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A Retrospective Analysis of the Peripheral Intravenous Access Rates that Emergency Medical Services Obtained for Pediatric Patients.

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Abstract:

The principal method for administering drugs is still peripheral intravenous (IV) access, a basic pre-hospital operation carried out by emergency medical services (EMS) staff. Out-of-hospital pediatric IV cannulation is frequently difficult. The purpose of this study was to assess how frequently EMS personnel set up peripheral intravenous access for pediatric patients in pre-hospital settings. 6331 records of emergency medical services (EMS) dispatches involving individuals under the age of eighteen were examined in this retrospective analysis. An evaluation of the cannulation rate based on the patient's age, case characteristics, diagnosis (International Classification of Diseases), and need for hospital transport was part of the study procedure.

Conclusions: Children under one year old had the lowest rates of peripheral intravenous access in establishment in pre-hospital settings, with a generally low prevalence among pediatric patients. The risk factors for cannulation were age, trauma, poisoning, and referral to HEMS teams. To assist EMS staff in managing vascular access in critically sick children, evidence-based algorithms and focused training are crucial.

Keywords: Emergency Medical Services, Pediatrics, Intravenous, Patients.

Introduction:

One of the fundamental practical skills needed to work with emergency medical services is securing peripheral intravenous access. The percentage of people who get and use intravenous access prior to hospitalization varies widely, ranging from 1.6% to over 80% and from 30% to 80%, respectively. In emergency situations, including pediatric cardiopulmonary resuscitation, intravenous access continues to be the principal method of drug delivery. Establishing access is usually not an issue, but on occasion it might be, particularly when working with patients who are in poor clinical condition. Only 74% of adult emergency patients have intravenous access obtained on their first try, and it takes 2.5 to 13 minutes for cannulation to be effective (Mason et al., 2020; Van et al., 2021).

The endeavor can be considerably more difficult in the pediatric population. Age, weight, low perfusion, and the veins' palpability and visibility are all factors that make it difficult to get

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peripheral IV access. Obtaining IV access during cardiopulmonary resuscitation takes more than ten minutes, and in six percent of cases, access is not achievable. According to Reigart et al.'s study, peripheral IV access in a pediatric hospital setting was successful 53.5% of the time on the first try, with an average access time of nine minutes. With 11 minutes till access establishment, the rate was only 38.9% in the younger subpopulation (Wang et al., 2023).

Alternative methods, such intraosseous or intranasal access, may be taken into consideration in situations where peripheral intravenous access is unavailable. Although gaining intraosseous access is simple, it can cause excruciating agony both during the procedure and when administering medications and fluids later. Although intranasal drug delivery is simple to utilize, it is not suitable for administering many medications, including some used in the rapid sequence intubation (RSI) process, and it is also incompatible with fluid treatment (Ng M, 2022; de la Vieja et al., 2022).

The staff's level of experience increases with the frequency of a procedure, increasing the likelihood of successful and accurate execution. Carr et al. demonstrated in a study of peripheral IV cannulation in people getting care at a hospital emergency room that the larger the percentage of staff members with more expertise, the more likely they were to acquire peripheral access on the first try (McInerny et al., 2017; Reigart et al., 2012).

This study's goals were to assess the rate at which emergency medical team members obtain peripheral IV access for pediatric patients in a pre-hospital scenario and to examine the factors influencing that rate.

Methods:

Study Design and Setting: This was a retrospective study that used anonymized records from the Independent Public Healthcare Facility database. The facility operated under the Law on the National Emergency Medical Services and the Action Plan for the State Medical Rescue System for the Masovian Voivodeship. About half a million people are served by the EMS system in this area, which includes the Masovian Voivodeship's counties and Węgrów. About 27,000 missions are carried out annually by its 18 EMS teams. All EMS team dispatches to patients under the age of eighteen were examined by us. All EMS team dispatches within the system are recorded in a computerized database, which offers standardized data for operational and clinical evaluation.

Participants in the Study:

This study examined pediatric patient interventions carried out by emergency medical services. The patient had to be younger than eighteen at the time of EMS dispatch to be included. Records

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with missing values or inadequate data that made basic statistical analysis impossible were eliminated.

Data Collection and Variables:

The EMS electronic database was used to extract the following variables for data analysis: the patients' age and sex, the date and time of departure, the location of the call, the reasons why the emergency medical teams intervened, whether the patient was taken to the hospital, and whether peripheral IV access was set up in the pre-hospital setting.

Statistical Analysis:

IBM SPSS Statistics for Windows was used to statistically analyze the data gathered from the examination of medical records. The chi-square test was used to compare baseline data and determine whether there were any significant differences between the qualitative variables under analysis. Using logistic regression analysis and the stepwise selection approach, the effect of each variable on the development of peripheral venous access in children was assessed.

Vascular Access in Modern Healthcare:

In contemporary healthcare, vascular access is essential for the efficient delivery of drugs and intravenous fluids via intraosseous (IO) and peripheral intravenous catheters (PIVC). Early vascular access establishment is frequently crucial in pre-hospital settings, and any failures or delays in obtaining it could seriously impair patient outcomes, especially in emergency scenarios like cardiac arrest, severe thermal burns, or serious multi-organ trauma (Ting et al., 2022; Carr et al., 2019).

The overall frequency of peripheral IV cannulation among pediatric patients treated by emergency medical services teams was a startlingly low 16.94%, according to an analysis done for this study. On the other hand, research that looked at a group of adults who were not in the hospital revealed that almost half of the individuals who were brought to the hospital had IV access set up. Notably, children younger than one year old had the lowest cannulation rates in our study. According to observations, paramedics are generally more cautious when considering IV access in children because of the associated trauma and emotional distress for both the child and their caregivers, even though clinical indications for cannulation are generally similar across age groups. This finding is in line with those observations (Rechel et al., 2018).

The frequency of a procedure determines its correct execution. The success rate rises with more frequency. Furthermore, the problem of pediatric patients' challenges in gaining vascular access has been the subject of many research in literature. determined that 39% of children had an

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unsuccessful first attempt at getting an IV cannula, and that the following factors contributed to the difficulties of venous access: age less than 3 years, a lack of viable veins, staff with less experience, and adverse environmental conditions (Mason et al., 2022).

However, this surgery can be unpleasant for patients and their families as well as challenging for medical professionals. They contend that selecting the best vascular access is essential to enhancing pediatric patients' immediate and long-term care (Sørgjerd , 2019).

Patients An Emergency Condition:

revealed vascular access in the pre-hospital context was more likely to be granted to patients who needed hospital transfer or who were in an emergency situation. Notably, children who are taken to the hospital by HEMS teams have a peripheral intravenous access rate that is over six times greater than the baseline. This is most likely since children who are eligible for evacuation by HEMS teams usually have more serious clinical conditions that necessitate cardiovascular access. Our findings further support the association between the higher frequency of PIVC implantation with the patient's clinical severity and the requirement for IV fluid or medication delivery (Evison et al., 2021).

Furthermore, as anticipated, our research revealed that peripheral IV access was more frequently established in trauma cases, with the cannulation rate nearly doubling with a trauma-related diagnosis. The cannulation rate was nearly four times greater than poisoning patients. This association is further supported by data, which indicates that most patients who were given IV access were taken to the hospital and that pre-hospital IV placement was more common among patients who were deemed to be in an emergency or life-threatening situation by EMS staff, especially those with cardiovascular disease (Dunstan et al., 2024).

The likelihood of a successful cannulation improves with patient age. Compared to children under one year old, the cannulation rate was 22 times greater in the teenage population. This indicates that peripheral IV access was established the least frequently in the youngest children's category. Due to anatomical variations and the emotional strain of caring for the youngest patients, this patient group presents the most challenges when it comes to obtaining peripheral IV access (Bennett , 2020; Engels et al., 2014).

Their analysis of 935 pediatric peripheral venous cannulation cases revealed that newborns had the highest failure rate (18.4%), indicating that younger patients had more trouble getting IV access Similarly, it was shown that anatomical variables like greater subcutaneous tissue, reduced artery width, and patient mobility make it more difficult to establish vascular access in babies. These

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factors all limit the visibility and palpability of veins. Furthermore, patient age was found to be a risk factor in numerous investigations (Chu et al., 2022).

Peripheral IV access is generally achieved at a low rate in the pediatric population in a pre-hospital situation. This raises questions about whether the EMS staff members possess the practical abilities and experience needed to perform the surgery. This calls for more research and the creation of algorithms to handle EMS staff's challenges in gaining peripheral IV access for pediatric patients.

Recommendations:

There are several restrictions on this study:

First and foremost, identifying causal links is limited by the analysis's retroactive character, which is reliant on EMS documentation. The fact that the study only included one regional EMS provider may restrict the findings' generalizability to other regions or healthcare systems with differing operating standards, even though it included a sizable number of EMS interventions involving pediatric patients. The range of possible variables was limited to those that were regularly documented during EMS operations, even if the adoption of standardized digital records decreased the possibility of data entry errors.

It was not possible to assess important factors like the intricacy of venous access procedures or the clinical background of EMS staff because they were not recorded. The strength or interpretation of certain correlations may have been affected by the lack of such data. Notwithstanding these drawbacks, this study offers insightful information on a neglected aspect of pediatric pre-hospital treatment and could be a starting point for future multicenter research with a wider range of demographics and more clinical variables.

Future research:

Should employ prospective, multicenter study designs to enhance external validity and allow for more accurate assessment of causal relationships in pediatric pre-hospital vascular access. Expanding data collection to include diverse EMS systems and geographic regions is recommended to account for variations in clinical practice, training, and resource availability.

It is recommended that future studies incorporate additional clinical and procedural variables, including the number of cannulation attempts, time to successful access, use of alternative techniques such as intraosseous access, and the level of experience and pediatric-specific training of EMS personnel. This would enable a more comprehensive evaluation of factors influencing vascular access success.

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From a clinical perspective, the implementation of standardized, evidence-based pediatric vascular access guidelines within EMS systems is strongly advised. These guidelines should promote early consideration of alternative access methods when peripheral IV cannulation is difficult or unsuccessful, particularly in younger age groups.

Ongoing pediatric-focused education, simulation-based training, and regular competency assessments for EMS providers are recommended to improve technical skills and clinical decision-making. Additionally, integrating continuous quality improvement initiatives and strengthening collaboration between ground EMS and advanced services, such as Helicopter Emergency Medical Services (HEMS), may further enhance the quality and consistency of pre-hospital pediatric care.

Conclusion:

According to this study, pediatric patients in the pre-hospital setting had a low overall rate of peripheral IV cannulation, especially those younger than one year. Establishing IV access was considerably more likely in cases of older age, trauma, poisoning, and referral to HEMS. To enhance vascular access outcomes for critically sick children under the care of emergency medical services (EMS), evidence-based guidelines and focused training are required, given the clinical significance of this route for drug delivery. In addition, the low rate of successful peripheral intravenous access in pediatric patients, especially infants, highlights the technical challenges associated with vascular access in the pre-hospital setting. Factors such as small vessel size, limited patient cooperation, and the urgent nature of emergency care contribute to these difficulties and may limit the frequency and success of IV attempts by EMS providers.

The higher likelihood of IV cannulation in cases involving trauma and poisoning suggests that the perceived severity of illness plays a role in clinical decision making. This variability in practice emphasizes the importance of implementing standardized, evidence-based guidelines to support consistent and timely vascular access for pediatric patients across different emergency scenarios. Moreover, the association between IV access success and referral to Helicopter Emergency Medical Services (HEMS) underscores the impact of advanced training and specialized expertise. Enhancing pediatric emergency training, simulation-based education, and collaboration between ground EMS and HEMS teams may improve procedural confidence and success rates.

Ultimately, ongoing quality improvement efforts and future research are necessary to address existing challenges, optimize training programs, and improve pre-hospital outcomes for pediatric patients.

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