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ORIGINAL ARTICLE

Road map for improvement: Point prevalence audit and survey of central venous access devices in paediatric acute care

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Aim: To identify the prevalence, management and complications associated with central venous access devices (CVADs) within Australian paediatric facilities, providing a map for clinicians, researchers and managers to focus solutions.

Methods: A point prevalence audit and survey of CVAD practices in Australian tertiary paediatric hospitals between September and November 2015, using validated data collection tools.

Results: Across the six sites, 1027 patients were screened with CVADs prevalent in 26.1% (n = 268), and 261 CVADs in 248 patients available for audit. Variations in management were evident with dressings not meeting the basic criteria of clean, dry and intact for 13.5% of CVADs (n = 35), and non-sterile dressings used to reinforce 26.4% of CVADs (n = 69). Almost half of CVADs (49.4%; n = 132) had no documentation regarding site assessment in the previous 4 h, and 13.4% had no planned use in the next 24 h (35 CVAD).

CVAD-associated complications within the previous 7 days were evident in 9.5% of CVADs (n = 27), most commonly catheter blockage (5.7% CVAD, n = 15), and bloodstream infection (1.9% CVAD, n = 5). Peripherally inserted central catheters (16.9%) in comparison to other catheter types (7.4%; P = 0.04), and subsequent CVADs (14.1%) in comparison to initial CVADs (6.5%; P = 0.04), had significantly higher proportions of CVAD-associated complications in the previous 7 days. Variation between the sites' guidelines was evident across many practices.

Conclusions: CVADs are prevalent and essential for paediatric health care; however, complications remain a significant problem. Areas identified for improvement were local CVAD guidelines, regular documentation of CVAD site assessment and review of dressing products to improve integrity.

Key words: audit; central venous catheter; evidence-based care; paediatrics; quality care; survey.

What is already known on this topic

1 One in four central venous access devices (CVADs) in paediatrics fail prior to completion of treatment.
2 Evidence-based strategies have been developed to reduce complications associated with CVAD, but it is not known whether they are consistently applied to the paediatric acute care setting.
3 Audits and benchmarking of practice are necessary to drive improvement strategies and inform the development of interventional studies.

What this paper adds

1 One quarter of children admitted to paediatric acute care settings have a CVAD *in situ*.
2 Several elements of paediatric CVAD management need improvement, including poor CVAD dressing integrity. Currently 13.5% of children audited did not have a clean, dry and intact dressing, and over a quarter were reinforced by non-sterile dressing products.
3 Clear, consistent clinical practice guidelines for the management of paediatric CVADs are necessary.

Central venous access devices (CVADs) are commonly inserted into large veins in the upper or lower limb, chest, neck or groin to provide access to the greater vascular system. Within paediatrics, CVADs are used for a variety of health conditions, including temporary administration of vesicant inotropes during critical illness, and for prolonged administration of nutrition for the chronically ill. Despite their necessity, one in four CVADs in paediatrics fail prior to completion of therapy due to infectious and

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mechanical complication, causing significant patient and health-care costs.[1]

Infectious complications of CVADs involve bacterial or fungal infection of the local site (e.g. exit site or tunnel) or bloodstream. CVAD-associated bloodstream infections are associated with high health-care costs, morbidity and mortality, and have been highlighted as a priority area by international health-care institutions including the World Health Organization.[2] Mechanical complications include accidental catheter dislodgement, catheter breakage venous thrombosis and catheter occlusion. Each complication results in an immediate interruption to prescribed treatment,[3,4] potentially delaying recovery, and frequently results in the insertion of a replacement vascular access device. Many CVAD-associated complications and failure are considered as preventable causes of patient harm.[5,6]

CVAD management is complex and many different multidisciplinary clinicians are involved in their care. Strategies have been developed to reduce preventable causes of CVAD complication and failure. This includes the use of chlorhexidine gluconate-impregnated dressing products,[7,8] needleless connectors,[9,10] regular site assessments,[9,10] administration set changes[11,12] and the prompt removal of redundant devices.[9,10,13] However, the translation of this evidence to the bedside is challenging. Previous surveys have reported that aspects of CVAD management are frequently not based upon evidence.[5,14–16] But these surveys are based upon reported practices from management representatives, and may not be indicative of the actual care that patients are receiving.

Audits and benchmarking of actual practice are necessary in order to drive improvement strategies, and inform the development of interventional studies.[17] Undertaking surveillance audits to identify clinical practice issues has been demonstrated as effective for improving health-care outcomes including health-care-associated infection,[17–19] providing a map for clinicians, researchers and managers to use in focusing on solutions and strategies. This prevalence study aimed to examine paediatric CVAD management practices in paediatric care by:

1 Identifying the prevalence of CVADs, CVAD characteristics and utility in Australian paediatric hospitals.
2 Identifying current clinical management for CVADs in Australian paediatric hospitals.
3 Describing the current incidence of complications in the past 7 days for CVADs in place in Australian paediatric hospitals.
4 Identifying clinical and CVAD characteristics associated with recent CVAD complication.
5 Describing the local guidelines and resources available to support CVAD management across Australian paediatric facilities.

Methods

Design

A point prevalence audit and survey of CVAD practices were conducted throughout tertiary paediatric hospitals in Australia between September and November 2015. The study included six hospitals: the Royal Children's Hospital (Melbourne); Sydney Children's Hospital (Randwick); Lady Cilento Children's Hospital (Brisbane), Princess Margaret Hospital (Perth); Women's and Children's Hospital (Adelaide); and the Gold Coast University Hospital (Gold Coast).

Setting and sample

All patients admitted as inpatients in tertiary paediatric hospitals in Australia at the time of the study were invited to participate in the point prevalence audit, and senior clinical representatives provided additional whole of site information via survey. For the point prevalence audit, all patients admitted to the hospital (with or without CVAD) on the study day were counted, to provide a denominator for the audit. Extensive data collection was undertaken for paediatric patients (<18 years) with CVAD in situ (including peripherally inserted central catheters (PICCs), haemodialysis catheters, non-tunnelled percutaneous CVADs, tunnelled CVADs, umbilical catheters and totally implantable CVAD), with a legal guardian and/or patient giving verbal or written consent. All other vascular access devices (e.g. peripheral or arterial catheters) were not included.

Data collection tools

The point prevalence audit data collection tool was originally designed and trialled by Russell *et al.*[17] New *et al.*,[20] with variables added by Alexandrou,[21] and optimised for the paediatric population. The tool included information regarding the CVAD types, health professional type who inserted the CVAD, use of dressing and securement products, site assessment, documentation and presence of CVAD-associated complications in the last 7 days. CVAD-associated complication definitions were in accordance with benchmark literature,[1] and included: CVAD-associated bloodstream infection;[22] local site infection;[22] dislodgement;[23] occlusion;[23] thrombosis[23] and CVAD breakage.[23] Patient demographic data were also collected. The described information was collected from a combination of clinical examination, conversation with patients (where feasible), family members, and clinical staff, as well as review of bedside charts, patient charts and electronic records.

Information regarding local management policies and guidelines at each site was also collected, using compilations and variations of the surveys previously developed by Ullman *et al.*,[5] Rickard *et al.*[15] and Alexandrou.[21] This includes CVAD-associated supplies provided by the hospital and hospital-wide policies in regards to frequency of CVAD maintenance procedures.

Content validity, feasibility and inter-rater reliability

To ensure the tools' completeness, accuracy and practical utility,[24] prior to use both data collection tools were assessed for content validity and the point prevalence audit tool was assessed for feasibility and inter-rater reliability. Content validity was achieved by a review of the surveys' items by five experts in paediatrics, vascular access and/or evidence-based practice. Feedback was provided using a four-point level of agreement surrounding the relevance of individual audit criteria, and the appropriateness of the answer responses. A Scale Content Validity Index (S-CVI)[25,26] was calculated to represent the proportion of items on the instrument that achieved a rating of high or quite relevant by all content experts. Experts also recommended whether to delete an item, major revision, minor revision or keep an item as is.

Overall, the experts found all audit and survey criteria to be highly relevant (S-CVI = 100% audit; 100% survey), the answer responses appropriate (S-CVI = 93.3% audit; 95% survey), with minor improvements recommended for seven audit items (23.3%) and three survey items (15%) with no improvements

needed. This feedback was then used to revise and strengthen the data collection tool.

Feasibility and inter-rater reliability testing of the audit data collection tool were performed by piloting the tool at one of the hospital sites. Three pairs of clinicians sequentially and independently audited three ward areas using the data collection sheets. These paired, completed sheets were then compared, and the data was then used to compute an index of agreement between the observers to ensure internal consistency.[27–29] A high level of agreement between the raters was found, with a Cohen k of 0.87 ($P < 0.001$, 95% confidence interval 0.78, 0.96).[29] Overall, the six clinicians reported that it took 15–20 min to complete the audit per participant, the data were readily available for the majority of participants, and the terminology used was well-defined and easy to understand.[30]

Process

Each hospital site identified an appropriate day to audit, in accordance with local hospital requirements and resourcing. Education and familiarisation with the data collection tool was undertaken prior to the study day. On the day of data collection, the site investigator and team screened all patients admitted to the study site, and audited all patients with a CVAD, including informed consent where required. A senior vascular access or infection control clinician was identified at each site and completed the site survey within a month of the audit. Both the point prevalence and survey data collection sheets were then scanned and emailed to the study coordinator, for central database entry.

Data analysis

Continuous variables are described as mean, median, standard deviation and interquartile range values. Categorical data are described using frequencies and percentages. Results are reported per device, per patient or per survey respondent as appropriate. Associations between failure and clinical or device characteristics were assessed using Fisher's exact test, χ^2 and Mann–Whitney U tests, as appropriate for sample size, distribution and data. Variables with a $P < 0.05$ were considered significant. Data were analysed using PASW 22.0 (SPSS Inc, Chicago, IL, USA). Missing data are described throughout the results tables.

Ethics

Prior to study commencement ethical approval was gained through the Griffith University, Human Research Ethics Committee, and the participating sites, as required. Consent for participation in the study was achieved via written or verbal consent by the legal guardian and child (if developmentally appropriate), depending upon local institutional and ethics requirements.

Results

Point prevalence audit

Across the six sites, 1027 patients were screened, with CVAD prevalent in 26.1% of patients ($n = 268$), and peripheral intravenous catheters in 47.5% of patients ($n = 488$). Twenty patients with CVADs could not be included in further data collection, as either consent was refused or legal guardians were not available to provide consent. Twelve patients had more than one CVAD (25 CVADs; 4.2% of patients with CVADs). A total of 261 CVADs, in 248 patients, were audited.

Participant and CVAD characteristics

As described in Table 1, the majority of patients had a single CVAD (95.2%; 236 CVADs), with the most prevalent being tunnelled, cuffed CVADs (32.6%; 85 CVADs) and totally implanted devices (25.7%; 69 CVADs), commonly placed in the internal jugular (44.1%; 115 CVADs). The majority were inserted for two or more clinical indications (65.0%; 169 CVADs) including vesicant medication (57.5%; 150 CVADs) and/or fluid therapy (43.3%; 113 CVADs). Over a third of CVADs were subsequent devices, replacing or adding to a previous or existing CVAD (37.9%; 99 CVADs).

CVAD management and utility

There was a large variation in the type of primary dressing and securement products in use, and 13.5% of CVAD dressings did not meet the basic criteria of clean, dry and intact ($n = 35$) (see Table 2). Non-sterile dressing products used to reinforce 26.4% of CVADs ($n = 69$). The majority of CVADs had two or more dressing and securement products applied (69%; 180 CVADs), with many having four or five products in use simultaneously (8.4%; 22 CVADs). Chlorhexidine-impregnated dressing products were only used in 16.7% of CVADs in intensive care ($n = 7$).

Inconsistency was evident in other management characteristics including flushing, needleless access connector types and documentation of site assessment. Over 13% of CVADs had no prescribed fluid or medications in the next 24 h (13.4%; 35 CVADs). Of these 35 unused CVADs, 31.4% were temporary (eight PICCs; two non-tunnelled, percutaneous CVADs; one haemodialysis catheter) and 68.6 % were more permanent devices (15 totally implanted devices; 9 tunnelled, cuffed CVADs).

CVAD complications

CVAD-associated complications in the last 7 days were evident in 9.6% of CVADs ($n = 25$) with the most frequent complications being catheter blockage (5.7% CVAD, $n = 15$) and bloodstream infection (1.9% CVAD, $n = 5$) (see Table 3). Local site complications were evident in 10.3% of CVAD ($n = 27$), most frequently bruising (5.0% CVAD, $n = 13$), and redness extending >1 cm from the insertion site (1.9% CVAD, $n = 5$).

As described in Table 4, PICCs had a higher proportion of complication in the previous 7 days (16.9%), than other CVAD types (7.4%; χ^2 4.78; $P = 0.04$). Subsequent CVADs also had a higher proportion of complication in the previous 7 days (14.1%), than initial CVADs (6.5%; χ^2 4.11; $P = 0.04$). No other clinical or CVAD characteristics were significantly associated with the frequency of CVAD complication in the previous 7 days.

Survey of CVAD management practices

Local CVAD guidelines

All surveyed hospitals had CVAD maintenance guidelines for staff, with one hospital having separate guidelines for the neonatal and paediatric areas, respectively. The breadth and content of the guidelines varied extensively between sites, most notably in

Table 1 Point prevalence audit: Participant and central venous access device (CVAD) characteristics

		n (%)
Prevalence (*n* = 1027)		
Overall	CVAD	268 (26.1)
	Peripheral intravenous device	488 (47.5)
Hospital	Royal Children's Hospital, Melbourne	86 (30.9)
	Lady Cilento Children's Hospital, Brisbane	65 (31.7)
	Princess Margaret Hospital, Perth	46 (25.3)
	Sydney Children's Hospital, Randwick	45 (34.1)
	Women's and Children's Hospital, Adelaide	35 (22.0)
	Gold Coast University Hospital	7 (10.0)
Participant (*n* = 248)		
Gender†	Male	138 (55.6)
	Female	109 (44.0)
CVADs *in situ*	One	236 (95.2)
	Two	11 (4.4)
	Three	1 (0.4)
Skin integrity‡	Good	209 (84.3)
	Fair	23 (9.3)
	Poor	4 (1.6)
Age (years)§	Median (IQR)	6 (1, 12)
CVAD (*n* = 261)		
CVAD type	Tunnelled, cuffed	85 (32.6)
	Totally implanted device	69 (25.7)
	Peripherally inserted central catheter	59 (22.6)
	Non-tunnelled, percutaneous	39 (14.9)
	Umbilical catheter	6 (2.3)
	Haemodialysis	5 (1.9)
CVAD lumens	Single	129 (49.4)
	Double	93 (35.6)
	Triple	36 (13.8)
	Quad	3 (1.1)
Vein placement¶	Internal jugular	115 (44.1)
	Basilic	24 (9.2)
	Subclavian	18 (6.9)
	Femoral	15 (5.7)
	External jugular	12 (4.6)
	Other	39 (14.9)
	Unknown	38 (14.6)
Inserted by††	Consultant	128 (49.0)
	Registrar	57 (21.8)
	Nurse	8 (3.1)
	Unknown	61 (23.4)
Inserted where‡‡	Operating room	185 (70.9)
	Intensive care unit	48 (18.4)
	Radiology	17 (6.5)
	Other	6 (2.5)
CVAD number§§	Initial	154 (59.0)
	Subsequent	99 (37.9)
Indication for insertion†	Prolonged treatment requirements	175 (67.0)
	Vesicant medication	150 (57.5)
	Fluid therapy	113 (43.3)
	Blood product transfusion	81 (31.0)
	Blood sampling	80 (30.7)
	Parenteral nutrition	59 (22.6)
	Poor peripheral vasculature	25 (9.6)
	Cardiovascular instability	23 (8.8)
	Other	19 (7.3)
CVAD dwell (days)†	Median (IQR)	18 (5, 108)

Missing data: †1, ‡12, §4, ¶6, ††7, ‡‡5, §§8 and ¶¶48. IQR, interquartile range.

regards to frequency of crystalloid fluid administration set changes and frequency of CVAD site assessment (see Table 5).

CVAD supplies

Also described in Table 5, the equipment and resources supplied to clinical staff for CVAD management varied between sites. While less than half of sites had a dedicated specialist IV team for CVADs (42.9%; three sites), a large range of cleaning solutions, dressing, securement and catheter types were available.

Discussion

CVADs are an essential component of paediatric health care, with this study describing CVADs prevalent in over a quarter of children admitted to acute care hospitals in Australia. However, these indispensable devices were also associated with a complication in the preceding 7 days (10%). Such complications would naturally be higher over the entire CVAD dwell. Similarly, a recent meta-analysis[1] described high proportions of occlusion (7.4%) and CVAD-associated bloodstream infections (10.3%) for paediatric CVADs. Complications associated with CVADs throughout paediatric specialties remains a substantial and significant problem that is likely under-appreciated and in urgent need of attention.

This audit and survey provides accurate, reliable data in order to provide a road map for future interventional studies and evidence-implementation. In agreement with previous studies,[5,15–17] CVAD management was variable between and within the study sites. Evidence-practice gaps were evident in several specific clinical practice areas. CVAD dressing and securement practice was complex, with nine different primary dressing products and seven different primary securement products in use. While un-bordered, transparent dressings remain the most common dressing product, 13.5% were not clean, dry and intact, and over a quarter were reinforced by non-sterile dressing products. This may reflect the inadequate integrity of some dressing products, and the reluctance of paediatric nurses to undertake unscheduled dressing changes, due to fear of CVAD dislodgement, accidental site contamination or resourcing issues. Poor CVAD dressing integrity may result in increased risk of site contamination and infection, and regular dressing assessment and proactive management should be the focus of improvement in paediatric CVAD practice. The audit findings indicate that more

Table 2 Point prevalence audit: Central venous access device (CVAD) management and utility (n = 261)

		n (%)
Dressing and securement		
Primary dressing†	Plain polyurethane	152 (58.2)
	Bordered polyurethane	44 (16.9)
	Advanced polyurethane	20 (7.7)
	None	18 (6.9)
	Gauze and sterile dressing/tape	14 (5.4)
	Other	10 (3.8)
Medication-impregnated dressing products‡	Chlorhexidine gluconate-impregnated disc	34 (13.0)
	None	226 (86.6)
Securement products‡	None	92 (35.2)
	Bordered/advanced dressing	64 (24.5)
	Silk suture	50 (19.2)
	Clip-based securement device	47 (18.0)
	Synthetic suture	27 (10.3)
	Velcro-based securement device	23 (8.8)
	Other	15 (5.8)
Additional dressing and securement products‡	None	172 (65.9)
	Adhesive-fabric dressing (non-sterile)	40 (15.3)
	Non-sterile tape	29 (11.1)
	Other	17 (6.6)
Dressing meeting the criteria clean, dry and intact§	Yes	200 (79.0)
	No	35 (13.5)
	No dressing	18 (6.9)
Other CVAD management		
Flushes ordered††	Yes, normal saline	57 (21.8)
	Yes, heparinised saline	39 (14.9)
	No	150 (57.5)
Needleless access connectors§	Negative	166 (63.6)
	None	32 (12.3)
	Positive	30 (11.5)
	Split septum	17 (6.5)
	Neutral	8 (3.1)
Documentation of site assessment¶	Yes, last 4 h	132 (50.6)
	Yes, last 24 h	200 (76.6)
	Not in last 24 h	55 (21.1)
CVAD utility		
Device planned use (next 24 h)	Continuous	186 (71.3)
	Intermittent	40 (15.3)
	No	35 (13.4)
Fluids infusing	Hydration‡‡	95 (36.4)
	None†	73 (28.0)
	To keep vein open‡‡	70 (26.8)
	Parenteral nutrition‡‡	63 (24.1)
	Other‡‡	45 (17.2)
Medications in next 24 h§§	Antibiotics	110 (42.1)
	Analgesia	77 (29.5)
	Chemotherapy	58 (22.2)
	None	51 (19.5)
	PRN	39 (14.9)
	Sedation	30 (11.5)
	Inotropes	27 (10.3)
	Other	72 (27.6)

Missing data: †3, ‡1, §8, ¶6, ††14, ‡‡4 and §§5. SD, standard deviation.

Table 3 Point prevalence audit: Central venous access device (CVAD) complications (n = 261)

	n (%)
CVAD-associated complications (in last 7 days)	
CVAD with one or more complications	25 (9.6)
No complications	236 (90.4)
CVAD blockage	15 (5.7)
CVAD-associated bloodstream infection	5 (1.9)
Local site infection	3 (3.1)
CVAD breakage	3 (1.1)
CVAD dislodgement	2 (0.8)
CVAD-associated clinically evident thrombosis	0
CVAD site complications (at assessment)	
CVAD site with any site complication†	27 (10.3)
None†	230 (88.1)
Bruising or blood around device†	13 (5.0)
Redness >1 cm from insertion site†	5 (1.9)
Itch or rash under dressing‡	4 (1.5)
Pain or tenderness on palpation‡	2 (0.8)
Purulence†	1 (0.4)
Leaking†	1 (0.4)
Blood in line§	1 (0.4)
Other§	1 (0.4)
Swelling, skin tears, palpable vein cord, induration of tissues, red streak along vein, extravasation or infiltration, complete or partial dislodgement	0

Missing data: †4, ‡2 and §1.

research is necessary to identify and implement effective dressing and securement devices for the paediatric acute care population. Multiple dressing products drive up costs and workload, which may be better spent on higher quality dressing and securement products, that are more effective.

While high level evidence supports the use of chlorhexidine-gluconate (CHG) dressing products in the intensive care population as an effective strategy to reduce CVAD-associated bloodstream infection (BSI),[7,8] only a small proportion of these products were in use for this population within this audit (7/49 CVADs in intensive care unit; 14.3%). As previously reported by other study authors, this may be due to concerns related to visibility of the insertion site,[17] and the potential for skin impairment.[16,31] High-quality evidence is now available to support the use of CHG dressing products as a valuable approach to reduce a preventable cause of patient harm; paediatric clinicians should work towards their consistent application within the intensive care setting. Documentation of the assessment of the CVAD insertion site is another specific area for improvement, as there was no documentation of site inspection within the previous 24 h in 21% of cases. Frequent CVAD site assessment and documentation should be a focal point for paediatric clinicians managing CVADs. This may impact upon the frequency of more progressive skin complications (e.g. exit site infection) and aid early identification of impaired dressing integrity.

Another variable and inconsistent practice was the prescription of flushing solutions. While there is little evidence to identify the optimal flushing interventions for CVADs,[32,33] flushes are

Table 4 Point prevalence audit: Participant and device associations with central venous access device (CVAD) complication in last 7 days (n = 261)

Characteristic		Complication (n = 25) n (%)	No complication (n = 236) n (%)	P-values
Gender	Male	16 (11.0)	129 (89.0)	0.41†
	Female	9 (7.8)	106 (92.8)	
Catheter type	Tunnelled, cuffed	6 (7.1)	79 (92.9)	0.38†
	Totally implanted device	5 (7.5)	62 (92.5)	0.77‡
	Peripherally inserted central catheter	10 (16.9)	49 (83.1)	0.04†
	Non-tunnelled, percutaneous	4 (10.2)	35 (89.7)	0.77‡
	Umbilical catheter	0	6 (100)	1.00‡
	Haemodialysis	0	5 (100)	1.00‡
CVAD number	Initial	10 (6.5)	144(93.5)	0.04†
	Subsequent	14 (14.1)	85 (83.9)	
Vein placement	Jugular	9 (7.1)	118 (92.9)	0.21†
	Basilic	3 (12.4)	21 (87.5)	0.71‡
	Subclavian	2 (11.1)	16 (88.9)	0.69‡
	Femoral	3 (20.0)	12 (80.0)	0.16‡
CVAD lumens	Single	16 (12.4)	113 (87.6)	0.14†
	Double	5 (5.4)	88 (94.6)	0.12†
	Triple	4 (11.1)	32 (88.9)	0.76‡
	Quad	0	3 (100)	1.0‡
Inserted by§	Consultant	13 (10.2)	115 (89.8)	0.83†
	Registrar	4 (7.0)	53 (93.0)	0.61‡
	Nurse	1 (12.5)	7 (87.5)	0.56‡
Inserted where	Operating room	17 (9.2)	168 (90.8)	0.82†
	Intensive care unit	3 (6.3)	45 (93.8)	0.59‡
	Radiology	1 (5.9)	16 (94.1)	1.00‡
Age (years)	Median (IQR)	6 (1.3, 10.0)	5 (0.9, 12.0)	1.00§
CVAD age (days)	Median (IQR)	21.5 (4.7, 56.5)	17 (5.0, 111.0)	0.83§

†χ^2 two-tailed. ‡Fisher's exact test two-tailed. §Mann–Whitney U test. IQR, interquartile range.

generally believed to maintain catheter patency by preventing internal luminal occlusion and biofilm formation.[34,35] Within this audit over half of CVADs had no flushes ordered at all, with variation in prescribed normal or heparinised saline for the remainder. This variation is likely to be a reflection of the poor level of evidence to support clinical decision-making. Considering the high frequency of catheter blockage described in the audit and other studies,[1] research is urgently required to compare the effectiveness of flushing solutions to maintain CVAD patency.

A key cause for the inconsistency in CVAD management is likely to be a result of the variations in CVAD guidelines between institutions, the large volume of CVAD products available at each site and the lack of specialist CVAD teams at over half of the study sites. Strong and consistent guidelines within and between hospitals, sufficient expert support and other resources to support decision-making are necessary to ensure consistent, evidence-based CVAD management to improve CVAD outcomes for children. Without these resources, clinicians are faced with a storeroom full of products to choose between, and variable understanding of the rationale and effectiveness of each strategy. Consistent practice based on evidence-based guidelines is likely to have a significant impact upon the rate of CVAD-associated complications within paediatric hospitals.

There are several limitations within this study. Multiple assessors undertook the audit across the study sites, which may have impacted the reliability of the results. However, the audit tool has been used in previous studies,[17,20,21] education resources were provided and audit tool achieved high levels of reliability.[29] This study was carried out in Australian tertiary paediatric hospitals on a single day and it may not be reflective of continuing practice. Finally, it was not possible to ascertain complications for CVADs beyond the 7-day window, due to study resources and the point prevalence design. Clinicians should compare these results with their own local procedures, prior to generalising it to their own institution.

Conclusion

Clinical audits and surveys can be an effective tool to promote best practice,[19] and this study has highlighted areas of paediatric CVAD management which require targeted educational programmes, quality improvement initiatives and interventional studies. Of greatest necessity is the development of clear and consistent CVAD guidelines and resources for paediatric clinicians. Also evident is a need to review the current dressing and securement products to improve dressing integrity and sterility, provide strategies to improve documentation and assessment of CVAD sites and further evidence to support CVAD patency practices. Improved CVAD management for paediatric patients will reduce complication rates of these essential devices. Providing

Table 5 Survey: Central venous access device (CVAD) management (six sites; seven surveys†)

		n (%)
Local guidelines		
Frequency of replacing CVAD	Not in guideline	3 (42.9)
	Clinically indicated	3 (42.9)
	>96 h (for umbilical catheters)	1 (14.3)
Frequency of CVAD dressing change	Not in guideline	0
	>96 h and PRN	2 (28.6)
	7 days and PRN	5 (71.4)
Frequency of administration set changes (crystalloid fluids)	Not in guideline	0
	48–72 h	1 (14.3)
	72–96 h	3 (42.9)
	96 h–7 days	2 (28.6)
	Monday, Wednesday and Friday	1 (14.3)
Frequency of site assessment‡	Not in guideline	1 (14.3)
	Hourly	2 (28.6)
	Every 8 h or once per 8-h shift	3 (42.9)
	Every 12 h or once per 12-h shift	1 (14.3)
	Once daily	1 (14.3)
	Every time CVAD is used	3 (42.9)
Criteria for choosing between CVAD characteristics (e.g. antimicrobial impregnation)‡	No	4 (57.1)
	Yes, documented in hospital policy	1 (14.3)
	Yes, an informal algorithm	1 (14.3)
	Yes, clinicians discretion	2 (28.6)
CVAD supplies and resources		
Dedicated specialist team for CVAD	No	4 (57.1)
	Yes	3 (42.9)
Cleaning solutions at CVAD insertion‡	Chlorhexidine without alcohol	3 (42.9)
	Chlorhexidine 0.5% in alcohol	2 (28.6)
	Chlorhexidine 1% in alcohol	1 (14.3)
	Chlorhexidine 2% in alcohol	5 (71.4)
	Povidone-iodine without alcohol	4 (57.1)
	Povidone-iodine in alcohol	1 (14.3)
	Normal saline	1 (14.3)
Cleaning solutions at CVAD dressing change‡	Chlorhexidine without alcohol	3 (42.9)
	Chlorhexidine 0.5% in alcohol	2 (28.6)
	Chlorhexidine 1% in alcohol	1 (14.3)
	Chlorhexidine 2% in alcohol	5 (71.4)
	Povidone-iodine without alcohol	2 (28.6)
	Povidone-iodine in alcohol	1 (14.3)
	Normal saline	3 (42.9)
CVAD dressings provided and used‡	Plain polyurethane	7 (100)
	Absorbent dressing	6 (85.7)
	Bordered or advanced polyurethane	1 (14.3)
	Chlorhexidine gluconate-impregnated disc	2 (28.6)
	Sterile strips	1 (14.3)
CVAD securement products provided and used‡	Synthetic suture	6 (85.7)
	Clip- or velcro-based securement devices	6 (85.7)
	Silk suture	4 (57.1)
	Bordered or advanced polyurethane	3 (42.9)
Number of CVAD brands provided	Mean (SD)	4.7 (1.5)
Number of different individual CVAD products provided	Mean (SD)	8.6 (2.2)

†Single site had two CVAD guidelines. ‡Respondents provided multiple responses per question. SD, standard deviation.

reliable, complication-free vascular access for children will improve the efficiency of paediatric health-care facilities worldwide.

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