African Journal of Emergency Medicine 15 (2025) 513–517

Contents lists available at ScienceDirect

African Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/afjem

ORIGINAL ARTICLE

Evaluation of the use of intraosseous access on adult patients presenting to the emergency department in urban South Africa

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ARTICLE INFO

Keywords:
Intraosseous
Adults
Emergency department
Knowledge
Barriers

ABSTRACT

Background: Timely vascular access forms a necessary part of patient management in the Emergency Department (ED). Factors such as hypotension, intravenous drug use, obesity, dark skin, patients at extremes of age, and patients with multiple injuries may make peripheral intravenous cannulation difficult. The intraosseous route remains a suitable alternative for emergency circulatory access. The objectives of this study were to describe the knowledge, attitudes, and practice of doctors in the ED about the use of intraosseous access in critically ill adult patients.

Methods: A descriptive study was performed in the EDs of four hospitals in Gauteng, South Africa. Questionnaires were distributed to doctors working in the ED, including intern medical doctors, community service medical doctors, emergency medicine medical officers, emergency medicine registrars, as well as emergency medicine consultants.

Results: Of 88 participants 64.8 % of participants had never used intraosseous access on adult patients in a resuscitation in the ED. Those who do use intraosseous access, use it 1.5 times a month, per clinician. Reasons for not using intraosseous access included: lack of equipment availability, lack of experience, and other preferable methods.

Conclusion: The advantages of using the intraosseous route for circulatory access include its reliability, ease of teaching, rapid use, and low complication rates. Despite sufficient knowledge of intraosseous access and training received at various courses; provider preference and other systemic barriers, lead to an overall reduction in intraosseous access being used in the clinical setting. Intraosseous access remains a cost-effective, life-saving technique for gaining circulatory access. These results can be used to create awareness regarding the availability of other alternatives for gaining circulatory access, enhancing education and training, and improve the standard of health care, particularly in resource-limited settings.

Introduction

In the Emergency Department (ED), vascular access forms a necessary part of patient management. It allows for the administration of fluid, blood products, and vasoactive medication in the setting of cardiopulmonary resuscitation (CPR) or other emergency presentations [1]. The preferred site for peripheral intravenous cannulation is the upper limb, but factors such as hypotension, intravenous drug use, obesity, dark skin, patients at extremes of age, and patients with multiple injuries may make peripheral intravenous cannulation difficult [2]. The intraosseous (IO) route remains a suitable alternative to obtaining emergency access to the systemic circulation.

There is a large body of evidence to support the use of IO access in adults. Studies have shown reduced times to insertion and a higher rate of first-pass success compared to central venous catheterization [3–5].IO access has a low complication rate, and the ability to maintain a patent non-collapsible marrow in states of profound hypotension or shock [3–5]. During CPR, IO access may be obtained at a site distant from the compressions, thus minimizing interruptions and improving CPR quality. Some of the complications that exist with intraosseous insertion include extravasation of fluid leading to compartment syndrome, cellulitis, skin abscess, osteomyelitis, mediastinal injury, and iatrogenic fractures [6,7]. The complication rates with proper placement are rare (<1 %) and the rates are increased with prolonged duration of the

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https://doi.org/10.1016/j.afjem.2024.11.001
Received 4 March 2024; Received in revised form 7 November 2024;
Available online 6 December 2024

needle in situ [7]. The 2020 update for the American Heart Association guidelines for Cardiopulmonary resuscitation and emergency cardiovascular care recommends the use of intraosseous access [1]. The 10th edition of Advanced Trauma Life Support (ATLS®) also mentions the use of intraosseous access in adults [8].

A study performed in the United Kingdom showed that only seven percent of clinicians used IO access in adults [3]. A study performed in the United States of America, which looked at over 150 emergency medicine programmes, showed that IO access was used less than five percent of the time in critically ill patients requiring immediate vascular access, where peripheral access has failed [9]. These studies represent first-world circumstances and are not necessarily translatable to lower-income countries. A precursory review of the literature demonstrated a lack of published research on the use of intraosseous access in adults in an African context. Also, no publications were found about the frequency and familiarity of this method of circulatory access in a local context. This research project aimed to assess the use of IO access on adults in the ED in an urban region of South Africa, and to assess the reported frequency of use of intraosseous access in adults by doctors in the ED and to compare the practice of academic hospitals versus non-academic institutions.

Methods

This was a multicentre survey study.

Population

The study population comprised ED doctors working in four hospitals in Gauteng, South Africa**.** There were two academic hospitals and two non-academic hospitals of which three were in the Johannesburg district and one was in the Ekurhuleni district. The ED is the unit that most patients will present to gain access to the hospital. This is where the initial investigations are performed as well as resuscitation, which may involve establishing access to the circulation. Participants included in the study were doctors who are allowed to use IO access which are: intern medical doctors, community service medical officers, emergency medicine medical officers, emergency medicine registrars, and emergency medicine specialists. Those excluded from the study were medical students, clinical associates, and those not willing to participate in the study. The questionnaire was divided into sections that looked at demographics, analysed participants' knowledge and attitude, compared academic and non-academic practices and looked at factors that may potentially influence intraosseous use. A convenience sample of the population completed the questionnaire. The study was approved by the Human Research Ethics Committee of the University of The Witwatersrand (M230219 MED 23–01–006).

Data collection

One hundred questionnaire packs were distributed to the population. Participants were instructed to refrain from using any external resources or discussing the questions to provide an accurate assessment of their knowledge at the time of completing the survey. The questionnaire pack comprised of an adapted questionnaire by Lavis et al. [10]. This was accompanied by the information sheet as well as a consent form. This was to ensure that the two sets of data could be handled separately and that anonymity would be maintained. Once participants had completed the questionnaire, the questionnaire packs were collected.

Data handling and analysis

Raw data captured by the researcher was exported from a Microsoft Excel worksheet into IBM SPSS version 28 for statistical analysis. Descriptive statistics are presented in frequencies and percentages, for categorical variables. Continuous variables are presented in means with standard deviation or median with interquartile range, depending on the normality of distribution of the data in question. The Pearson chi-square and Fishers Exact tests were used to compare categorical responses. Statistical significance testing was set at the 95 % confidence level and therefore a p-value <0.05 denotes statistical significance.

Results

Of the 100 questionnaires distributed, there was an 88 % response rate. The analysis excluded eight questionnaires that were not completed and four that were only partially completed.

Knowledge, attitudes, and practice

From the completed questionnaires received, 69 % (60/80) of the participants knew there was no maximum age for intraosseous use. Participants could identify 53.1 % of the correct recommended sites for intraosseous insertion and 77.5 % of the correct indications for intraosseous use.

The mean number of patients seen with difficult vascular access per month by each doctor was 14.6, of which 60 % of these patients were critically ill patients. The average number of times that each respondent used IO access was 1.5 times per month. Of the patients seen with difficult vascular access, one of every five (20 %) patients received intraosseous access per month. IO use according to role in the emergency department is shown in Table 1.

Table 2 demonstrates providers who have certification in additional courses. The courses that participants stated had taught IO use were as follows: 45 % ATLS®, 36 % PALS, 18 % ACLS, 4 % AMLS, and 1 % ITLS.

The two most favoured sites for IO insertion are the proximal tibia (57 %) and the proximal humerus (31 %). The least favoured sites are the distal femur and sternum (1 %) respectively. The reasons for preferences of IO sites are illustrated below (Fig. 1).

The equipment/devices that participants stated that they had access to for IO insertion were: Large hollow needle eg 20 gauge or bigger (55 %), Arrow® EZIO® (42 %), the remainder were unsure or had no device/equipment available (3 %).

Academic vs non-academic practice

There was a larger number of participants from academic institutions, compared to non-academic institutions (see Table 1). The percentage of participants who stated that they have used IO access in adult resuscitation in the ED was 19 % in non-academic institutions and 40.3 % in academic institutions (p-value = 0.115).

Barriers to use

Fig. 2 shows that the most common reason respondents avoid using IO access is their preference for other methods of gaining access to the systemic circulation. Of the 60 % of participants who stated that they do not use IO access on adult patients in the ED because other methods were preferred, 82.3 % of these participants preferred central venous access catheter placement and 20.5 % preferred ultrasound-guided peripheral access.

Concerning barriers to teaching, lack of clinical competence, preference, and lack of resources were shown to be common reasons for the porous transfer of information in the work setting (see Fig. 3).

Discussion

Little is known about any aspect of IO use in adult patients in African EDs. Since the placement of an IO device can be a potential lifesaving intervention, it is important to understand the patterns of its current usage as well as identify any barriers to its use. The importance in this study lies in its preliminary exploration of this field, and the

Table 1
Practice of intraosseous use.

Role in the emergency department	Have you ever used intraosseous access in an adult resuscitation in your department						P-Value
	Yes		No		Total no.		
	Academic	Non-academic	Academic	Non-academic	Yes,(n%)	No(n%)	
Emergency medicine consultant	1	1	0	0	2(100 %)	0(0 %)	<0.001
Emergency medicine registrar	7	0	4	0	7(63.6 %)	4(36.4 %)	
Emergency medicine medical officer	18	3	15	14	21(42 %)	29(58 %)	
Community service medical officer	1	0	5	1	1(14.3 %)	6(85.7 %)	
Intern medical officer	0	0	16	2	0(0 %)	18(100 %)	
Total number	**27**	**4**	**40**	**17**	**31(35 %)**	**57(64.7 %)**	

Table 2
Participants who have done additional courses.

	Are you an instructor, completing instructor training or a provider in any of the following : ATLS,ACLS,AMLS,PALS,ITLS	
	Yes, n(%)	No, n(%)
Emergency medicine consultant	2 (100.0 %)	0 (0.0 %)
Emergency medicine medical officer	11 (22.4 %)	38 (77.6 %)
Emergency medicine registrar	2 (18.2 %)	9 (81.8 %)
Community service medical officer	4 (57.1 %)	3 (42.9 %)
Intern medical doctor	2 (11.8 %)	15 (88.2 %)

ATLS=Advanced Trauma Life support. ACLS=Advanced Cardiac Life Support. AMLS=Advanced Medical Life Support. PALS=Paediatric Advanced Life Support. ITLS=International Trauma Life Support.

identification of potential educational opportunities.

This study showed that although clinicians in the ED have adequate theoretical knowledge of intraosseous (IO) access in adults, its practical use remains low. Participants reported that 60 % of patients presenting to the ED with difficult vascular access were critically ill. However, clinicians indicated that they only use IO access once or twice a month on average. This suggests that more patients could be eligible for IO access each month, but clinicians often choose alternative methods for obtaining vascular access. However, the current study did show that IO was used in more critically ill patients than reported in a similar US study (20 % vs 5 %) [9]. IO access was also used by a greater proportion of ED physicians (35 % vs 25 %) than reported in a European study [3].

While 45 % of participants reported learning IO use during their ATLS® training, 73 % indicated that they do not teach this skill to colleagues. This suggests that, although clinicians are proficient in IO use in adults, there is limited skill transfer within the workplace. One of the centres assessed was a medical emergency unit that does not treat trauma patients, which may have influenced the results. Since most participants learned IO use through the ATLS® course, which focuses on trauma care, the absence of a trauma unit could have impacted these findings.

For clinicians who use or teach IO access in adults, the proximal tibia and proximal humerus were the most commonly used sites, aligning with findings from Bloch et al. Reasons for preferring these sites include

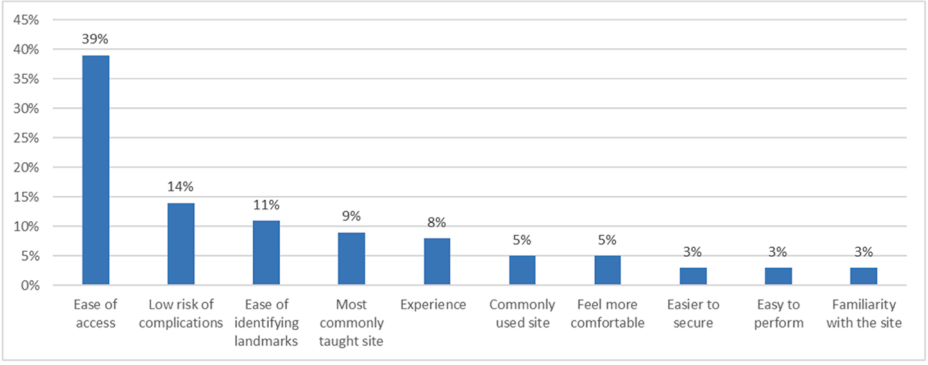

Fig. 1. Reasons for preferred intraosseous sites.

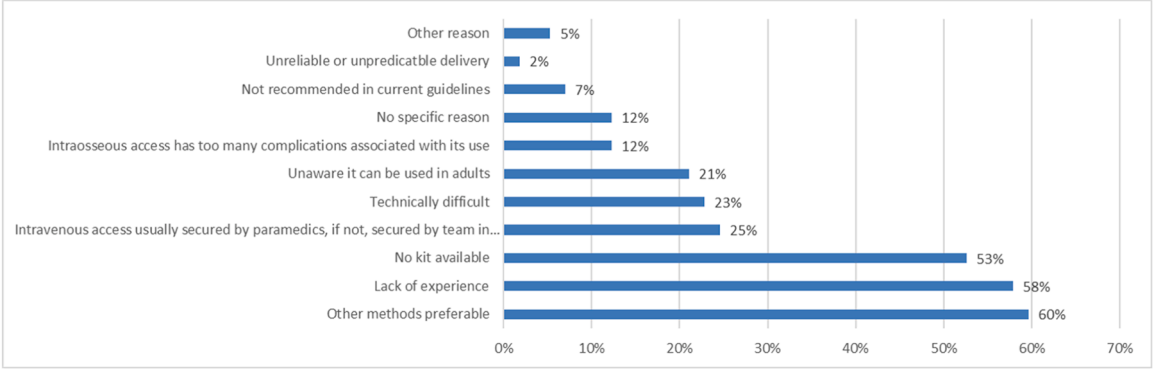

Fig. 2. Reasons why respondents do not use intraosseous access in adult patients in the emergency department.

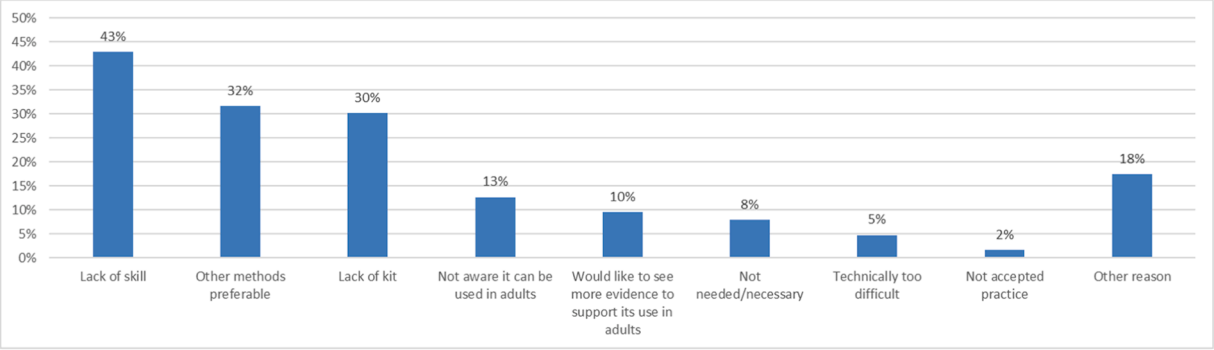

Fig. 3. Reasons why respondents do not teach intraosseous access to colleagues.

ease of access, low complication risk, and identifiable landmarks. The proximal humerus is particularly favoured, as it has been shown to cause less pain than the proximal tibia and achieves significantly higher flow rates compared to other sites [11,12]. In this study and others, the sternum was the least commonly used site for IO access [9]. The perceived risks associated with this approach likely outweighed its benefits, explaining its limited use.

The use of IO access was similar across institution levels, with most individuals reporting they had not used it during adult resuscitations in the ED. Although there appeared to be a difference in IO use between institution levels, this difference was not statistically significant, likely due to the small sample size. However, there was a significant difference in IO access use based on experience level. Emergency medicine consultants and registrars reported the highest use of IO access in resuscitations, possibly due to their greater experience or familiarity with IO techniques as part of their teaching roles.

Common reasons for not using IO access included lack of experience, limited availability of IO kits, and a preference for other methods, similar to findings in a UK-based study [10]. Preferred alternatives included ultrasound-guided vascular access and central venous catheter placement. Ultrasound has become an increasingly popular bedside tool for diagnostics and interventions [13,14], and greater availability and familiarity with it may explain its preference over IO access. Since 2008, the Emergency Medicine Society of South Africa (EMSSA) has provided training and credentials in Emergency Point-of-Care Ultrasound (ePoCUS), with a >150 % increase in accredited providers over the last five years [15,16]. A U.S. study by Bloch et al., involving over 150 emergency medicine programs, found a similar preference for central line access when peripheral access fails in critically ill patients [9], suggesting that these preferences extend across both resource-replete and resource-limited settings.

Studies have demonstrated that early administration of adrenaline improves outcomes, including return of spontaneous circulation, survival to discharge, and favourable neurological outcomes [17,18]. Conversely, delays in epinephrine administration, as shown in a large multi-centre study, can negatively affect survival and neurological recovery [19]. Intraosseous (IO) access, as highlighted by a prospective observational study at a level 1 trauma centre, offers significantly faster access compared to central venous catheter insertion ($p < 0.001$) [20]. Given the high incidence of cardiac arrest and critically ill patients in the emergency department (ED), rapid and reliable vascular access is essential. However, current practices in the ED do not align with best practices, and efforts should be made to review and address this gap. Junior doctors were a large majority of doctors who were unaware that IO access may be used in adults. One possible explanation is that many interns are not providers in courses that teach IO insertion, which may lead to a gap in knowledge and contribute to the underuse of IO access in clinical practice.

Study limitations

This was a small study, with 88 questionnaires being analysed. Eight incomplete questionnaires were received which were not included in the study. The number of questionnaires received from non-academic institutions was less when compared to academic institutions. The study was performed in urban centres in Gauteng and rural areas were not included.

Conclusion

The intraosseous route is an alternative route that is reliable, quick, easy to teach, has multiple access points and a low complication rate [4–7,21]. The study suggests that intraosseous access is rarely used in adults, with clinicians preferring ultrasound-guided peripheral or central access instead. In an African context, where resource limitation is an ever-present issue, IO access could be a valuable skill and more cost-effective compared to preferred alternatives. These results can raise awareness of alternative circulatory access methods, improve education and training, and ultimately enhance healthcare quality, especially in resource-limited settings. Medical students may be taught intraosseous access on cadaver models, to increase knowledge and skill competency [22]. Further development and training can include workshops and simulations to familiarize clinicians with IO indications, uses, sites, and practical application

Dissemination of results

Results of the study are to be shared with the Division of Emergency Medicine at the University of the Witwatersrand as well as all participating hospitals involved in the research.

Authors contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: KH 70 %, KS 20 % and MW 10 %. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interests

The authors declared no conflicts of interest.

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