Critical Care

CORRESPONDENCE

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Short and long-term complications of prehospital arterial catheterisation performed by a Helicopter Emergency Medical Service in the United Kingdom

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In patients with life-threatening physiological derangement, non-invasive blood pressure measurements are often inaccurate and are affected by logistical factors associated with the transfer to the hospital [1]. Prehospital arterial catheterisation and invasive blood pressure monitoring is increasingly being performed by Helicopter Emergency Medical Services (HEMS), however, due to the clinical urgency of device insertion coupled with possibly compromised asepsis, procedures performed in this environment may be at higher risk of complication than those delivered in-hospital [2]. The objective of this study was to report the complication rate of prehospital arterial catheterisation from admission to hospital discharge in patients attended by HEMS in the UK.

The East Anglian Air Ambulance (EAAA) is one of the largest providers of physician-paramedic prehospital critical care in the East of England. Prehospital arterial catheterisation has been performed by EAAA for over ten years, using a 20G arterial catheter (BD Arterial Cannula with Flow Switch, Sandy, UT, USA) for peripheral catheterisation and a 5Fr sheath introducer (MERIT Prelude, MERIT Medical, South Jordan, UT, USA) for femoral artery catheterisation.

This retrospective observational study included adult (≥18-years-old) patients who underwent prehospital arterial catheterisation and were conveyed to the regional major trauma centre (MTC); 01/02/2015–17/04/2023. The primary outcome was to report the complication rate of prehospital arterial catheterisation from admission to discharge. Complications were categorised as infective, vascular, or neurological and were sub-classified as major or minor [3, 4]. The secondary outcome was to report the duration of arterial catheter placement and the association between duration of placement and incidence of complication.

The following data were retrieved from both the EAAA electronic medical record (HEMSbase, Medic One Systems Ltd, UK) and the hospital electronic medical record (Epic Hyperspace Production®, Epic Systems Corporation, Verona, WI, USA): sex; age in years; aetiology (medical or trauma); insertion site; insertion time and date; complications; removal time and date. Notes were reviewed until the date of hospital discharge or death if in-hospital. Characteristics of the sample were described as number (percentage) for categorical variables and median [interquartile range (IQR)] for continuous

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variables. Categorical variables were analysed using Fisher's exact test reported with a Baptista-Pike calculated odds ratio (OR) with 95%CI, and a *p*-value; significance was pre-defined at < 0.05.

During the study period 353 patients were eligible for inclusion. 31 (8.8%) patients were excluded; 322 patients were included in the analysis per-protocol, Fig. 1. The median age was 55 [37–70] years, $n = 218$ (67.7%) were male, and $n = 198$ (61.5%) presented with trauma. The radial artery was the most prevalent insertion site, Table 1.

During the study period there were seven reported complications (2.2%). Four were infective (minor) and three were vascular (one major, two minor). The four minor infective complications were local inflammation around the insertion site, prompting suspicion of superficial infection and catheter removal. The two minor vascular complications were delayed capillary refill and distal colour changes, suggestive of temporary radial artery occlusion. Both complications resolved immediately after catheter removal. The major vascular complication was a complete brachial artery occlusion, requiring fasciotomy and thrombectomy. The median arterial catheter duration of placement was 32.6 [14.8–98.8] hours. Catheter duration ≥ 5 days was associated with increased odds of complications, OR 6.8 (95%CI 1.5–31.4, $p < 0.05$).

In this study, infection was the most prevalent complication. Radial arterial catheters are generally associated with a low rate of major infective complications in critical care settings [3]. Interventions performed prehospital theoretically carry a higher complication rate, owing to the inability to deliver complete asepsis [2]. However, the low-overall rate of infective complications (1.2%) and zero catheter-related bloodstream infections in this study is likely due to robust training mechanisms and high rates of HEMS clinician compliance with aseptic insertion standard operating procedures.

In critical care settings, the duration of catheter placement is the single most important risk factor in the prediction of catheter-related bloodstream infection [4]. The findings of this study support those of previous work, with a significantly increased odds of complications for catheters in-situ ≥ 5 days. Whilst the benefit of routine replacement at five days remains controversial [5], $n = 67$

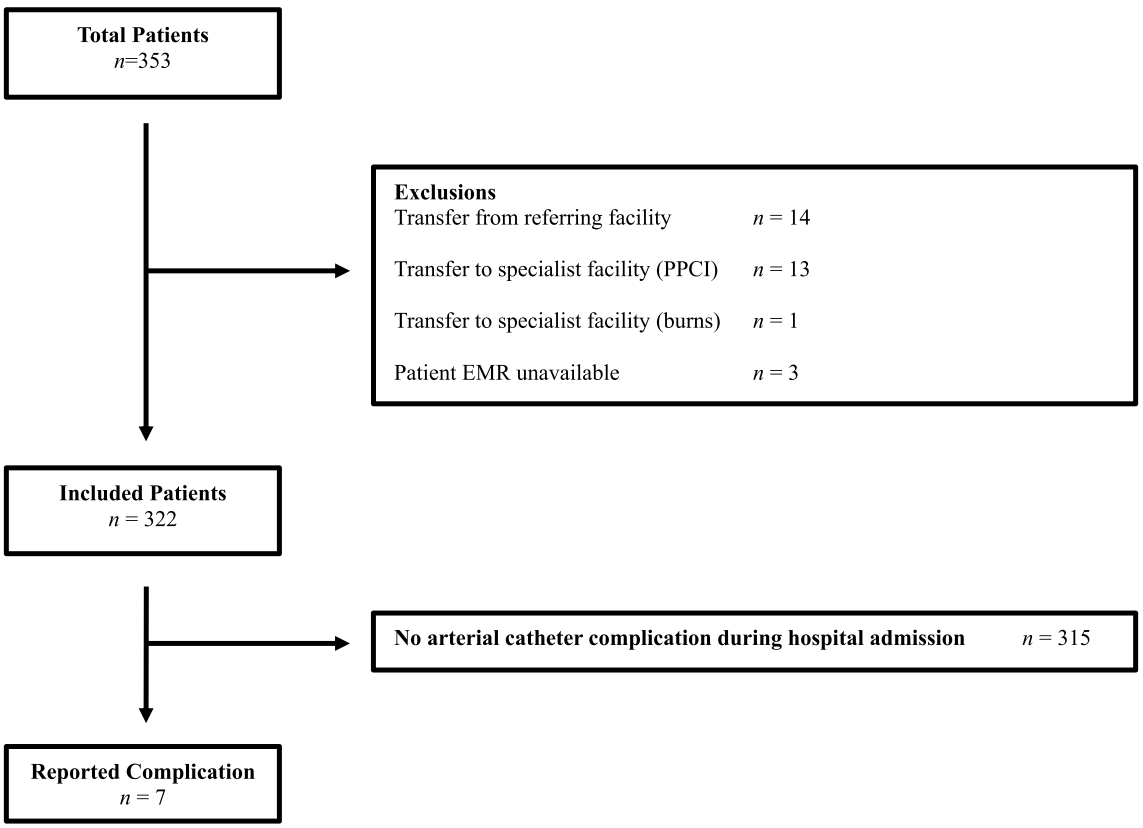

Fig. 1 Study flow diagram of patients undergoing prehospital arterial catheterisation by EAAA and transferred to Cambridge University Hospitals NHS Foundation Trust; 01/02/2015–17/04/2023. EAAA—East Anglian Air Ambulance, MTC—Major Trauma Centre, PPCI—Primary Percutaneous Coronary Intervention, EMR—Electronic Medical Record

Table 1 Baseline characteristics of patients undergoing prehospital arterial catheterisation by EAAA and transferred to Cambridge University Hospitals NHS Foundation Trust; 01/02/2015–17/04/2023

Gender	***n* (%)**
Male	218 (67.7%)
Female	104 (32.3%)
Age	Median [IQR]
Years	55.0 [37.0–70.0]
Aetiology	*n* (%)
Trauma	198 (61.5%)
Medical	124 (38.5%)
Anatomical site of insertion	*n* (%)
Radial artery	276 (85.7%)
Brachial artery	19 (5.9%)
Femoral artery	16 (5.0%)
Not recorded	11 (3.4%)
Complication rate	*n* (%)
Overall	7/322 (2.2%)
Infective	
Major (Catheter-related bloodstream infection confirmed on catheter tip colonisation)	0
Minor (Localised skin erythema or inflammation)	4/322 (1.2%)
Vascular	
Major (Pseudoaneurysm, vessel rupture, compartment syndrome, permanent ischemic damage)	1/322 (0.3%)
Minor (Temporary vessel occlusion, delayed capillary refill time or colour change, minor bleeding)	2/322 (0.6%)
Neurological	0
Complication rate/site of insertion	*n* (%)
Radial artery	6/276 (2.2%)
Brachial artery	1/19 (5.3%)
Femoral artery	0
Duration of catheter placement	
Hours (median [IQR])	32.6 [14.8–98.8]

IQR—interquartile range

(20.8%) of patients in this study had catheter duration of ≥ 5 days with no reports of any major complications.

The limitations of this study include data from only a single HEMS, transporting patients to a single MTC in the East of England. Patients attended by HEMS are the most haemodynamically unstable leading to selection bias of a group of patients at highest risk of catheter-associated complication. Complication data was self-reported by the clinical team and is therefore subject to recall and reporting bias.

This study demonstrates that prehospital arterial catheterisation in critically unwell and injured patients is safe and associated with a low rate of complications. Most complications were minor (1.9%) and associated with superficial skin erythema or temporary radial artery occlusion, with a very low rate of major complications (0.3%).

Abbreviations

EAAA	East Anglian Air Ambulance
HEMS	Helicopter Emergency Medical Services
IQR	Interquartile Range
MTC	Major Trauma Centre
UK	United Kingdom

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Author contributions

The study was conceived by JP and EBGB, with input from ELPWPS. Data acquisition was undertaken by ELPWPS, OH, JP, and EBGB. Data analysis was completed by ELPWPS, OH, and KL. The manuscript was drafted by ELPWPS,

OH, and JP, with critical revisions by RM, PR, and EBGB. All authors have agreed the final version.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study met the UK Health Research Authority definition of service evaluation and was registered locally with EAAA (REF: 2024/09) and the Cambridge University Hospitals NHS Foundation Trust Audit, Quality and Safety Department (PRN 11794).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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