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Research Article

Central Venous Access Device Selection and Insertion in Children With Blood Disorders and Cancer: An International Cross-Sectional Survey

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Background: Central venous access devices (CVADs) are crucial for treating children with cancer and blood disorders. However, international variations in CVAD practices may impact patient outcomes. This study aimed to explore current CVAD selection and insertion practices in paediatric cancer care globally.
Methods: An international cross-sectional survey was conducted among clinicians involved in CVAD insertion and management for paediatric cancer patients. Convenience snowball sampling was used with participants invited via established clinical trial networks and other associated networks. The survey explored CVAD selection, insertion techniques, and related practices across economic classifications (high-income vs. other-income [lower middle and higher middle income]).
Results: Of 300 respondents from 42 countries who completed the demographic section of the survey, 220 (73.3%) reported using CVADs in their practice. There were more respondents with no CVAD access in other-income countries ($n = 25$; 21.7%) compared to high-income countries ($n = 8$; 4.3%). PICCs were predominantly inserted by nurses in other-income countries ($n = 30$; 50.9%) versus anaesthetists ($n = 49$; 48%) and radiologists ($n = 48$; 47.1%) in high-income countries. Ultrasound guidance for PICC insertion was used less frequently in other-income countries (45.8% [$n = 27$] vs. 68.6% [$n = 70$]). Device selection generally aligned with guidelines, but variations existed, particularly for long-term use. Skin decontaminant choices also varied, with alternative formulations more common in other income countries.
Conclusions: This survey reveals global disparities in CVAD practices for paediatric cancer care. Resource availability appears to influence device selection, insertion techniques and insertion-related care practices. These findings highlight the need for context-specific guidelines and increased research participation from resource-limited settings to improve global equity in paediatric cancer care.

Keywords: central venous access devices; global health; healthcare disparities; paediatric oncology; vascular access

1. Introduction

Children and young people in their treatment for cancer and other haematological conditions require medium- to long-term venous access to facilitate treatment, supportive therapies and recurrent blood sampling [1]. There is an array of central venous access devices (CVADs) (e.g., totally implanted devices and peripherally inserted central catheters [PICCs]), device characteristics (e.g., lumen number, size and vessel placement) and insertion procedures (e.g., surgical implantation and interventional radiological guidance), available at paediatric cancer care health globally [2]. Although each of these CVAD practices and products has been developed to reduce the risk of significant complications, studies continue to report high rates of overall CVAD complications [1].

Guidelines for CVAD selection and insertion are available for paediatrics and cancer care [3, 4], including recommendations on insertion sites, placement, technologies required for the insertion procedure and prevention of complications [5–9]. However, many individual practice recommendations do not have high-quality evidence [2]. Regional variations in CVAD practice exist due to tradition, opinion and resource availability rather than best practice [10]. Standardisation of CVAD selection and insertion is also challenging as it involves multiple specialities in addition to the primary team. Recognising the global variability in CVAD practice for paediatric cancer care is an initial step towards comprehending the underlying factors of such disparities (e.g., health equity) and addressing specific needs. These interventions can be designed to be both effective and sustainable, ultimately improving outcomes for paediatric cancer patients worldwide [11].

This study aimed to explore the current CVAD selection and insertion practices in paediatric cancer care globally. The objectives of the study were to (1) describe clinical practice globally and (2) compare practices across economic classifications (high-income and other-income countries [lower middle and higher middle income]).

2. Methods

2.1. Study Design. A cross-sectional global survey was undertaken to explore current CVAD-related practices in paediatric cancer care. Respondents were asked if and how CVADs are used in their practice for paediatric cancer care. In this study, the response to the selection and insertion domains were extracted and reported. Findings related to CVAD management and complications are published elsewhere [12]. The study was reported in accordance with the Consensus-based Checklist for Reporting of Survey Studies (CROSS; see Supporting Table 1) [9].

2.2. Participants. Eligible participants were any clinicians who usually insert/manage CVADs in a paediatric cancer setting. The survey used a convenience snowball sampling method and was invited via established clinical trial networks and other associated networks. These included the Australian and New Zealand Children's Haematology and Oncology Group, the Cancer Nurses Society of Australia, the International Society of Paediatric Oncology and the World Congress on Vascular Access. Via an expression of interest pathway from these networks, a translated survey was also opportunistically distributed to Thailand and Brazil, aiming to collect inclusive and representative global responses on CVAD practices, particularly in countries where English is not the primary language. Due to the descriptive nature of the survey, there was no target sample size.

2.3. Survey Questionnaire. The survey questions were developed based on the Infusion Nursing Society (INS) Standards of Practice for Infusion Therapy [4], the American Society of Clinical Oncology [13], the Infectious Diseases Society of America, American Society of Anaesthesiologists [6] and the European Society for Medical Oncology Clinical Practice Guidelines [5]. The first part of the survey reported the demographic characteristics of the participants and the healthcare organisation the respondents represented. If respondents had access to CVADs, they were eligible to continue to the device section of the survey. If not, they were asked what they primarily used for cancer treatment and closed the survey. The device section consisted of five CVAD-related practice domains: selection, insertion, management, removal and complication management. The survey tool was assessed for face validity and feasibility by a small group of paediatric cancer care interdisciplinary clinicians ($n = 4$) prior to distribution [11]. The questionnaire was translated into Brazilian, Portuguese and Thai by vascular access researchers who are native speakers of the language [12].

2.4. Data Collection. The online survey link was distributed to the participants between May 2022 and December 2023. The survey was integrated into the Research Electronic Data CAPture (REDCap; Vanderbilt, USA; https://project-redcap.org/). After obtaining permission to access potential participants from the clinical trials and clinical networks, a brief description, including the research purpose, was provided to potential participants. The team sent the online invitation with the survey link to the potential participants via established networks. It took approximately 1 h to complete the survey. Responders were advised to contact the investigation team via email at any time with questions. A reminder email was sent 2 weeks later to the clinicians who did not participate in the online survey.

2.5. Data Analysis. Data were analysed and visualised using the Stata Statistical Software: Release 15 (College Station, TX: StataCorp LP) and Tableau (Version 2021.1; Tableau, WA). Missing data are described throughout the results' tables; however, due to the descriptive nature of the study, the missing values were not imputed, or weighting was used to account for nonresponse. We used descriptive statistics, including frequencies and percentages, to analyse the survey data. For economic comparisons, countries were categorised according to the World Bank income level classification system [14].

2.6. Ethical Consideration. Ethical approval was obtained from the University of Queensland (# 2023/HE000076). The potential participants were informed about their right not to participate in the survey, and the completed surveys were considered consent. A web-based data management system, REDCap (Vanderbilt), was password protected and only accessible to designated personnel, and no identifiable information was collected.

3. Results

A total of 300 responses were collected for the demographics section, of which 220 (73.3%) respondents had access to CVADs to administer treatment for paediatric cancer care, which made them eligible to continue to the device section of the survey. There were 161 responses ($n = 161/220$; 73.2%) that completed the device section.

3.1. Demographics. Demographic information is presented in Table 1. The responses represented 42 countries (Figure 1). There were 185 respondents (61.7%) from high-income countries and 115 (38.3%) from other-income countries (Supporting Table 2). More than half of the respondents were registered nurses ($n = 118$, 39.3%) and nurse practitioners ($n = 48$, 16.0%). Oncologists ($n = 31$, 10.3%) and anaesthetists ($n = 29$, 9.7%) also responded to this survey. The majority of high-income country respondents had more than 10 years of experience caring for cancer patients ($n = 127$, 68.6%), whereas most other-income country respondents had experience of fewer than 10 years ($n = 72$, 62.6%). For high-income countries, 50.3% ($n = 93$) of the responses were from paediatric hospitals, while 69.6% ($n = 80$) were from mixed hospitals in other-income countries.

3.2. CVAD Availability for Paediatric Cancer Care. Regarding CVAD availability for cancer care, 33 (11.0%) reported not having access to CVADs, with 8 (4.3%) in high-income countries and 25 (21.7%) in other-income countries highlighting variations between income levels. Among those without CVAD access ($n = 33$), 15.2% ($n = 5$) primarily used peripheral intravenous catheters (PIVCs) for cancer treatment, while the majority ($n = 25$; 75.8%) reported unknown alternatives.

3.3. Device Selection and Insertion Practice

3.3.1. Indication. Overall, as presented in Figure 2, the majority of participants chose PICCs when treatment was likely to be less than 3 months ($n = 125$; 77.6%; Supporting Table 3). Totally implanted devices ($n = 106$; 65.8%) followed by tunnelled-cuffed ($n = 85$; 52.8%) were most frequently selected for therapy exceeding 3 months. Totally implanted devices were also preferred for intermittent/episodic therapy ($n = 87$; 54.0%) and treatment for solid tumours ($n = 110$; 68.3%). Tunnelled-cuffed devices were selected for continuous therapy ($n = 88$; 54.7%), and nontunnelled were chosen for high complexity infusion regimens ($n = 92$; 57.1%) and for aphaeresis ($n = 90$; 55.9%). For haematological malignancy, totally implanted devices were the most selected ($n = 86$; 53.4%). There was no apparent variation in device selection between income categories (Supporting Figures 1 and 2, Supporting Tables 4 and 5).

3.3.2. Selection. Selection characteristics of CVADs were reported by device types (Table 2) and by income levels (Supporting Tables 6 and 7). About 60.0% of the respondents answered that they routinely measure the catheter vessel ratio for PICC ($n = 95$, 59.0%), but only one-third answered that they measured the catheter vessel ratio for other CVAD types. When comparing income groups, measurement practices differed: catheter-to-vessel ratio measurement for PICCs was more common in other-income countries ($n = 42$, 71.2%) than that in high-income countries ($n = 53$; 52.0%). The same trend was observed for other types of devices.

A difference between income groups was noticed: About half of professionals (52%) in high-income countries measured the catheter-to-vessel ratio for PICCs, whereas the proportion was higher in other-income countries ($n = 42$, 71.2%). The same trend was observed for other types of devices.

For CVAD material, the majority opted for plain polyurethane for PICCs ($n = 65$; 40.4%), tunnelled noncuffed CVADs ($n = 53$; 32.9%), and totally implanted devices ($n = 51$; 31.7%). Silicone was the most common choice for tunnelled cuffed CVADs ($n = 51$; 31.7%). These trends were observed in both high-income and other-income countries. Differences in CVAD material usage were particularly evident in PICCs, where no one reported the use of antibiotic-coated polyurethane in other-income countries, compared to ($n = 5$; 4.9%) in high-income countries.

3.3.3. Insertion. Almost half of the respondents reported PICCs were inserted by nurses ($n = 77$; 47.8%), followed by anaesthetists ($n = 56$; 34.8%), whereas tunnelled cuffed, noncuffed and totally implanted devices were inserted mainly by surgeons ($n = 115$, 71.4%; $n = 75$, 46.6%; $n = 122$, 75.8%, respectively). When comparing different income countries, the majority of PICCs in other-income countries are inserted by nurses ($n = 30$; 50.9%), followed by surgeons ($n = 18$; 30.5%) and anaesthetists ($n = 7$; 11.9%). In contrast, in high-income countries, PICCs are predominantly inserted by anaesthetists ($n = 49$; 48%), followed by interventional radiologists ($n = 48$, 47.1%) and nurses ($n = 47$; 46.1%).

PICCs were commonly inserted in the basilic ($n = 105$; 65.2%) or brachial vein ($n = 90$; 55.9%), and other types of CVADs were commonly inserted in the internal jugular and subclavian veins. The same trend was observed in the other-

Table 1: Demographics of survey respondents by group of countries classified by income level ($N = 300$).

Questions	Answers	Total n (%)	High-income countries $n = 185$ n (%)	Other-income countries $n = 115$ n (%)
Role of the respondents	Registered nurse	118 (39.3)	86 (46.5)	32 (27.8)
	Nurse practitioner	48 (16.0)	21 (11.4)	27 (23.5)
	Oncologist	31 (10.3)	13 (7.0)	18 (15.7)
	Anaesthetist	29 (9.7)	25 (13.5)	4 (3.5)
	Surgeon	27 (9.0)	8 (4.3)	19 (16.5)
	Interventional radiologist	9 (3.0)	7 (3.8)	2 (1.7)
	Clinical nurse specialist	9 (3.0)	9 (4.9)	0 (0.0)
	Paediatrician	5 (1.7)	2 (1.1)	3 (2.6)
	Registrar in oncology, haematology and/or paediatrics	4 (1.3)	3 (1.6)	1 (0.9)
	Vascular access team	4 (1.3)	3 (1.6)	1 (0.9)
	Haematologist	3 (1.0)	3 (1.6)	0 (0.0)
	Intensivists	3 (1.0)	3 (1.6)	0 (0.0)
	Other (pharmacist, nurse technician, physiotherapist and professor)	4 (1.3)	0 (0.0)	4 (3.5)
	No answer	6 (2.0)	2 (1.1)	4 (3.5)
Years of caring for patients with a cancer diagnosis	< 5 years	53 (17.7)	19 (10.3)	34 (29.6)
	5–9 years	72 (24.0)	34 (18.4)	38 (33.0)
	10–19 years	82 (27.3)	62 (33.5)	20 (17.4)
	Over 20 years	84 (28.0)	65 (35.1)	19 (16.5)
	Unknown	9 (3.0)	5 (2.7)	4 (3.5)
Level of hospital	First-level hospital	25 (8.3)	20 (10.8)	5 (4.4)
	Second-level hospital	30 (10.0)	15 (8.1)	15 (13.0)
	Third-level hospital	234 (78.0)	146 (78.9)	88 (76.5)
	Unknown	11 (3.7)	4 (2.2)	7 (6.1)
Types of hospitals*	Public or governmental	250 (82.2)	167 (90.3)	83 (69.7)
	Private or for-profit	41 (13.5)	14 (7.6)	27 (22.7)
	Unknown	13 (4.3)	4 (2.1)	9 (7.6)
Patient demographic*	Paediatrics only	122 (40.7)	93 (50.3)	29 (25.2)
	Mixed (adults and paediatrics)	168 (56.0)	88 (47.8)	80 (69.6)
	Unsure	10 (3.3)	4 (2.2)	6 (5.2)
Annual number of children with cancer managed at the hospital	< 20	28 (9.3)	20 (10.8)	8 (7.0)
	20–49	22 (7.3)	9 (4.8)	13 (11.3)
	50–99	29 (9.7)	18 (9.7)	11 (9.6)
	100–299	81 (27.0)	57 (30.8)	24 (20.9)
	≥ 300	76 (25.3)	46 (24.9)	30 (23.1)
	Unsure	64 (21.3)	35 (18.9)	29 (25.2)

Table 1: Continued.

Questions	Answers	Total n (%)	High-income countries $n = 185$ n (%)	Other-income countries $n = 115$ n (%)
Access to central venous catheters to administer treatment for paediatric cancer care[a]	Yes	220 (73.3)[a]	144 (77.8)	76 (66.1)
	No	33 (11.0)	8 (4.3)	25 (21.7)
	Unsure	47 (15.7)	33 (17.8)	14 (12.2)
	If not, what do you primarily use for cancer treatment?	$n = 33$	$n = 8$	$n = 25$
	Oral therapy	0 (0.0)	0 (0.0)	0 (0.0)
	Peripheral intravenous catheters	5 (15.2)	2 (25.0)	3 (12.0)
	Others	3 (9.1)	2 (25.0)	1 (4.0)
	Unknown	25 (75.8)	4 (16.0)	21 (84.0)

*Multiple options can be selected.
[a]Only a response of 'yes' to this question moved to the device section of the survey.

Figure 1: Map of survey respondents ($N = 300$).

Indication of CVAD devices ($N = 161$)

Proportion of total

0.0 100.0

Indications	PICC	Tunnelled non-cuffed	Tunnelled cuffed	Non-tunnelled	Totally implanted
Duration of therapy less than 3 months	125	49	27	34	20
Duration of therapy exceeding 3 months	58	33	85	14	106
Intermittent/episodic therapy	65	24	28	21	87
Continuous therapy	64	40	88	19	72
High complexity of infusion regimen	58	44	92	37	34
Aphaeresis	12	13	53	90	13
Bone marrow transplant	33	30	94	24	21
Solid tumours	50	23	66	8	110
Haematological malignancy	59	32	78	12	86
Acute clinical instability of the patient	77	45	20	66	18
Others	2	3	2	2	1

Figure 2: Indication of CVAD ($N = 161$). Abbreviations: CVAD: central venous access device; PICC: peripherally inserted central catheter. Higher to lower proportion is depicted in a darker colour to a lighter colour. See Supporting Table 3 for the full table with proportions and results by income level in Supporting Tables 4 and 5.

income cohort. For all devices, ultrasound/sonography and intra- and postinsertion X-ray were the most common technologies used for CVAD insertion, including tip confirmation. For PICC insertion and tip confirmation, the most commonly used technologies in high-income countries were ultrasound/sonography ($n = 70$, 68.6%), intraoperative X-ray ($n = 52$, 51.0%) and ECG/EKG guidance ($n = 27$, 26.5%), compared to postinsertion X-ray alone ($n = 23$, 22.6%). In other-income countries, PICC insertion verification methods included postinsertion X-ray ($n = 32$; 54.2%), ultrasound/sonography ($n = 27$, 45.8%), intraoperative xX-ray ($n = 19$, 32.2%) and ECG/EKG guidance ($n = 10$, 17.0%).

3.3.4. Pain and Sedation Management. Procedural sedation was most commonly used for inserting PICCs ($n = 76$, 47.2%), and general anaesthesia was preferred for other CVADs, for tunnelled noncuffed ($n = 85$, 52.8%), for tunnelled cuffed ($n = 106$, 65.8%) and for totally implanted devices ($n = 116$, 72.1%). This trend remained consistent when comparing high-income countries with other-income countries. However, the utilisation of general anaesthesia was significantly lower in other-income countries ($n = 10$; 17.0%) than that in high-income countries ($n = 54$; 52.9%).

3.3.5. Skin Decontaminants. The most utilised skin decontaminant across all devices was chlorhexidine 2% in 70% alcohol. However, in other-income countries, alternative formulations were used, including chlorhexidine 2% in alcohol and chlorhexidine 0.5% in alcohol without specified alcohol concentrations.

3.3.6. CVAD Selection and PICC Design. The treating team and proceduralist were the most common decision-makers for device selection across all CVADs (Supporting Table 8). Survey responses showed that power-injectable PICCs were most commonly chosen in high-income countries ($n = 66$; 64.7%), while in other-income countries, 37.3% had access to power-injectable PICCs ($n = 22$). PICCs with external clamps were reported by 40.2% ($n = 41$) of respondents in high-income countries and 37.3% ($n = 22$) in other-income countries. PICCs with internal valves were used less frequently than PICCs with external clamps in both settings (high-income: $n = 25$, 24.5%; other-income: $n = 11$, 18.6%; Supporting Table 9).

3.3.7. Catheter Tip Position. The CVAD tip location goal for upper extremity devices was the cavoatrial junction ($n = 94$;

Table 2: Selection characteristics of CVADs by device type ($n = 161$).

Questions	Options	PICC n (%)	Tunnelled, noncuffed n (%)	Tunnelled, cuffed n (%)	Totally implanted device (port) n (%)
Do you routinely measure the catheter vessel ratio?	Yes	95 (59.0)	54 (33.5)	50 (31.1)	48 (29.8)
	No	30 (18.6)	46 (28.6)	50 (31.1)	56 (34.8)
	Unsure/unknown	36 (22.3)	61 (37.9)	61 (37.9)	42 (26.1)
What is the commonly chosen CVAD material?*	Silicone	29 (18.0)	12 (7.5)	51 (31.7)	39 (24.2)
	Plain polyurethane	65 (40.4)	53 (32.9)	34 (21.1)	51 (31.7)
	Antithrombogenic polyurethane	24 (14.9)	15 (9.3)	12 (7.5)	12 (7.5)
	Antibiotic-coated polyurethane	5 (3.1)	10 (6.2)	4 (2.5)	8 (4.4)
	Antiseptic-coated polyurethane	7 (4.4)	9 (5.6)	5 (3.1)	6 (3.7)
	Others	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Unsure/unknown	42 (26.1)	48 (29.8)	51 (31.7)	52 (32.7)
Who inserts CVAD at your site?*	Anaesthetists	56 (34.8)	57 (35.4)	30 (18.6)	24 (14.9)
	Surgeons	35 (21.7)	75 (46.6)	115 (71.4)	122 (75.8)
	Interventional radiologists	55 (34.2)	42 (26.1)	53 (32.9)	47 (29.2)
	Consultants and treating team	6 (3.7)	11 (6.8)	2 (1.2)	1 (0.6)
	Nurses	77 (47.8)	13 (8.1)	5 (3.1)	4 (2.5)
	Others	2 (1.2)	1 (0.6)	0 (0.0)	0 (0.0)
	Unknown/unsure	2 (1.2)	3 (1.9)	3 (1.9)	2 (1.2)
Where do you commonly insert the CVADs at your site?*	Internal jugular vein	14 (8.7)	89 (55.3)	92 (57.1)	89 (55.3)
	Subclavian vein	5 (3.1)	59 (36.7)	77 (47.8)	76 (47.2)
	Femoral vein	7 (4.4)	28 (17.4)	9 (5.6)	5 (3.1)
	Basilic vein	105 (65.2)	8 (5.0)	1 (0.6)	6 (3.7)
	Brachial vein	90 (55.9)	4 (2.5)	4 (2.5)	5 (3.1)
	Cephalic vein	46 (28.6)	2 (1.2)	0 (0.0)	2 (1.2)
	Brachiocephalic vein	2 (1.2)	6 (3.7)	6 (3.7)	5 (3.1)
	Saphenous	4 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)
	Others	4 (2.5)	1 (0.6)	3 (1.9)	2 (1.2)
	Unknown/unsure	12 (7.5)	18 (11.2)	17 (10.6)	14 (8.7)
What technology is used for CVAD insertion (including tip confirmation)?*	Ultrasound/sonography	97 (60.3)	70 (43.5)	66 (41.0)	67 (41.6)
	Intraoperative X-ray (including final tip position and fluoroscopy)	71 (44.1)	74 (46.0)	95 (59.0)	106 (65.8)
	Postinsertion X-ray (after the patient has left the procedure room)	55 (34.2)	47 (29.2)	41 (25.5)	43 (26.7)
	ECG/EKG guidance	37 (23.0)	18 (11.2)	14 (8.7)	16 (9.9)
	Others	3 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)
	Unsure/unknown	21 (13.0)	25 (15.5)	21 (13.0)	21 (13.0)

Table 2: Continued.

Questions	Options	PICC n (%)	Tunnelled, noncuffed n (%)	Tunnelled, cuffed n (%)	Totally implanted device (port) n (%)
Which pain and sedation management are commonly administered to support CVAD insertion?*	Topical anaesthetics	65 (40.4)	16 (9.9)	13 (8.1)	15 (9.3)
	Intradermal lidocaine	67 (41.6)	38 (23.6)	39 (24.2)	39 (24.2)
	Behavioural interventions (distraction, relaxation)	59 (36.7)	12 (7.5)	9 (5.6)	12 (7.5)
	Procedural sedation	76 (47.2)	42 (26.1)	35 (21.7)	31 (19.3)
	General anaesthetics	64 (39.8)	85 (52.8)	106 (65.8)	116 (72.1)
	LA under GA	0 (0.0)	2 (1.2)	2 (1.2)	3 (1.9)
	Others	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
	Unsure/unknown	12 (7.5)	14 (8.7)	10 (6.2)	9 (5.6)
Which skin decontaminant is routinely used for CVAD insertion?*	Chlorhexidine 2% in 70% alcohol	99 (61.5)	88 (54.7)	88 (54.7)	87 (54.0)
	Chlorhexidine 0.5% in 70% alcohol	27 (16.8)	22 (13.7)	24 (14.9)	24 (14.9)
	Povidone–iodine in alcohol^	17 (10.6)	16 (9.9)	17 (10.6)	18 (11.2)
	Povidone–iodine without alcohol^	7 (4.4)	8 (5.0)	10 (6.2)	12 (7.5)
	Chlorhexidine 2% in alcohol^	8 (5.0)	6 (3.7)	6 (3.7)	8 (5.0)
	Chlorhexidine 0.5% in alcohol^	7 (4.4)	6 (3.7)	7 (4.4)	7 (4.4)
	Others	1 (0.6)	1 (0.6)	4 (2.5)	1 (0.6)
	Unknown/unsure	19 (11.8)	20 (12.4)	19 (11.8)	19 (11.8)

Abbreviations: CVAD, central venous access device; GA, general anaesthetics; LA, local anaesthetics; PICC, peripherally inserted central catheter.
*Multiple options could be selected.
^With unspecified alcohol concentration.

Table 3: Position of CVADs* ($n = 161$).

	Superior vena cava (upper third)	Superior vena cava (mid-third	Superior vena cava (lower third)	Cavoatrial junction	Right atrium	Unknown/unsure
Where is the goal CVAD tip location for upper extremity devices in your practice?^	10 (6.2)	6 (3.7)	57 (35.4)	94 (58.4)	18 (11.2)	18 (11.2)
If the CVAD is functioning (aspirating, injecting), which position would require the CVAD tip to be modified/exchanged/replaced?^	51 (31.7)	14 (8.7)	9 (5.6)	20 (12.4)	59 (36.7)	32 (19.9)
If the CVAD has a poor function (not aspirating), which position would require the CVAD tip to be modified/exchanged/replaced?^	79 (49.1)	47 (29.2)	36 (22.4)	36 (22.4)	64 (39.8)	29 (18.0)

Abbreviation: CVAD, central venous access device.
*Data reflect upper extremity devices.
^Multiple options could be selected.

58.4%; Table 3 and Supporting Tables 10-11). If the CVAD was still functioning, clinicians considered it necessary to modify or replace the CVAD tip if it was positioned in the right atrium ($n = 59$; 36.7%) or the upper superior vena cava ($n = 51$; 31.7%). If the CVAD is dysfunctional (e.g., not aspirating), half of the respondents selected that the CVAD tip position should be modified/replaced/exchanged if it was in the upper superior vena cava ($n = 79$; 49.1%).

4. Discussion

This international survey provides valuable insights into the current practices of CVAD selection and insertion in paediatric cancer care. The findings highlight several key areas of focus: inequity in CVAD practices, variability in practice and adherence to guidelines, workforce considerations and recommendations for guideline development.

Our survey reveals significant variations in clinical practices between economic classifications. In other-income countries, one-in-five respondents reported no access to CVADs for paediatric cancer care, versus one in 20 in high-income countries. Instead, these countries rely on administrating anticancer and supportive therapies via peripheral devices and oral therapies [11]. This limits the breadth and intensity of treatment options for these children, resulting in reduced survival [11]. A narrative review of paediatric oncology disparities highlighted the urgent need to understand these inequities and inform efforts for high-quality care to achieve equitable outcomes [11].

Indications for CVAD types were similar across income levels, but the availability and use of advanced insertion technologies varied. The results draw attention to these practices and the preventable sequelae of their absence, as ultrasound-guided CVAD insertion techniques are associated with reductions in insertion failure and arterial puncture [15–17]. Resource-limited settings often default to available options rather than the most appropriate device. This impacts clinical decision-making in low- and middle-income countries, potentially worsening paediatric cancer inequities through increased CVAD-associated complications such as bloodstream infections and thrombosis [18].

The survey results indicate variability in CVAD practices, both globally and in terms of existing guidelines and high-quality evidence [3]. An example of this was using skin decontaminants to prevent CVAD-associated infections. While chlorhexidine 2% in 70% alcohol was the most commonly used across all devices, there are considerable reports of povidone–iodine use. However, data from both RCT and meta-analysis recommend 2% chlorhexidine in 70% alcohol over other antiseptic solutions [16, 19]. In addition, there were significant differences in the use of alternative formulations in other-income countries, likely due to differences in availability, cost and/or local guidelines [20]. Pain and sedation management was less utilised in other-income countries, suggesting potential under-performance in this crucial aspect of insertion [17].

Survey results showed varied workforce patterns for CVAD insertion. Half of PICCs were inserted by nurses in other-income countries, whereas anaesthetists and interventional radiologists were more commonly involved in PICC insertion in high-income countries. The prominent role of nurses in PICC insertion in other-income countries is consistent with trends observed in other studies [21], which have shown that nurse-led PICC insertion can be safe and effective when supported by appropriate training and protocols [22]. These patterns likely reflect traditional practices and resource availability rather than evidence-based guidelines.

4.1. Limitations. This study has several limitations that should be considered when interpreting the results. Convenience sampling and self-reporting may have introduced bias, limiting accuracy and generalisability. However, the survey was distributed using well-recognised professional organisations across the globe, with anonymity provided. Language barriers may have affected response accuracy where native translations were unavailable. Our study's limited representation from low and lower-middle income countries highlights a significant research gap and emphasises the urgent need for more studies focused on CVAD practices in resource-limited settings, where challenges and solutions may differ substantially from high-income contexts. This initiative has the potential to promote equitable advancements in CVAD practices on a global scale. Additional limitations included survey design constraints, such as not including femoral inserted central catheter (FICC) tip position options, which restricted our ability to comprehensively assess all CVAD positions. Finally, the cross-sectional nature of the survey provides only a snapshot of practices at a single point in time, not changes over time or responses to evolving evidence. Future studies should monitor evolving CVAD practices globally and evaluate quality improvement initiatives across diverse economic settings. Increased research participation from resource-limited settings is essential for developing guidelines that are both globally applicable and locally adaptable, ultimately helping reduce disparities in paediatric cancer care outcomes.

5. Conclusions

This survey highlights the global disparities and variabilities in CVAD practices for paediatric cancer care. By assessing the current state, we can better plan, implement and evaluate future paediatric cancer care CVAD research priorities and educational strategies to enhance patient safety and care experience. Patient preferences for device characteristics and placement must be considered, as some devices limit physical activity (e.g., PICCs with water-based activities), and care procedures involve exposure of personal spaces (e.g., chest for people with breast tissue).

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. *(Supporting Information)*

Supporting Information provide additional detailed information supporting the main findings. Supporting Table 1 presents the Checklist for Reporting Of Survey Studies (CROSS) compliance checklist. Supporting Table 2 lists participating countries categorised by World Bank economic classification. Supporting Tables 3, 4 and 5 and Supporting Figures 1 and 2 provide detailed breakdown of CVAD indications across all countries and stratified by income levels. Supporting Tables 6 and 7 present comprehensive selection characteristics of different CVAD types by income classification, including catheter-vessel ratio measurement, material selection, insertion personnel, anatomical sites, technologies used, pain management approaches and skin decontaminants. Supporting Tables 8, 9, 10 and 11 detail decision-making processes in device selection, popular PICC designs and goal tip positioning practices across different economic settings.

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