

# It is possible to create a vascular access team in a middle resource country? Experience of Hevi Paediatric Teaching Hospital at DUHOK – IRAQ

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## Abstract

**Background:** Vascular access devices are critically important for the treatment of neonates and paediatric patients. Vascular cannulation is a key clinical skill for healthcare professionals working in the neonatal and paediatric wards. The creation of specialised Teams dedicated to the positioning of Vascular Venous Accesses is increasingly used and of fundamental importance for good patients care. The aim of the study is to evaluate the effectiveness of a training intervention for the staff of the Intensive Care Units for the insertion of the short/long peripheral catheter and to create a NuVa Team (Nurse-led Vascular Access Team).

**Methods:** At the Hevi Paediatric Teaching Hospital, a course and an on-the-job training programme were carried out for two doctors and six nurses on the insertion of the in long peripheral catheters newborns and paediatric patients admitted at the hospital. The data collected were analysed from April 2017 to December 2020. A pre and post-procedure study was designed to determine whether establishing the Nurses Vascular Accesses Team (NuVa) is associated with higher success rates and a reduced risk of catheter-related complications.

**Results:** A total of 271 Leader-cath<sup>TM</sup> catheters were placed during the study period. The mean age at catheters insertion was 2.9 years, the mean residence time was 11.7 days. Most catheters were inserted by five nurses ( $n=216$  (80%)); the remainder was entered by two paediatricians ( $n=55$  (20%)),  $p=0.001$ . General reasons for removal were home discharge ( $n=103$  (38%)), deceases ( $n=81$  (30%)), accidental causes ( $n=43$  (16%)), leg/arm oedema ( $n=21$  (8%)), mechanical problems ( $n=10$  (3.5%)), physician's indication ( $n=9$  (3%)) and skin infection ( $n=4$  (1.5%)),  $p=0.001$ .

**Conclusions:** The standardisation of the procedure for inserting the catheters placement and the creation of a NuVa Team has been of fundamental importance in gaining awareness of the procedure and allows healthcare professionals to insert the catheter without complications.

## Keywords

Long peripheral catheter, short peripheral catheter, vascular access team, training, nursing care, international cooperation, Iraqi Kurdistan

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## Introduction

For decades, veins have been accessed with fine hollow tubes to deliver life-saving fluids and medications directly into the venous circulation<sup>1</sup> and many infants and children require central venous access during an acute or chronic illness.<sup>2</sup> The placement and maintenance of central venous lines are especially difficult in the paediatric population due to small patient size and inability or unwillingness to cooperate with an invasive procedure.<sup>3</sup> Considering the limitation of peripheral venous access (multiple sticks, pain, risk of extravasation), long-lasting venous access has become mandatory in the last three decades to administer safely intravenous complex therapy and improving the quality of care.<sup>4</sup> Short peripheral catheters (SPCs) are peripheral catheter <6 cm and long peripheral catheters (LPCs)<sup>5</sup> are 6–15 cm that are inserted via a catheter-over-needle or direct Seldinger (catheter-over-guidewire) technique.<sup>3,6</sup> Small veins and poor visualisation can make cannulation difficult, and repeated venepunctures are often a source of significant stress in children requiring IV infusions over a prolonged time span.<sup>7</sup> Vascular Access can be associated with several complications such as malfunctions, infections and thrombosis that may lead to prolonged hospitalisations, increased costs and sometimes require the adoption of additional systemic treatments (antibiotics, antifungal, heparin) or the removal of the catheter itself.<sup>8</sup> Venous accesses to a peripheral catheter type insertion have entered paediatric clinical practice especially in more recent times,<sup>9</sup> and specifically only after the advent of the ultrasound-guided technique. Real-time ultrasound guidance for catheter placement has become standard of care, as this approach decreases complications and time to cannulation.<sup>10</sup> Multiple studies have demonstrated significantly increased safety, effectiveness and efficiency of ultrasound-guided vascular access. Although these procedures can have major and minor complications, their success significantly depends on patient anatomy, comorbid conditions and operator skill.<sup>11</sup> The need to create a Team for the positioning of the venous accesses is of fundamental importance to reduce continuous venous cannulation, the reduction of pain and stress in infants and children. The aim of the study is to analyse and evaluate the possibility of creating a vascular access team (NuVal) in a middle resource country.

## Methods

### Study design

A retrospective cohort study was carried out about the new-borns and paediatric patients with Vascular Access at the Hevi Paediatric Teaching Hospital between April 2017 and December 2020.

### Setting

Hevi Paediatric Teaching Hospital have 190 beds: 29 for Intensive Care Units, 111 for the Paediatric Ward, 26 for

Emergency Department and 24 for Surgical Ward. Hevi is the only third-level hospital in the whole province, all patients in critical conditions or in a life-threatening condition are transferred to this hospital (it can be deduced by the fact that about 1 million people depends on the services of this hospital). In 2015 the Paediatric Intensive Care Unit (PICU) with six beds was open, followed by the Neonatal Intensive Care Unit (NICU) with nine beds in June 2017 and the Semi-Intensive Care Unit (SICU) with 10 beds in July 2018.

Two workshops were carrying out in 15th–16th–17th April 2017 and 10th–11th–12nd June 2018 and they were structured in two parts: theoretical and practical. For the first Workshop the participants were two physicians and three College Nurses and for the second one was one Institute Nurses and two College Nurse. The course was based on the international guidelines and protocols for the insertion and management of the LPCs/SPCs. The courses are dividing in 3 days and the total hours was 15. The workshop was called: “Vascular Access Course guided by ultrasound” the theoretical part was performed in all days and the practical part was performed with the chicken breast model in the second day. After the 3 days of the training the staff were monitored and tutored for 2 years training on-the-job during the placement, dressing, management and removal of the catheters. All training and lessons were coordinated by the same clinical supervisor. All the catheter-related information, including current age, disease, date for insertion, catheter name, catheter type, name of punctured vein, failed/successful puncture, category of operators inserted, Fr and cm of the catheter, date and reason for removal and duration of catheter insertion (dwell time).

The Italian Association for Solidarity Among People (AISPO NGO) is specialised in the implementation of international cooperation projects in the health sector, developed and implemented in partnership with the local Directorate General of Health a joint strategy to promote and enhance the critical care of neonatal and paediatric patients through a programme of more than 10 projects carried out over 7 years, funded by Italian Cooperation, WHO and the European Union.

The equipment donated consist of one ultrasound with linear 7-MHz transducer, 800 Leader-cath™ (single lumen) 3 Fr–4 cm, 400 Leader-cath™ (single lumen) 4 Fr–8 cm, 100 Leader-cath™ (single lumen) 4 Fr–10 cm and transparent dressing 10 × 10 cm.

### Participants

The Nurses-led Vascular Access Team (NuVal Team) consists in two paediatrician and six nurses: five College Nurses and one Institute Nurses from Paediatric Intensive Care Unit at Have Paediatric Teaching Hospital. The age mean of the participants was 27 years old and they six females were and two males. All training participants were

educated to international standards and protocols and had 1-year on-the-job training for critically ill newborns and paediatric patients.

Furthermore, for 35 nurses from Intensive Care Units and for 51 nurses from Paediatric Ward was carried out a course and training on-the-job for dressing and management of the Vascular Accesses. Selection criteria of the staff to participate to the training included dedicated training, proven IV insertion expertise, level of interest and motivation, Paediatric Intensive Care Unit experience (1 year), communication and organisational skills and previous performance evaluations.

The Paediatric Intensive Care Unit (PICU) admitted the patients from 31 days to 16 years, the Neonatal Intensive Care Unit (NICU) admitted newborns from 0 days to 30 days and the Semi-Intensive Care Unit and Medical Ward admitted patients from 0 days to 16 years.

The NuVal Team identified patients in need of LPC placement based on patient characteristics (for example: admitted in the ICUs), fluid characteristics and duration of therapy.

All patients who did not need vascular access or all patients whose parents refused the procedure were excluded from the study.

### Methodology of the procedure

The learning technique to carry out the procedure requires the development of specific abilities such as coordination of both hands and eyesight as well as the correct anatomic interpretation revealed through ultrasound.<sup>12,13</sup> Leader-Cath™ in polyethylene is a catheter designed for introduction with the Seldinger method and were utilised for the entire duration of the study period. Before catheter insertion, written informed consent was obtained from the parents of participating children. All Leader-Cath™ were inserted on the bedside of the patients. The catheter sizes were selected according to the calibration of the vein of the patients.

The indication for catheter placement, diameter and cm was established based on individual clinical evaluation and systematic vascular ultrasound evaluation.

In smaller patients or patients with insufficient calibres, the femoral route was preferred, to make the procedure easier for operators.

Maximal sterile barriers and an aseptic insertion technique were standardised by protocol for insertion the Vascular Accesses. There is robust evidence that attention to hygiene, skin preparation, aseptic intervention and catheter aftercare will help to minimise infections for that reason for all the insertion the area of insertion was cleaned with 2% Chlorhexidine.<sup>14</sup> All catheters were inserted with a modified micro-Seldinger technique. Real-time ultrasound was used to guide venepuncture and catheter progression. Multiple studies have consistently confirmed that the utilisation of ultrasound guidance during vascular guidance

significantly reduces major complications.<sup>11,15</sup> A sterile transparent dressing was used to cover the insertion site.

Dressings were changed once every week or whenever there was any curling, damage or contamination to the dressing.

Careful post-procedure management is vital to maintain catheters patency and prevent complications. Catheters were removed after completion of therapy or owing to a complication.

### Statistical analysis

Variables are reported as numbers and percentages, whereas quantitative variables are reported as mean-SD or as median (interquartile range (IQR)) when appropriate.

Normally distributed continuous variables between groups were compared using Student's *t*-test. Dichotomous outcomes were compared by  $\chi^2$  test or Fisher's exact test. Two-sided *p*-values 0.01 were considered statistically significant, and no adjustments were made for multiple comparison

### Results

During the study period, a total 271 catheters (Leader-Cath™) were placed in patients admitted at Hevi Paediatric Teaching Hospital. Catheter placement annually ranged from 42 in 2017, 121 in 2018, 55 in 2019 and 53 in 2020 and the catheters were followed for 3114 days. The mean age of the patients was 2.9 days (median 1, standard deviation (SD)=3.8) and 150 (55%) were males and 121 (45%) were females. Catheter was inserted to 34 (12%) newborns and 237 (88%) paediatric patients. The catheters were put on the bedside 150 (55%) at Paediatric Intensive Care Unit, 43 (16%) at Semi-Intensive Care Unit, 33 (12%) at Neonatal Intensive Care Unit and 45 (17%) at Paediatric Ward, *p*=0.001. Overall, the most prevalent indication of insertion of Vascular Access were respiratory disease (*n*=99 (36.5%)), neurological disease (*n*=76 (28%)), cardiovascular disease (*n*=54 (20%)) and others disease (*n*=42 (15.5%)). Eighth health staff inserted catheters, the majority were inserted by five nurses (*n*=216 (80%)); the remainder were inserted by two paediatricians (*n*=55 (20%)), *p*=0.001 (Table 1). The ultrasound guidance was used during 100% of catheters placement. The majority characteristic of the catheters and the patients side placement were explained in the Table 2. Patients were sedated for catheter placement in 56 (20.5%) of cases and 215 (79.5%) none. The mean dwell time of the catheter were 11.7 days (median 8, SD=11.2). The general reasons of removal were expressed in the Table 3.

### Discussion

This study is the first to report data on the effectiveness of creation a Vascular Access Team for the newborns and

**Table 1.** Characteristics of the health staff inserted the Vascular Accesses.

Insertion category – operators	Year 2017 (n=42)	Year 2018 (n=121)	Year 2019 (n=55)	Year 2020 (n=53)	Total (n=271)	p-Value
Nurse, n (%)	7 (16)	108 (89)	49 (89)	52 (98)	216 (80)	0.001
Doctor, n (%)	35 (83)	13 (11)	6 (11)	1 (1)	55 (20)	

**Table 2.** Catheter characteristic of the midlines inserted at Hevi Paediatric Teaching Hospital.

Variables	Year 2017 (n=42)	Year 2018 (n=121)	Year 2019 (n=55)	Year 2020 (n=53)	Total (n=271)	p-Value
Insertion vein						
Basilic vein (%)	3 (7)	3 (2.5)	0 (0)	0 (0)	6 (2)	0.001
Brachial vein (%)	0 (0)	2 (2)	0 (0)	0 (0)	2 (0.5)	
Jugular vein (%)	1 (2)	14 (11.5)	20 (36)	7 (13)	42 (15.5)	
Femoral vein (%)	38 (91)	102 (84)	35 (64)	46 (87)	221 (82)	
Catheter sizes						
3 French – 4 cm, n (%)	27 (64)	94 (78)	30 (55)	42 (79)	193 (71)	0.01
4 French – 8 cm, n (%)	15 (36)	25 (20)	21 (38)	9 (17)	70 (26)	
4 French – 10 cm, n (%)	0 (0)	2 (2)	4 (7)	2 (4)	8 (3)	

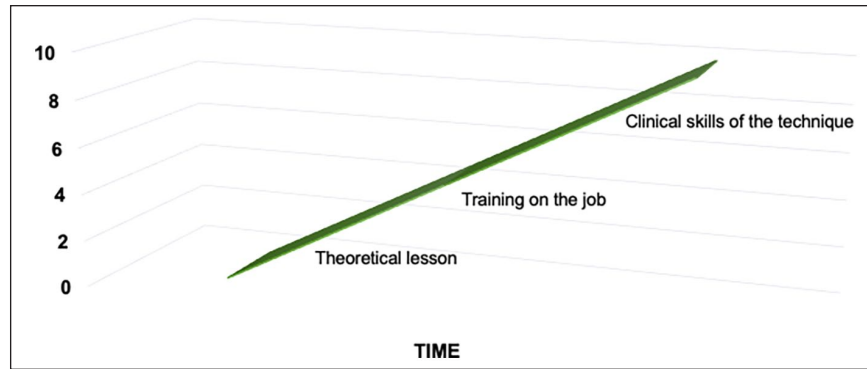
**Table 3.** Cause of removal the midlines at Hevi Paediatric Teaching Hospital.

Cause of removal	Year 2017 (n=42)	Year 2018 (n=121)	Year 2019 (n=55)	Year 2020 (n=53)	Total (n=271)	p-Value
Discharge to home, n (%)	14 (33)	57 (47)	15 (27)	17 (32)	103 (38)	0.001
Deceased, n (%)	13 (31)	38 (31)	20 (36)	10 (19)	81 (30)	
Accidental causes, n (%)	5 (12)	18 (15)	6 (11)	14 (26)	43 (16)	
Oedema of the leg/arm, n (%)	6 (15)	2 (2)	11 (20)	2 (4)	21 (8)	
Mechanical problems, n (%)	4 (9.5)	4 (3)	1 (2)	1 (2)	10 (3.5)	
Physicians' indication, n (%)	0 (0)	0 (0)	2 (4)	7 (13)	9 (3)	
Skin infection, n (%)	0 (0)	2 (2)	0 (0)	2 (4)	4 (1.5)	

paediatric patients in the Kurdistan Region of Iraq. During the course, the simulator with the chicken breast model was used, to create manual skills in the operators and the ultrasound was used in all the procedures. The use of cadaveric animal models can be integrated in the armamentarium of advance simulators in US-guided vascular access, resulting in a low economic cost of personnel training.<sup>16</sup> Nurses were new to catheter insertion technique and acquired skills during training and on-the-job training (Graphic 1). The nurses inserted more catheter compared to the doctors, they became more expert in this procedure and they continued to increasing the number of the patients during the years from 7 to 52. Instead, the physicians decreased the number of insertions, from 35 to 1. The nurses' knowledge regarding the technique of catheter insertion, observing the international protocols and guideline, to avoid possible entry errors, resulting in an ethical care supported professionally in legislation and safety regulations. The training for the staff increased the quality-of-care competences, skills, and knowledge to taking care of patients and they were able to improve their response to

the population health needs. After the long peripheral catheters, it is important to ensure its correct positioning to prevent potentially fatal complications. During the study, no patient had major complications during catheter placement or management. Continual education of health-care workers and parents has been shown to decrease the incidence of catheter-related blood stream infection (CRBSI) in Vascular Access.<sup>17</sup>

Given the context, we tried to cannulate catheters that normally insert into peripheral veins in central veins to make the procedure less difficult for the operator, always trying to cannulate large-calibre veins. The staff was trained for 3 years, the workshop was repeated two times and all the staff of the ICUs and Paediatric ward were training for the manage net of the SPC/LPC. Use of Team has led to an increased adherence to infection control.<sup>9,18</sup> These dedicated nurse Vascular Access Teams receive additional training in anatomy, physiology, and ultrasound techniques and have been associated with improved safety and cost-effectiveness.<sup>19,20</sup> SPC/LPC are an integral part of providing care for hospitalised paediatric patients especial the one



**Graphic 1.** Project Implementation Timing.

admitted at Intensive Care Units<sup>21</sup> majority of the catheters inserted during the study were in the paediatric ICU 150. However, ultrasound visualisation, puncture and cannulation of central veins in neonates and children require more training and it has a longer learning curve than in adults. The use of the SPC/LPC is ideal for paediatric patients but positioning in the arm of the newborn/paediatric patient is only possible in the presence of veins with a diameter of at least 3 mm. During the study, the location of the catheter was decided based on the type of patient, the femoral and internal jugular veins for newborns and infants while, the deep vein of the arm in children and adolescents. The femoral vein was the most cannulated during the study because the deep veins in the arms are too small and practitioners find it difficult to cannulate them even in older children. The femoral cannulation is a commonly used technique for obtaining central access in children.<sup>3</sup> The most important cause of catheter removal is for the discharge of the patients 38% and the lowest cause of the removal was the skin infection 1.5% with a significant statistic relevance. The limits for the study are multiple and different, the number of samples is not high, but this study could be the beginning and the stimulus for new one. Hevi Paediatric Teaching Hospital does not have the possibility to analyse the blood culture, for that reason they were not performed for any case. This project has been implemented thanks to a series of international development cooperation actions.

## Conclusions

The overall feedback from the project was very positive, even in a country with a middle outcome it is possible to create a Vascular Access Team with continuous training and supervision of the international staff. At the beginning of the project all the nurses had difficulty in performing the procedure correctly, especially in the use of the ultrasound system during the venepuncture but, with adequate coaching, they were able to overcome the difficulties. The use of the LPC especially about the reduction of peripheral punctures and therefore pain and stress of the patients, as well

as favouring a safe venous access for the infusion of the prescribed therapy.

Therefore, the Team involved in this study demonstrated knowledge of catheter indication, insertion, handling, maintenance and removal.

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## Declaration of conflicting interests

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## Ethical approval

This study has been developed in accordance with international ethical principles and respect for the confidentiality, and anonymity of participants' data has been guaranteed. Consent to the use of data collected for research purposes has been requested in writing from the Directorate General of Health in Duhok (protocol n. 030322021-2-3/3rd March 2021).

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