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# Understanding consumer preference for vascular access safety and quality measurement: an international survey

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**Abstract.**

**Objectives.** The aim of this study was to examine patient perceptions regarding vascular access quality measurement.

**Methods.** A web-based, cross-sectional survey was performed using a convenience sample of healthcare consumers with vascular access experience, recruited from September 2019 to June 2020. Survey respondents were asked to rate the

 

perceived importance of 50 vascular access data items, including patient demographics, clinical and device characteristics, and insertion, management and complication data. Data were ranked using a five-point Likert scale (1, least important; 5, most important), and are reported as median values. Respondents proposed additional items and explored broader perspectives using free-text responses, which were analysed using inductive thematic analysis.

**Results.** In all, 68 consumers completed the survey. Participants were primarily female (82%), aged 40–49 years (29%) and living in Australia or New Zealand (84%). All respondents indicated that measuring the quality of vascular access care was important. Of the 50 items, 37 (74%) were perceived as 'most important' (median score 5), with measures of quality (i.e. outcomes and complications) rated highly (e.g. thrombosis and primary blood stream infection). Participants proposed 16 additional items. 'Gender' received the lowest perceived importance score (median score 3). Two themes emerged from the qualitative analysis of broader perspectives: (1) measurement of vascular access device complication severity and associated factors; and (2) patient experience.

**Conclusion.** Measuring vascular access quality and safety is important to consumers. Outcome and complication measures were rated 'most important', with respondents identifying a need for increased monitoring of their overall vascular access journey through the health system.

**What is known about the topic?** The use of vascular access devices is common among hospitalised patients. Quality surveillance is not standardised, with no incorporation of patient preference.
**What does this paper add?** We identify the data items consumers perceive as valuable to measure related to their vascular access journey; most importantly, consumers perceived the collecting of vascular access data as important.
**What are the implications for practitioners?** Health services can use these data to develop platforms to monitor the quality and safety of vascular access care.

**Keywords:** adults, co-design, consumer engagement, consumer priorities, patient safety measurement, pediatrics, quality and safety, vascular access.

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## Introduction

It has become increasingly recognised that patients' subjective experiences related to disease, treatment or both can uniquely inform targets for disease intervention to ensure that results directly translate to benefits for the patient.[1] This is reflected in a shift in patient-centred outcomes research, with the US National Institutes of Health (NIH) highlighting the need for measures of clinical outcomes that are important to patients in their Roadmap for Medical Research,[2] and the US Food and Drug Administration (FDA) identifying patient-reported outcomes as a regulatory standard for drug approval and labelling.[3] As such, patient input has become a cornerstone for global safety and quality health service standards, leading to patient input informing clinical decision making, contributions to clinical practice guidelines, health policy, drug approval, pricing and reimbursement decisions and shared decision-making and consent for treatment.[4]

Vascular access devices (VADs) are essential to deliver medical treatment during hospitalisation. For this reason, millions of VADs are inserted annually,[5] facilitating the delivery of infusates such as chemotherapeutics, antimicrobials, analgesic agents and contrast media for diagnostic studies. Despite their necessity, device complications are common: one in two peripheral intravenous catheters and one in four central venous catheters fail before treatment completion.[6–9] This high failure rate is unacceptable and results in poor-quality care, placing significant burden on patients and health service resources.[6,10] In addition, approximately 50% of adults report significant pain and/or anxiety during VAD insertion,[11] and studies exploring patient experiences of VADs report varying satisfaction with devices.[12–16] Patient input into the decision-making processes and care of VADs can reduce the risk of complications and failure,[17] and prevent unnecessary device insertion.[18] Patient perspectives are therefore important for ensuring active participation in care and are integral to ensuring value-based care. However, to date, patient involvement in the management of vascular access care quality has been largely overlooked.

The patient is a fundamental part of the vascular access care journey, yet consumers have had little involvement in determining what is quality vascular access care. Historically, the measurement of vascular access safety and quality has relied on local audits, incident reporting or siloed, simple electronic databases.[19–21] This ad hoc non-standardised approach limits benchmarking and is associated with a range of errors, including missing data. Further, current practice neglects more intelligent systems of monitoring and feedback, such as integrated electronic platforms that can facilitate external benchmarking of key outcome metrics for patients with VADs worldwide. Current methods rely on resource-intensive clinical audits and non-standardised outcome measurement. Therefore, most healthcare organisations have limited capacity at present to analyse, monitor or learn from safety and quality information related to vascular access care. One exception is central venous catheters and blood stream infection surveillance; however, given peripheral catheters are used at much higher rates than central catheters, increased efforts need to focus on measuring quality across all catheters and outcomes. With the global adoption of electronic medical records and increasing

application of clinical quality registries, the quality and value of vascular access care can be monitored and improved for every patient. In order for these advances to contribute to improved clinical outcomes, the patient perspective and care experience must be considered.

As efficient capabilities for electronic medical record data extraction are refined, the promise of data-driven decision making is becoming a reality for many health disciplines.[22,23] However, in vascular access, medical record ontologies are fragmented,[19,24] making data extraction challenging and unreliable. To date, limited enquiry has been undertaken with consumers regarding what aspects of care are valuable and important to measure for them. With efficient vascular access care based on the provision of easily accessible and reliable data, current methods for quality monitoring are suboptimal. The provision of these data could augment clinical decision making and reduce low-value healthcare practices[8,25] (e.g. routine peripheral intravenous catheter replacement); failure to consider the patient perspective in this process could hinder progress, and so the patient perspective is of paramount importance. Implementing clinical decision support systems and streaming analytics in vascular access has immense potential when coupled with consumer engagement, with such functionality promising wide impact and significant clinical and research implications that may contribute to improved patient outcomes and quality of life.

The first step in creating patient-centred, data-driven support systems for vascular access care is the standardisation of data items, including item definitions and associated elements. Given previous research has shown that patient and clinician preferences may differ with respect to vascular access decision making,[26] the next step is to incorporate patient perspectives to ensure patient-centred outcomes are included in quality measurement. The aim of the present consumer-driven quality improvement project was to understand which vascular access quality and safety measures consumers consider should be measured and collected.

## Methods

### *Study design*

This study was a cross-sectional opt-in Internet survey conducted from September 2019 to June 2020 using non-probability convenience sampling. We followed the American Association for Public Opinion Research (AAPOR) reporting guideline.[27] Ethics exemption was granted by the Children's Health Queensland ethics committee before study commencement. Implied informed consent was provided by all survey participants and based upon completion of survey items. Participants were able to terminate the survey at any time. Partial results were included with missing data described. The survey was anonymous, and confidentiality of information was assured.

### *Participants and sampling strategy*

To include international perspectives and representation, sampling was not limited to geographical location (i.e. regions outside of the host country could participate). Consumers who had access to an electronic device with Internet connectivity, could read the English language and had experience with VADs, either as a patient or parent representative, were eligible to participate. We invited consumer participation via advertisement with consumer groups (e.g. Parenteral Nutrition Down Under), professional organisations (Australian Vascular Access Society), investigator networks and a general invitation on social media (Facebook and Twitter). We identified consumer groups through a web-based search using the key terms 'vascular access', 'patient' and 'healthcare consumer'. We contacted 24 consumer groups, and six agreed to disseminate the survey information and link. The sampling strategy was limited to healthcare consumers because we have previously reported healthcare providers' experiences and perceptions with vascular access data collection.[24] Due to the broad dissemination strategy (used to minimise coverage and sampling error[28]), we were not able to calculate a denominator and subsequent response rate. To encourage a greater sample size, the survey link remained active until no new responses had been received for 7 days. Two reminder notices were published during this time, along with three retweets/shares of social media posts.

### *Outcomes and tool development*

Questions were based on prior work to develop international recommendations for a vascular access minimum dataset[29] and included: a scoping review of vascular access outcome measures and quality indicators;[19] international[30] and local[31,32] quality databases; interviews with healthcare professionals;[32] and international peripheral intravenous catheter[5] and central venous catheter research.[33] Consumers rated 50 items across the domains of patient demographics, device characteristics, insertion items, management items and complication and removal items using a five-point Likert scale, rated from 1, 'least important', to 5, 'most important'. Demographic questions (five items) were included to capture respondent characteristics. Four open-ended response questions were included at the end of the survey to capture broader perceptions: (1) what additional variables do you believe are important to collect; (2) what information related to VADs do you believe is a priority for the hospital to collect; (3) what has been your overall experience with VADs; and (4) what was your biggest worry related to your VAD? The final survey included 59 items.

Prior to survey distribution, the tool was piloted with four consumers who provided feedback on the clarity and feasibility (ability to answer) of survey questions using a four-point level of agreement (1, not; 2, somewhat; 3, quite; 4, highly).[34,35] All items scored $>3$ for clarity and feasibility, except for catheter material and catheter-to-vein ratio, which scored 2 for both clarity and feasibility. Consumers were then asked to recommend major revision, minor revision or to keep the item as it was. Overall, consumers recommended minor revisions to eight items, suggesting additional detail to explain complex medical terminology (e.g. 'catheter material' and 'catheter-to-vein ratio'). The feasibility of the tool was established, with the consumer panel reporting the survey took 15 min to complete and that the questions were presented in a logical sequence. No technical difficulties were reported.

### *Data analysis*

Data were analysed using IBM SPSS Version 25. Descriptive statistics were used to summarise respondents' characteristics and demographic details including counts and percentages. The median and interquartile range (IQR) were calculated for each

item. All responses were included in the analysis, with missing data described in tables.

Qualitative data were analysed using iterative and inductive thematic analysis as per Braun and Clarke's six phases of thematic analysis[36] and in line with similar studies.[37,38] Initially, two researchers (JS, KC) read the transcribed interviews and independently generated initial codes. An audit trail was used to enhance dependability.[39] Following this, the codes were collated into potential themes. The themes were reviewed by both researchers in relation to coded extracts and a thematic map was generated. To ensure authenticity, the resulting themes were reviewed by a third team member (RP). A selection of extract examples is provided in the text to support the final themes. Several strategies were used to enhance data quality, credibility and increase rigour, including data immersion, using a critical approach to analysis and confirmation of emerging findings between the two researchers.[40] Further, a wide inclusive sampling technique was adopted to enhance the transferability of findings.[41]

### *Patient and public involvement*

Patients were involved in the pilot testing of the tool and helped develop the initial minimum dataset as members of a hospital advisory group. The results of the study, in the form of a short summary of study findings, will be disseminated to study participants who provided an email on the first page of the survey.

## Results

### *Demographic characteristics*

Overall, 68 surveys were returned, with 60 respondents (88%) completing the full survey and 8 (12%) surveys partially completed due to breakoffs or missing data. Of the responding participants, 69% ($n = 47$) identified as a previous or ongoing patient and 31% ($n = 21$) were patient representatives. The demographic and geographical data of the respondents are presented in Table 1. Most participants (84%) were from the Oceania region, with female respondents comprising 82% of the cohort. Respondents reported most experience with peripheral intravenous catheters.

**Table 1. Participant characteristics ($n = 68$)**
Data are presented as *n* (%)

| | |
|---|---|
| Participant | |
| Yourself, as a previous or ongoing patient | 47 (69) |
| Your child, as a patient representative | 21 (31) |
| Sex | |
| Female | 56 (82) |
| Male | 10 (15) |
| Prefer not to say | 2 (3) |
| Age[A] (years) | |
| 20–29 | 3 (4) |
| 30–39 | 18 (26) |
| 40–49 | 20 (29) |
| 50–59 | 13 (19) |
| ≥60 | 8 (12) |
| Country | |
| Oceania (Australia, New Zealand) | 57 (84) |
| European Union | 4 (6) |
| North America | 4 (6) |
| South America | 3 (4) |
| Cather experience[B] ($n = 117$) | |
| Peripheral intravenous catheter | 51 (46) |
| Peripheral inserted central catheter | 19 (16) |
| Tunnelled central venous catheter | 16 (14) |
| Totally implantable vascular access device | 14 (12) |
| Non-tunnelled central venous catheter | 9 (6) |
| Mid-line catheter | 4 (3) |
| Haemodialysis catheter | 4 (3) |

[A]Missing data $n = 6$.
[B]Multiple responses were allowed.

### *Importance of vascular access data items*

All participants perceived the collection of vascular access data for quality and safety measurement as 'most important' (median score 5; IQR 5–5). When evaluating responses to questions of items' perceived importance, 37 (74%) were rated as 'most important' and 12 (24%) were rated as 'somewhat important'. Gender was the lowest scoring item (median importance rating 3; IQR 1–3). Across domains and items measured, all device complications received a median score of 5, as did the item 'complication identified' (median 5; IQR 5–5). Pain relief for device insertion received a median score of 4 (IQR 3–5), along with the demographic items 'age', 'weight' and 'diagnostic group'. Perceived importance scores are outlined in Fig. 1 and Supplementary material Table S1.

### *Additional measures of care quality*

Respondents proposed an additional 16 items to integrate into a vascular access dataset. Items were focused on device complications ($n = 6$; e.g. frequency of complications and safety data), insertion difficultly ($n = 5$; e.g. difficult intravenous access risk), patient experience ($n = 5$; e.g. quality of life, previous vascular access experience). Fig. 2 outlines the additional factors proposed by respondents with integration of the qualitative feedback.

### *Broader perceptions of vascular access device data collection*

Two priority themes emerged from the respondents' broader perceptions of VAD data collection: (1) measurement of VAD complication severity and associated factors and (2) patient experience, influenced by patient or personal factors such as disease chronicity and hospital factors such as staff experience.

#### *Measurement of vascular access device complication severity and associated factors*

Participants identified a perceived 'deficit' in how the 'degree' or 'severity' of vascular access complications was tracked:

> I think the hospital needs to survey patients to determine how much difficultly patients have.

One participant suggested there needs to be improved measurement of 'ALL complications – currently this is poorly done'. Participants perceived a focus on the measurement of infection, with one participant identifying this as a concern:

> Throughout my cancer treatment the clinicians seemed most concerned with infection; however, when my catheter tip

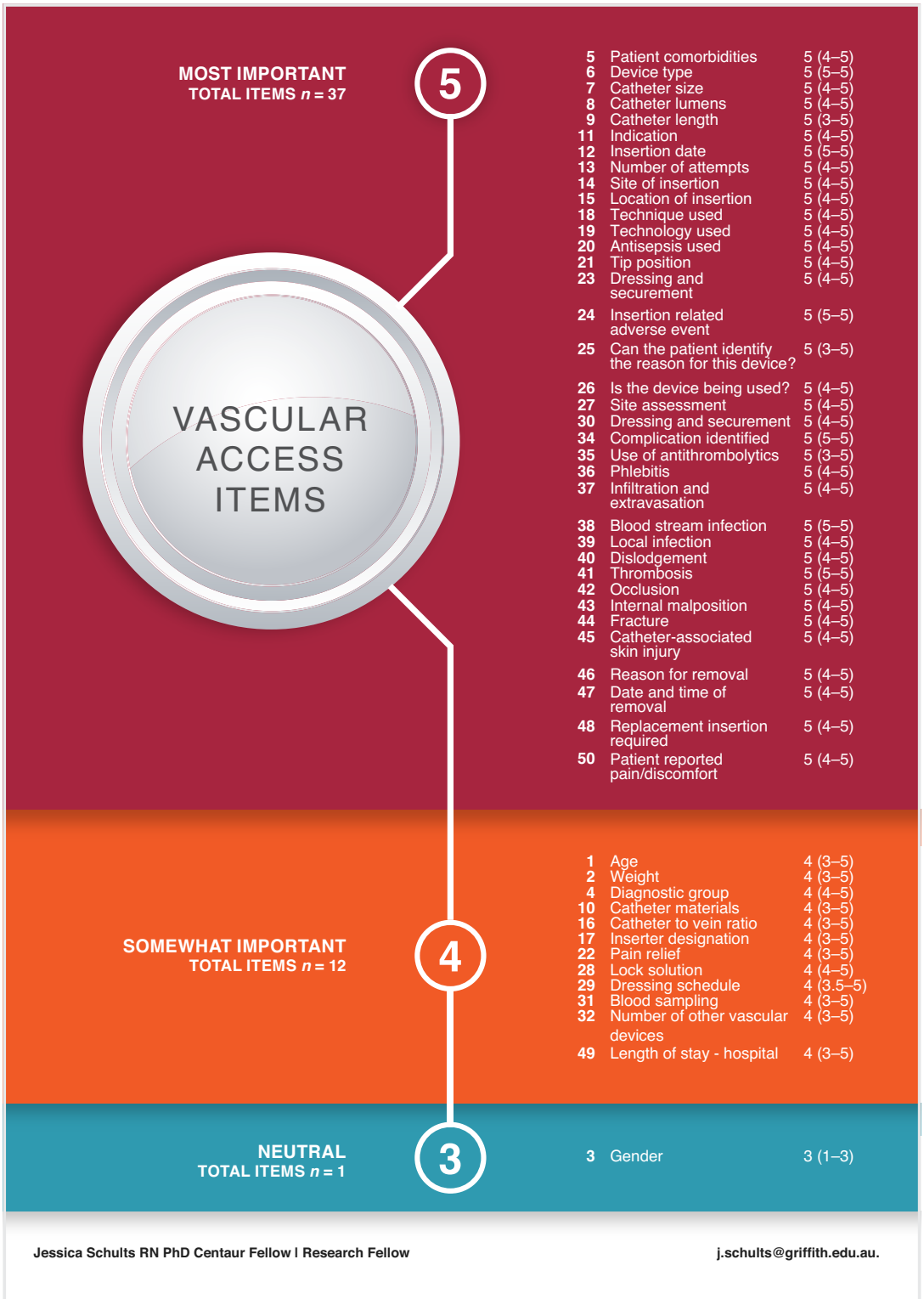


**Fig. 1.** Items' perceived importance scores. Items are listed in rank from most to least important. Values to the right are the median (interquartile range) score of perceived importance.

moved out of the correct place, I felt terrible, irregular heartbeats, and the risk of the catheter accidentally falling out always worried me. I think there are far more painful complications to measure than infection, so it surprised me this was the focus. Although I recognise infection may lead to death.

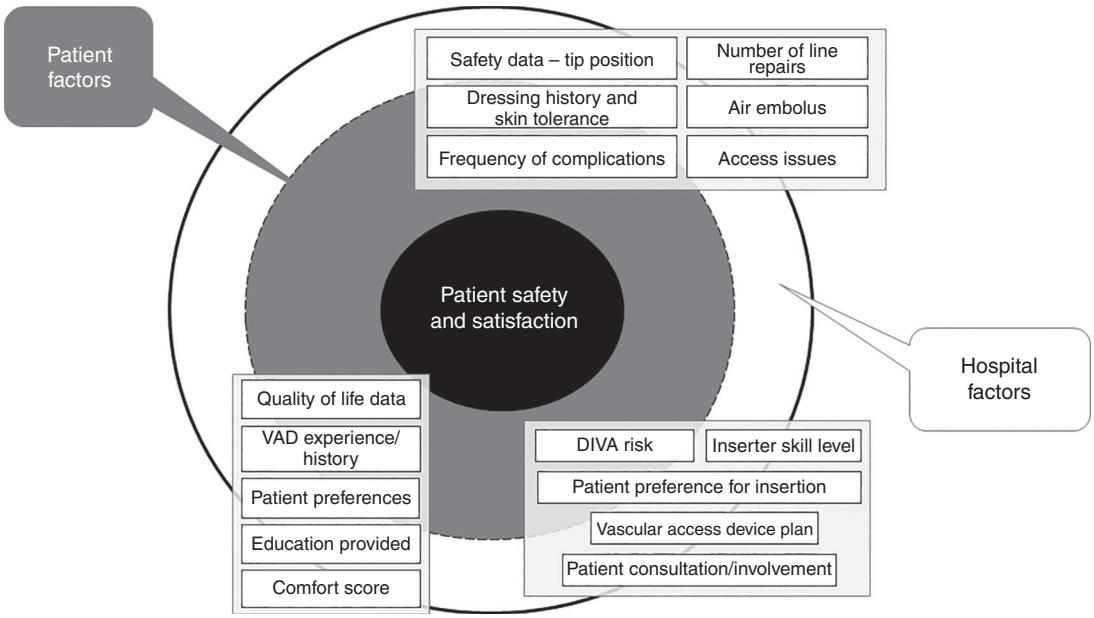


**Fig. 2.** Mapping additional variables for vascular access data collection. Variable names are presented as closely as possible to respondent wording. DIVA, difficult intravenous access; VAD, vascular access device.

Many respondents shared the perception that healthcare facilities need improved mechanisms to track patient preferences related to their 'vascular access history'. Respondents highlighted a need to collect data around effects on activities of daily living or 'restriction(s) to lifestyle due to line', which should be used to inform future device decisions. Approximately half the respondents reported feeling uncertain regarding long-term treatment and the lack of a documented long-term vascular access plan, and they stressed the importance of collecting data that informs future vascular access decisions to prevent 'damage to veins' and facilitate 'long-term venous access' and therapy. Respondents believed collecting data around previous experiences and 'what works' could 'prevent multiple and traumatic tries' and affect patient satisfaction with care.

### *Patient experience*

Measures of the difficultly of insertion, including 'number of attempts' and 'difficult intravenous risk', were discussed as important inclusions in data collection tools. Respondents described their experience with establishing reliable vascular access as 'stressful and overwhelming', with many participants relating multiple needle sticks and parents reporting traumatic insertions:

> My son got held down by two people and it was very traumatic for him.
>
> The insertion procedure was long, traumatic and painful for my daughter.

Measurement of pain and discomfort were highlighted by participants, with pain mentioned in 90% (45/50) of comments related to 'What was your biggest worry related to your VAD?' A considerable proportion of respondents expressed frustration at the inadequate or poor measurement of 'pain and comfort'. Participants noted there was 'not enough…[information collected] about pain issues with vascular [access] devices', describing their experience as '…quite confronting' and 'it was always a source of low-level pain'. Parents discussed a need for change in relation to procedural pain measurement, commenting:

> …maybe this study will prompt a change in the way these things are done and as a result our children are less traumatised.

Some respondents did not perceive themselves to be active participants in their vascular access care decisions, which they deemed important and believed could be improved with the documentation of patient preferences (e.g. 'site of insertion or pain relief').

## Discussion

Vascular access is a critical issue for the healthcare system. Approximately 70% of hospitalised patients require a VAD; poor clinical practices and VAD-associated morbidity entail significant additional healthcare costs per annum.[5,42,43] To the best of our knowledge, this study is the first to evaluate consumer perceptions regarding vascular access quality measurement using health data. Not only do we report consumer preferences for quality measurement, but the data we have presented also demonstrate agreement between clinicians (previously established consensus[24,29]) and consumers regarding what data are 'important' to measure. These data are primarily concerned with outcomes and complications, which are measures of the quality of care and the patient's vascular access journey. The consumer engagement in this study is vital to the development, implementation and sustainability of a vascular access dataset to measure safety and quality. Without patient input into the design of vascular access datasets, outcomes important to patients may not be captured, data capture during hospitalisation may become overly burdensome and patient safety and overall satisfaction could be negatively affected.

Overall, respondents indicated that the measurement of device complications was important to them. Previous studies have shown that patients report frequent and burdensome complications associated with their VADs.[11,44] Therefore, although unsurprising, the present study highlights that, for consumers, the measurement and collection of vascular access complication data across the patient's lifespan and healthcare journey is important and should be a priority for healthcare institutions. This is even more relevant given that current deficits in standardised vascular access complication measurement prohibit international benchmarking.[19] In order to reduce the VAD-related burden on the healthcare system, we need to monitor VAD outcomes from the point of insertion to removal and beyond, for every patient. This requires a defined dataset collected as part of routine care for every patient, which can be extracted and monitored. Any adverse safety signals must then be addressed.[45]

Measurement of the patient experience associated with VADs is understandably challenging. One device-related factor noted to contribute to a negative patient experience was pain and discomfort. Respondents rated ongoing 'pain and discomfort' as most important to measure in clinical practice, a finding that aligns with an international survey of consumer experiences.[11] Interestingly, the importance ratings for 'pain relief for insertion' received a median importance rating of 4 (IQR 3–5). Although it was beyond the scope of this study to estimate the proportion of respondents who received sedation or analgesia for device insertion, it is possible that participants perceived the recording of analgesics on insertion as less important for the healthcare institution or less valuable to prevent complications during device dwell time. It is also likely that pain during catheter dwell is more 'bothersome' than pain on insertion, as reflected in previously published consumer experience work.[11] Standardised and routine collection of pain measures in practice may be challenging, but these difficulties may be overcome using an integrated electronic medical record and validated numerical rating scale. The present study demonstrates that consumers believe the consistent and reliable measurement of this variable is important.

Some ways that researchers, clinician informaticians and healthcare providers can use the information generated in this study to strengthen their vascular access performance measurement include collaborating on more user-friendly, data-driven support systems and incorporating the measures outlined in this study in addition to hospital (context)-specific variables.[46] For national policy makers and local safety and quality managers, our findings have important implications for vascular access quality measurement. Using patient-reported outcomes is an essential aspect for improving clinical care and should be included in the design and implementation of hospital-reported outcome frameworks. The inclusion of such measures supports the creation of a learning healthcare system, a system of continuous knowledge development, improvement and application. Ultimately, this will require systematic problem solving and the development of computing capabilities and analytics that offer real-time information on patient care to support continuous improvement in health care through outcomes.

This work has demonstrated consumers perceive the collection of vascular access data as an important aspect of their healthcare journey. To advance outcome and quality management in vascular access care, it would be useful for future research to explore improved shared decision making in patients' vascular access journeys to further understand the effects of vascular access care on outcomes and how to improve patient quality of life and experience. Although the automated, integrated and standardised measurement of vascular access care quality and safety has received little attention to date, this work shows that more research and quality initiatives are needed to develop platforms to support measurement of care quality in this space.

### *Limitations*

There are several limitations to our work. The nature of sampling, small sample size and large representation from female consumers from the Oceania region limit the generalisability of findings. We also engaged individuals with a history of vascular access interventions, potentially biasing our findings, with qualitative data limited to four questions. Further, due to the diverse and broad survey dissemination strategy, we were unable to calculate a survey response rate. However, the broad dissemination of the survey using online social media and consumer groups is a strength of the sampling framework. Finally, we used a purpose-built survey that had not been previously validated, and we did not estimate survey internal consistency. However, the tool was piloted and the questions were based on extensive prior work.

## Conclusion

The results of this study, in combination with existing work, suggest agreement between clinicians, researchers and patients about which vascular access data are important to measure. Future quality improvement projects should focus on how the collection and reporting of vascular access data can contribute to a patient's overall health care and vascular access experience, along with producing tangible benefits to the healthcare system and patient safety.

## Author's contributions

Jessica Schults, Rebecca Paterson, Tricia Kleidon, Marie Cooke and Claire Rickard conceived the study, drafted the protocol, collected and analysed data, drafted the manuscript and approved the final manuscript. Amanda Ullman, Gillian Ray-Barruel and Nicole Marsh reviewed the protocol and data analysis, and reviewed and approved the final manuscript. Karina Charles analysed the data and reviewed and approved the final manuscript. Keith McNeil, Vineet Chopra, Claire Sullivan and David Sturgess reviewed the methods and data analysis and reviewed and approved the final manuscript.

## Data availability

Data supporting the findings of this study are not available due to the qualitative and confidential nature of interview data.

## Competing interests

Jessica Schults has received grant funding from Griffith University and the Children's Hospital Foundation, as well as

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The remaining authors report no conflicts of interest.

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