

Use of peripheral vascular access in the prehospital setting: is there room for improvement?

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Abstract

Background: Previous studies have shown that prehospital-insertion of peripheral vascular access is highly variable. The aim of this study is to establish the proportion of peripheral vascular access placement and its use with regard to both the severity of cases and the main problem suspected by the paramedics involved. Over-triage was considered to have taken place where peripheral vascular access was placed but unused and these cases were specifically analysed in order to evaluate the possibility of improving current practice.

Methods: This is a one-year retrospective study conducted throughout one state of Switzerland. Data were extracted from the state's public health service database, collected electronically by paramedics on RescueNet® from Siemens. The following data were collected and analyzed: sex, age, main diagnosis suspected by paramedics and the National Advisory Committee for Aeronautics score (NACA) to classify the severity of cases.

Results: A total of 33 055 missions were included, 29 307 (88.7%) with a low severity. A peripheral vascular access was placed in 8 603 (26.0%) cases, of which 5 678 (66.0%) were in patients with low severity. In 3 948 (45.9%) cases peripheral vascular access was set but unused with 2 626 (66.5%) of these cases being patients with low severity. Opiates represent 48.3% of all medications given. The most frequent diagnosis among unused peripheral vascular access were: respiratory distress (12.7%), neurological deficit without coma or trauma (9.6%), cardiac condition with thoracic pain and without trauma or loss of consciousness (9.6%) and decreased general condition of the patient (8.5%).

Conclusions: Peripheral vascular access was set in 26% of patients, nearly half of which were unused. To reduce over-triage, special attention should be dedicated to cases defined by EMS on site as low severity, as they do not require placement of a peripheral vascular access as a precautionary measure. Alternative routes, such as the intra-nasal route, should be promoted, particularly for analgesia, whose efficiency is well documented. Emergency medical services medical directors may also consider modifying protocols of acute clinical situations when data show that mandatory peripheral vascular access, in stroke cases for example, is almost never used.

Background

The insertion of peripheral vascular access (PVA), intravenous (IV) or intraosseous (IO), is a common medical procedure in emergency medical services (EMS). However, there are no guidelines for its use in the prehospital setting and a lack of evidence supporting the efficacy of such a measure, especially in non-trauma or non-cardiac arrest patients.

Previous studies show that, once in place, prehospital-inserted PVAs were used in 17%¹ to 67%² of cases, other PVAs being considered as a precautionary measure. Placement of PVA in the prehospital setting is motivated by the immediate need to give IV or IO medication or fluid therapy³. Paramedics are also taught to establish PVA as precautionary measure because they might need to quickly administer medication or fluid, and inserting a catheter while the patient is stable might therefore be easier than in an emergency situation⁴. The circumstances in which a paramedic finds it appropriate to insert a catheter in the field are also determined by each individual and much discrepancy therefore exists⁴.

Although it is a very rare occurrence, a PVA set in the prehospital setting has more potential complications than one set in the hospital, particularly with regard to bacteraemia (mean dwell time 3.5 days)⁵. Placement of a PVA should therefore be considered carefully before the insertion occurs, to avoid the "just-in-case" insertion and to promote procedures that truly benefit the patient.

The aim of this study is to establish the proportion of PVA setting and its use with regard to both the severity of the cases and the main problem suspected by the paramedics involved. Over-triage was considered to have taken place where PVAs were placed but unused. These cases were specifically analysed in order to evaluate the possibility of improving current practice.

Method

This is a retrospective study conducted from January 1st 2017 to December 31st 2017 throughout the State of Vaud in the French-speaking region of Switzerland, where a centralised prehospital medical dispatch centre serves a population of 790 000 and handles over 80 000 calls per year.

This is a three-tier system. Paramedics use state protocols and algorithms for autonomous IV access (or IO when facing a life threatening emergency and a complicated IV setting), cardiopulmonary resuscitation procedures, defibrillation and drug administration (crystalloids solutions, acetylsalicylic acid, adrenaline, amiodarone, clonazepam, diazepam, fentanyl, glucose, glucagon, isosorbide dinitrate, morphine, midazolam, naloxone, paracetamol, salbutamol, thiamine, ondansetron). Paramedics are also allowed to use oral, subcutaneous, intra-rectal, intra-nasal, sublingual and intramuscular access. According to the state's paramedic protocols⁶, a precautionary or anticipated IV access is mandatory in case of delivery of a baby and when a stroke is suspected. In other situations, the PVA is considered because of the need for systemic medications, such as in the case of: anaphylaxis, pain with a visual analogue pain scale ≥ 3 , hemodynamic instability, trauma, acute coronary syndrome, burn, seizure, cardiopulmonary arrest, suspected opioid intoxication, hypoglycemia and the impossibility to give glucose by mouth. Paramedics can also ask support from an emergency physician, either by telephone or on site, to administer other medications not included in their protocols.

With a specific authorisation from the State's public health services, data collected electronically on RescueNet® from Siemens by paramedics at the end of each mission were extracted.

The registry contains all ambulance protocols of intervention: all patients, including pediatrics, were included in this study, except for the cases with a catheter inserted before EMS arrival, failure and/or refusal of insertion or missing data from the mission. Inter-hospital transfers were excluded.

The following data were collected: sex, age, main diagnosis suspected by paramedics and the National Advisory Committee for Aeronautics (NACA) score. (Figure 1) The NACA score comprises eight categories ranging from 0 (no injury or disease) to 7 (lethal injuries or disease, with or without resuscitation attempts). It does not rely on specific clinical or biological parameters but consists of classifying patients according to the most probable outcome of their current injuries or disease. It can efficiently discriminate between patients with regard to their short-term mortality⁷, and a score ≥ 4 implies a potential life-threatening condition while a score < 4 may be classified as low severity⁸. The study team therefore decided to specifically analyse the latter category, as it may not need a PVA as a precautionary measure.

Details of any medication given through PVA were collected while information on medications given through intra-muscular, intra-nasal, intra-rectal and oral routes were not. The amount of vascular filling was taken into consideration (NaCl 0.9% and/or Ringer Lactate). Volumes equal to 500 mL or more were considered as a treatment for patients above 14 years old while 10 mL/kg was considered for patients under 14 years old. The national growth curve and the child's sex and age were used to determine the weight.⁹

Results

A total of 35 088 primary missions were completed during the study period. Of these, 2 033 (5.8%) were excluded due to either the catheter already being in place prior to EMS arrival, failed insertion, patient's refusal or missing data. In total, 33 055 missions were therefore included, 8603 (26.0%) with a PVA.

Among patients with a NACA score < 4 (29 309; 88.7% of total), 5 978 (20.4%) had a PVA and among those 2 626 (43.9%) PVA were unused (Table 1). Among unused PVAs, the most frequent diagnoses were: respiratory distress (12.7%), neurological deficit without coma or trauma (9.6%), cardiac condition with thoracic pain and without trauma or loss of consciousness (9.6%) and decreased general condition of the patient (8.5%) (Table 2). (additional file 1 details diagnosis with a NACA score < 4 and additional file 2 details those with a NACA score ≥ 4). Figure 2 details the setting of PVA with regard to the case mix of the study and figure 3 presents the use of PVA with regards of the case mix and the severity (NACA score).

Among patients with a PVA, 4 655 (54.1%) patients received at least one medication. The most frequent were: opiates (48.3%), acetylsalicylic acid (8.6%), vascular filling (8.2%). (Table 3). Table 4 lists medications received by low severity patients (NACA < 4) and the most frequent were opiates (71.6%), anti-nausea treatment (10.3%) and acetylsalicylic acid (6.5%).

Discussion

Only a small percentage of patients in this study received a PVA (26%), significantly lower than seen in other studies where proportions varied from 50%¹⁰ up to 60%¹. Among those patients receiving a PVA, 46% were unused. This is lower than previous studies, where values of 83%¹ and 72%¹¹ were attributed to unused PVA. This implies a small absolute number of unused PVAs globally. Nevertheless, as the insertion of a PVA is more complicated in the prehospital setting, especially regarding the asepsis procedure¹², placement of such a device should be carefully assessed. EMS must consider many variables, including clinical presentation of the patient, paramedic's differential diagnosis, EMS protocols, "gut feeling" and anticipation of a worsening scenario. The setting of a PVA is mainly validated in the case of a life-threatening emergency (principles of precaution) or when a medication or fluid is needed without alternative route. EMS should not anticipate the use of a catheter by the hospital as hospital personal would be able to place it under better conditions and perform blood puncture at the same time. It was shown that a PVA inserted in the prehospital setting, but unused in the field, did not shorten the time to access treatment once the patient arrived in the emergency department¹³.

In this study 66% of the unused PVA were found to be among patients with a NACA score < 4 , which equates to 9% of NACA < 4 patients. As these PVA would not be considered as precautionary in terms of case severity, they may be the easiest to avoid. Therefore, efforts to reduce over-triage should be concentrated on patients categorised by EMS themselves as low severity.

When looking specifically at prehospital diagnosis, some cases (intoxication without coma, neurological deficit without coma or trauma, impossible care at home, decreased general condition, hypertension, hypothermia) had more than 50% of unused PVAs. As some of these conditions required placement of a PVA and were rated NACA ≥ 4 , the decision to postpone the PVA placement must not be entrusted to paramedics. Medical directors should use these data to modify existing protocols where necessary. For example, in the case of a stroke registered as a "neurological deficit without trauma or coma" in this setting, the state's protocol recommends the insertion of a PVA, but results showed that this represents 20.6% of unused PVA among patients with a NACA score ≥ 4 .

This study also showed that the prevailing medication with a NACA score < 4 was opiates, followed by acetylsalicylic acid. When dealing with low severity cases, it can be suggested that alternative routes could be used such as intramuscular injection in case of seizure¹⁴, or the intra-nasal route for analgesia. Regarding the latter, based on the published literature, intranasal administration of fentanyl, sufentanil, ketamine, and hydromorphone may be a safe, effective, and well-tolerated alternative to intramuscular or intravenous administration in the prehospital and ED settings.^{15 16 17} In this case-mix, if all NACA score < 4 patients who received opiates through PVA (which represent 71% of patients in this category) had benefitted from an alternative route without a PVA set, there would be a drop from 26 to 18% in the total of patient with a PVA. This reflection process is probably well performed when dealing with children as the setting of a PVA is sometimes complicated in those cases; we observe a very low proportion of unused PVAs in this group of patients compared to adults. (Table 1) Finally, with regard to acetylsalicylic acid, in the absence of impaired consciousness or difficulty swallowing, it has been validated to give it orally for patients presenting chest pain¹⁸.

Limitations

This is a retrospective study in a specific setting and may not be reproducible elsewhere.

This study was not designed to estimate under-triage (situations where PVA was not placed but may have been a benefit to the patient) nor the failure to set a PVA.

This study was not specifically designed to measure how many PVA could have been avoided if alternative routes had been prioritised.

Conclusion

Although only 26% of patients received a PVA in this study, nearly half of them were unused, which gives some room for improvement. To reduce over-triage, special attention should be dedicated to cases defined by EMS on site as low severity, as these cases do not require placement of a PVA as precautionary measure. Paramedics could also reduce placement of PVA if alternative routes, such as intramuscular and intra-nasal, were promoted, particularly for seizure and analgesia whose efficiency is well documented. EMS medical directors may also modify protocols for acute clinical situations when data show that the mandatory PVA, in stroke cases for example, is almost never used. Finally, PVA placement should be limited to acute severity cases or when there is no alternative to IV or IO treatment.

List Of Abbreviations

- PVA Peripheral vascular access
- EMS Emergency Medical Services
- IV Intravenous
- IO Intraosseous
- NACA National Advisory Committee for Aeronautics

Declarations

Ethics approval and consent to participate

The ethic committee (decision 2018-00781) authorised the study without consent as the data were completely anonymised and non-clinical were collected

Consent for Publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from the Health Service of the State of Vaud but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are, however, available from the authors upon reasonable request and with permission of the Health Service of the State of Vaud.

Competing interests

There were no financial and non-financial competing interests for this study.

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Authors' contributions

EG analysed the data. EG, TS, EA and FD wrote the draft and all authors read and approved the final manuscript.

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Tables

Due to technical limitations, the tables could not be displayed here. Please see the supplementary files section to access the tables.

Figures

NACA 0 No injury or disease

NACA 1 Injuries/diseases without any need for acute physicians care

NACA 2 Injuries/diseases requiring examination and therapy by a physician but hospital admission is not indicated. Including: large contusions, finger and toe fracture, 2nd degree burn (10-20% of body surface), exhaustion without hypothermia

NACA 3 Injuries/diseases without acute threat to life but requiring hospital admission. Including: maxillofacial trauma, wound with vascular/neurological impact, 3rd degree burn (10-20%), hypoglycemia without coma, TIA, supra-ventricular arrhythmia with conserved hemodynamic, right iliac fossa pain syndrome, hypothermia stage I, 2nd degree burn (20-30%), isolated limb fracture (femur excluded)

NACA 4 Injuries/diseases which can possibly lead to deterioration of vital signs. Including: open skull fracture, hypothermia stage II, suspicion SCA, suspicion ectopic pregnancy/placenta praevia

NACA 5 Injuries/diseases with acute threat to life. Including: head trauma GCS<8, heart infarct, bradycardia (< 30/min), tachycardia (>180/min), complete heart bloc, eclampsia, hypothermia stage III, haemodynamic shock, multiple ribs fractures, acute dyspnea, pulmonary edema

NACA 6 Injuries/diseases transported after successful resuscitation. Including: chest trauma with severe dyspnea, aortic rupture, airways total obstruction, central apnea, emergency external pacing, cardiac arrest (ventricular fibrillation or asystole from any cause)

NACA 7 Lethal injuries or diseases (with or without resuscitation attempts)

Figure 1

National Advisory Committee for Aeronautics (NACA) score revised by the State of Vaud (Switzerland)

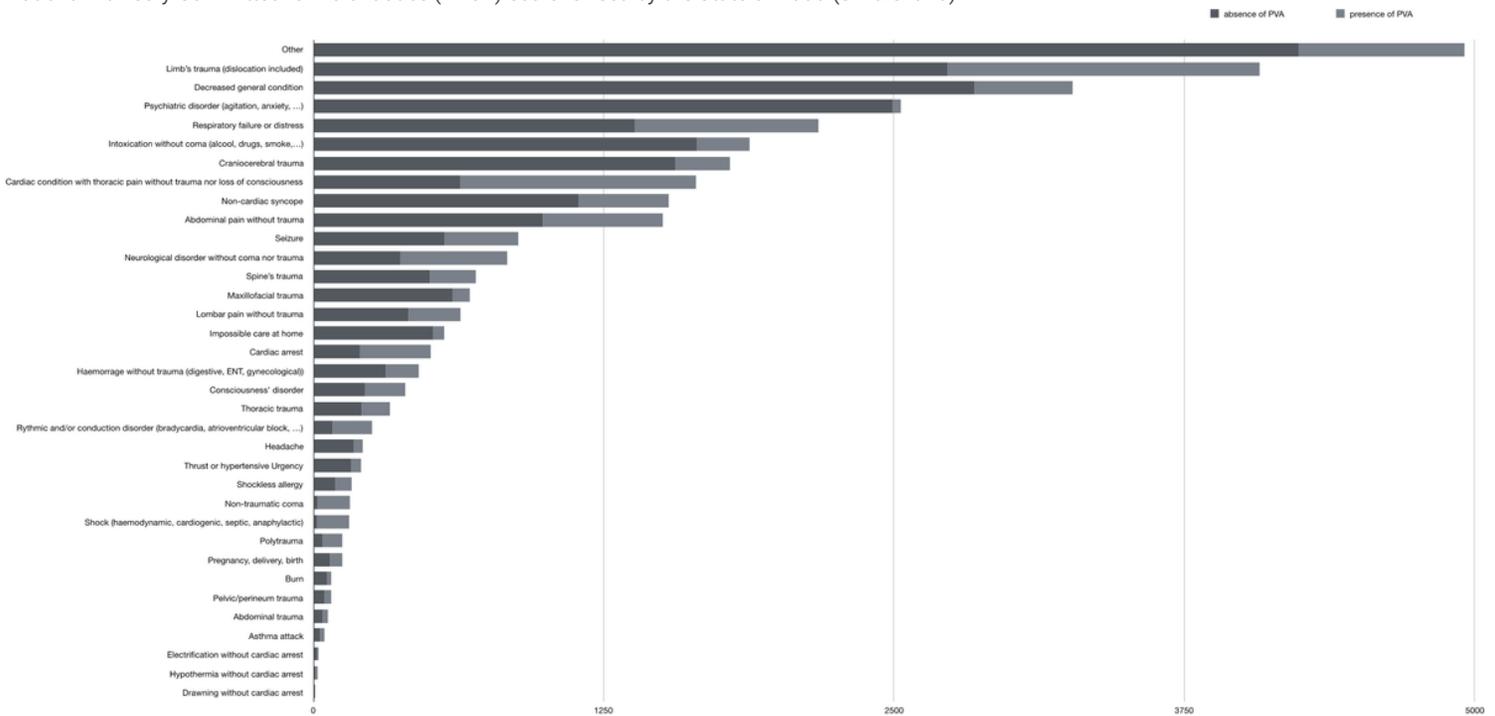


Figure 2

Case-mix with or without peripheral vascular access (PVA)

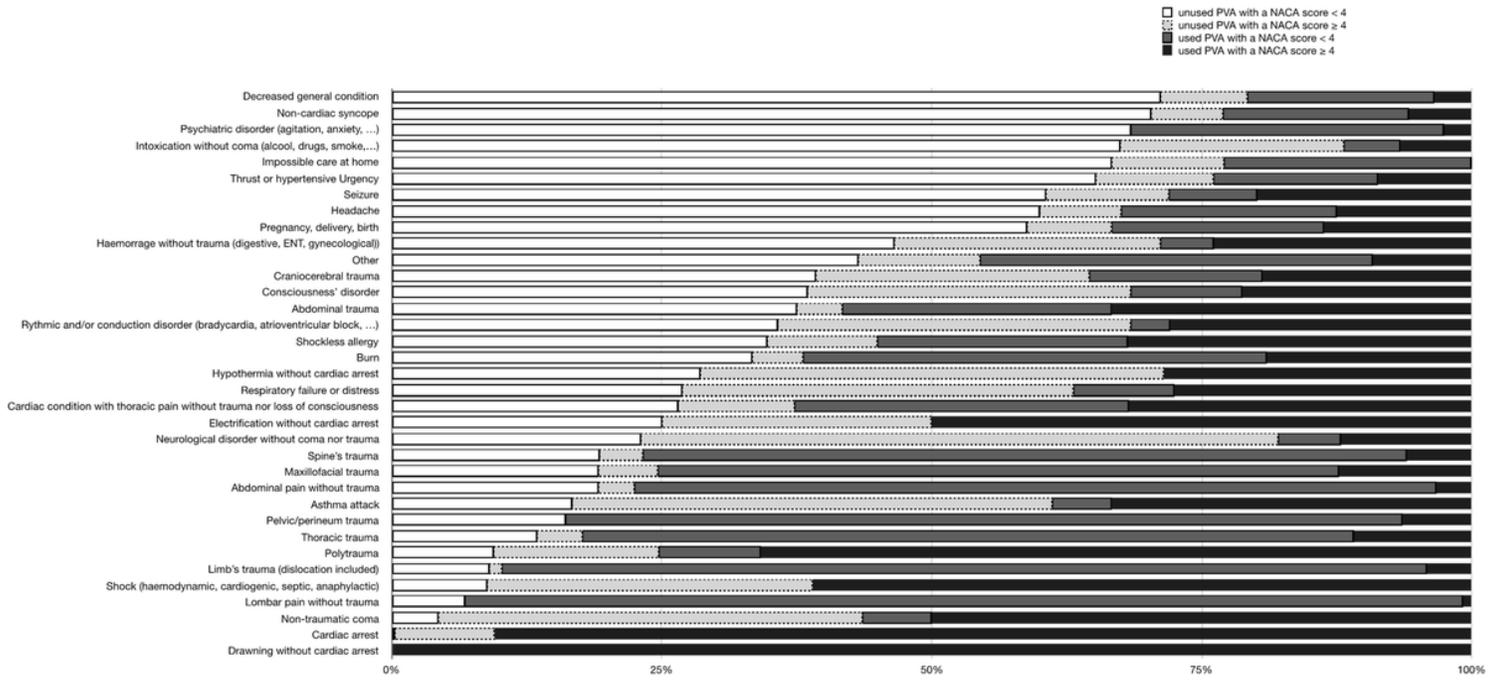


Figure 3

Proportion of patient without/with peripheral vascular access (PVA), used or not, and severity of case

Supplementary Files

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