin et al., 2020b; Siebert, Bloudeau, et al., 2019a; Siebert, Ehrler, et al., 2019; Siebert et al., 2021b,

2021a). Quick, accurate and safe preparation and administration of continuous infusions is complex and time-consuming in pediatric critical situations, such as septic shock, cardiogenic shock and the return of spontaneous circulation after cardiopulmonary resuscitation of cardiac arrest (6,14,15).

The effect of Mobile Application on therapy monitoring

Monitoring in the administration of therapy is needed in the administration of emergency drugs so that it is hoped that therapy can be effective and efficient and appropriate as needed. From the review of the article that has been carried out, it takes time for monitoring for approximately 60 to 90 minutes in intravenous drug administration (2,3,11). Based on the results of all the article review, data were obtained that p value <0.05 with a 95% confidence interval for accuracy in therapy monitoring compared to conventional methods. Important indicators in monitoring the implementation of therapy are the period of preparation, the accuracy of calculations according to the needs of the child's body weight and the effectiveness of drugs that enter faster using the application that has been made. This shows that mobile applications in calculating drug titration are more effective and efficient compared to conventional methods.

Medical Error Events

The incidence of medical errors in this 7 article review decreased by 20-40% and in 1 articles not found percentage of medical errors in cases of drug administration in the intravenous titration method (2,7,8,10,

12,13,15) . Medical errors that occur in drug administration with conventional titration methods include errors in the administration of vasoactive drugs in intravenous fluids based on the child's body weight (3,12). Medical error events that can be prevented by using a mobile application based on this Literature review are drug administration errors, drug administration errors not according to dosage and errors in administration according to the drug route (1–3,8,13,16).

Time in drug preparation is one of the important factors in the speed and accuracy of drug administration using the titration method. The risk of incorrect preparation varies throughout the drug when using conventional methods, with a higher risk for drugs that are more difficult to prepare or less frequently used. However, the risks are no different when using the app. A consistent reduction in risk to a low level of approximately 5% for all 4 drugs with the use of application regardless of the varying degrees of difficulty of drug preparation may reflect the influence of the application on securing the preparation stage of the treatment process regardless of the context(6,14,17).

This stage is particularly prone to treatment errors when several steps are required, with each step being a potential source of error and especially when the task is loaded cognitively and unusually. Pediatric situations account for about 7% of EMS calls, with epinephrine deliveries to children accounting for only 3.6% of total adult drug administration(9,18–22). In many critical situations, paramedics still rely on conventional paper-based support, empirical

calculators, height and weight estimation tapes (e.g., Broselow-Luten or Handtevy tapes), or spreadsheets to ensure correct drug delivery.

Monitoring therapy with a mobile app is indeed easier, faster and more accurate in monitoring the patient's condition, while drug administration with conventional methods requires continuous time so it requires time and proper supervision (5,23,24). Monitoring in the administration of therapy is carried out by observing all incoming drugs and seeing the response of children given drug titration with multiple therapies. From the review of the article that has been carried out, it takes time for monitoring for approximately 60 to 90 minutes in intravenous drug administration (2,3,11).

Monitoring therapy in drug administration with titration requires observant observation, especially by observing thoroughly including setting the device, calculating the dose in titration on an ongoing basis with the incoming intravenous fluid. In the use of monitoring applications carried out with the time that has been provided according to the child's body weight, the correctness in calculating the dose of drugs and solutions that must be present and this route of administration makes monitoring easier than conventionally (2,9,12,15)

Medical error especially medication error events are often found when counting, preparing or administering drugs in the form of titration with conventional methods. Most medications given intravenously to children are provided in vials originally prepared for adults, weight-based drug dosage calculations and preparations for each child that vary widely across age groups.

Treatment errors are one of the most common medical mistakes in conventional drug administration. This error-prone process puts children at high risk for life-threatening medication errors, especially in critical situations where continuous infusion preparation and administration are complex and time-consuming (9,25).

Emergency situation makes critical thinking, fast response time and accurately in drug preparation. Mobile apps on calculating drug is useful especially during times when cardiovascular resuscitation in children must be carried out. Cardiovascular resuscitation is a procedure that makes nurses feel stress, dilemmas and must be quick in making decisions to overcome problems that arise. Cardiovascular resuscitation requires precise treatment accurately according to the age and weight-loss of the child. This sometimes makes the process a bit long because of the preparation, titration and giving to the child so that sometimes it also makes a medication error.

This mobile app for the calculation and preparation of titrated drugs for cardiovascular resuscitation is effective and efficient for making an accurate formulation in drug administration. The mobile app is very useful because the nurse includes the child's weight, age and type of medication so that the time and number of titrations in the infusion can be recorded and read properly.

This form of application is expected to reduce the incidence of medical errors in drug administration in cardiovascular resuscitation in children. Errors in administering drugs with infusions are often found due to several factors, namely improper dilution in accordance with the child's absorbing ability,

administration below the dose and above the dose so that this is what makes cardiovascular resuscitation fail in children.

The limitation of this literature review is that it only focuses on RCT research and only analyzes in terms of the effectiveness of using the M Health application and does not analyze the extent of long-term use in patients other than children and not emergency cases and it can't describe off all patient responses about the experiences of paramedic in drug preparation and all of the patients effect of drug therapy.

CONCLUSION AND RECOMMENDATION

This mobile app for the calculation and preparation of titrated drugs for cardiovascular resuscitation is effective and efficient for making an accurate formulation in drug administration. Mobile app is effective for monitoring therapy for patient with multiple therapy with titration. The mobile app is very useful because paramedics include the child's weight, age and type of medication so that the time and number of titrations in the infusion can be recorded and read well. This form of application is expected to reduce the incidence of medical errors in drug administration in cardiovascular resuscitation in children.

The implication of this research is the development of a mobile app for the drug administration process from dose counting, drug preparation, administration and therapy monitoring is very necessary and makes it easier for nurses to deliver drugs to patients correctly and precisely. Mobile apps can also reduce the number of medical errors that can arise in the process of administering drugs.

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