How to needle: A mixed methods study on choice of cannulation technique for arteriovenous fistula

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Abstract

Aims and objectives: The aim of this study was to describe the basis for choosing a cannulation technique for arteriovenous fistula.

Background: Four cannulation techniques are relevant to cannulating an arteriovenous fistula: rope ladder, area puncture and buttonhole using blunt or sharp needles. The chosen technique may affect both the patency and number of complications.

Design: The study used a convergent mixed methods design and inductive approach.

Methods: A questionnaire and an inquiry of local guidelines were sent to nurses in all dialysis units in Sweden. Questionnaires were answered by nurses from 37 units, and 29 units included their local guidelines. The questionnaires were analysed using descriptive statistics and qualitative content analysis, and the guidelines were analysed using qualitative content analysis. The different analyses were combined in a final result. The study is based on GRAMMS guidelines.

Results: Local guidelines, patients' and nurses' own judgement, and consultation with colleagues were found to greatly influence the choice of cannulation technique. Buttonhole was the most preferred cannulation technique in the participating units and was favoured by nurses when choosing a cannulation technique. The process of choosing a cannulation technique was found to be influenced by the dedication to good cannulation technique and healthy arteriovenous fistulas, whether the technique is perceived as being easy to use and is expected to prevent complications and based on the experienced-based knowledge of each dialysis unit.

Conclusions: Choosing a cannulation technique is a process based on the nurse, local guidelines and the patient. Most dialysis nurses and units in Sweden consider buttonhole to be a good cannulation technique and use it as their standard technique.

Relevance to clinical practice: The results provide insight into why cannulation techniques are chosen differently in different units. The results also show the importance of evidence in making decisions on cannulation technique.

Keywords: area puncture, blunt needle, buttonhole, haemodialysis, nursing, rope ladder, sharp needle
1 | INTRODUCTION

Vascular access is a prerequisite for haemodialysis treatment and, therefore, often called the patient's lifeline. The most common and most beneficial access is the arteriovenous fistula (AVF) (Lok et al., 2020; Schmidli et al., 2018).

Both the function and patency of an AVF are affected by several factors, such as anatomical conditions, co-morbidities, age, the surgical technique used to create it, the daily care and the needling technique used (Schmidli et al., 2018). An AVF used for haemodialysis is normally cannulated with two needles three times a week all year round, totalling at least 312 cannulations a year. Few studies have addressed the optimal cannulation technique, and the majority of guidelines are based on expert opinions. The choice of cannulation technique affects both the outcome of complications and, in the long-term, fistula patency (Staaf et al., 2021).

2 | BACKGROUND

European and American guidelines describe three needling techniques when cannulating an AVF: rope ladder (RL), area puncture (AP) and buttonhole (BH) (Gallieni et al., 2019; Lok et al., 2020; Schmidli et al., 2018). When using RL, the cannulator creates new puncture sites each time, and the puncture site is placed 0.5 cm from the last one using the whole length of the AVF. Cannulators using AP also create new puncture sites each time but place all sites in the same area, rarely larger than 2–3 cm in diameter. When BH is used, the needle is placed in exactly the same tunnel track using the same angle each time (Parisotto & Pancirova, 2018). Blunt needles are normally used (buttonhole with blunt needles; BHb), but sharp needles (buttonhole with sharp needles; BHSs) may also be used (Staaf et al., 2021). Both American and Australian, as well as some of the European, guidelines recommend RL as the primary technique because it leads to fewer infections, but when the cannulation segment is short, BH can be considered (Ibeas et al., 2017; Lok et al., 2020; Polkinghorne et al., 2013; Schmidli et al., 2018). AP is not recommended because this technique is reported to increase the risk of complications, such as stenosis, bleeding and aneurysms (Schmidli et al., 2018).

The cannulation techniques are used to various degrees in different parts of the world. RL is the most common technique in the US (Lyman et al., 2020). In Europe, AP is used by the majority of patients (66%), whereas RL (28%) and BH (6%) are less common. However, the same study also found a difference in cannulation techniques between countries, and even between hospitals (Parisotto et al., 2014). In Sweden, for example, BH (BHb and BHSs) was used in 84% of cannulations over a 5-year period, whereas RL and AP were used in 13% and 3%, respectively. In those who were cannulated by BH, more than half of the patients were cannulated using BHSs (Staaf et al., 2021). As both blunt and sharp needles can be used in BH, hereafter, the type of needle will be described only if it is known. If the type of needle is unknown, it will be referred to simply as BH.

What does this paper contribute to the wider global community?

- In the process of choosing a cannulation technique, the dialysis nurse, influenced by the patient and local guidelines, reaches a decision on the preferred technique.
- Nurses are interested in AVF cannulation and the well-being of patients and their AVFs. Therefore, a dedication to good cannulation technique and healthy AVFs may inspire the choice of cannulation technique and AVF care.
- In Sweden, the majority of dialysis nurses and dialysis units perceive buttonhole as the standard technique due to a decreased risk of complications, its ease of use and the belief that it preserves the function of the AVF.

The cannulation technique chosen in each clinic often depends on the nurse’s opinion/traditions regarding one technique or the other (Wong et al., 2014). These traditions are often based on the needling technique the nurse was trained in during their first years as a dialysis nurse (Harwood et al., 2016). The extent to which guidelines influence the cannulation technique that is chosen is unclear.

Cannulation of an AVF is associated with different emotions, often related to the fact that patients experience the AVF as their lifeline. Anxiety, stress and pain are described in the literature as emotions associated with AVF (Casey et al., 2014). There is anxiety before the moment of cannulation and for various kinds of complications. The complications that the patient experiences in everyday life, such as cannulation difficulty, hematoma, bleeding and pain, affect the patient more than, for example, anxiety regarding AVF infections (Kosa et al., 2016). If and how these emotions affect the nurse when choosing a cannulation technique is unknown.

Nurses have a great responsibility regarding the choice of cannulation technique and daily care of the AVF and, therefore, have a substantial possibility to affect AVF patency. There are guidelines on how to perform cannulation and which technique to choose. However, previous research has shown that these guidelines are not always followed and the preferred cannulation techniques vary between countries and hospitals (Parisotto et al., 2014; Schmidli et al., 2018; Staaf et al., 2021). Considering these differences in guidelines and clinical practice, the aim of the present study was to describe the basis for choosing the cannulation technique for AVF.

3 | METHODS

3.1 | Design

The study has a convergent parallel mixed methods design with an inductive approach. Both data and method triangulation allow more complete understanding of the research question. Looking at the
issue from different angles also provides a more valid answer. The reporting of findings in this paper is based on Good Reporting of A Mixed Methods Study (GRAMMS) (O’Cathain et al., 2008) (File S1).

### 3.2 Data collection

Data were collected simultaneously via an online questionnaire and by collecting local guidelines from participating units. All dialysis units (71 units) in Sweden were randomly distributed to participate with one answering nurse or three answering nurses. For practical reasons, information and an offer to participate in the study were sent to first-line managers during autumn 2020. Dialysis units wanting to participate had the online questionnaire sent to one or three (randomly selected to examine coherence within units) of the registered nurses designated by the first-line manager. Inclusion criteria for answering the survey were knowledge of the Swedish language and at least 1 year of experience in haemodialysis and AVF cannulation. The first-line managers were also asked to send their local guidelines about cannulation and AVF to the researchers (Figure 1). Data collection ended in February 2021.

The survey was created by the authors to answer the aim of the study (File S2). The questions were based on both a literature search and author experience with cannulation of AVFs and haemodialysis. The survey contains questions describing the dialysis unit, the responders and how, why and in what proportion different cannulation techniques were used and how the nurse took care of the AVF. The questions were both open-ended and closed-ended.

All participating dialysis units with answers from one nurse were included in the quantitative analysis. From the units in which two to three nurses participated, for the coherence investigation, only the nurse who answered first was included in the quantitative analysis in order to not have a preponderance of responses from certain units. All open-ended answers were included in the qualitative analysis (Figure 1).

### 3.3 Rigour

Both data and method triangulation were used in this study. During the process of creating the questionnaire, four different dialysis nurses from three different dialysis units evaluated the questions for understanding and simplicity in answering the questions. The nurses were chosen by purposive sampling. They had long experience (10–20 years each) in dialysis and AVF cannulation, worked at hospitals of varying size and were not involved in the research group. The survey was updated based on the nurses’ opinions, but also so that their way of interpreting the questions was in line with the researchers’ aim of asking the question. This strengthens the results.

All authors have several years of experience in haemodialysis (20–30 years each), first and last author as registered nurses and second author as a senior nephrologist. This pre-understanding was used in combination with previous research during creation of the survey to include as many aspects of the complexity of AVF cannulation as possible. During the analysis, pre-understanding was held back, so as to not let it affect the analysis process or the findings.

The analysis was, for the most part, performed by the main author. Throughout the process, the findings were discussed with the last author to reach a consensus. The final result was approved and discussed by all three authors.

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**FIGURE 1** Flow diagram of the study sample
3.4 | Analysis

Local guidelines and the answers to the open-ended questions were analysed using inductive qualitative content analysis (Elo & Kyngäs, 2008). Closed-ended questions were analysed using mainly descriptive statistics. The analyses were performed in parallel. The results were then integrated into a final result (Farmer et al., 2006) (Figure 2). The main author analysed and integrated the results, supported by the last author.

3.4.1 | Qualitative analysis

Local guidelines and open-ended questions were analysed in parallel. The text was read several times, and the meaning units and codes were noted. The codes were then compared, grouped and reduced to sub-categories and categories. All of this was done with the aim of the study and the main text and the meaning units close in mind. The categories and sub-categories from both analyses were compared and integrated, and the main category emerged (Table 1).

3.4.2 | Quantitative analysis

Closed-ended questions were mainly described using descriptive statistics. A comparison of coherence explored whether nurses’ routines were more similar within units than between units. Cohen’s kappa was used to investigate the level of agreement between nurses working in the same unit compared with pairs of nurses who worked in different units. Half of the pairs in the control group were working at hospitals of the same size and the other half of the pairs worked at hospitals of different sizes. Comparisons regarding coherence were made by comparing the mean kappa values between the groups.

Data were analysed using mean and standard deviation (SD). Averages were compared using t-test and ANOVA, and the post hoc

![Figure 2](image-url)

**FIGURE 2** Description of the mixed methods design and the parallel analysis leading to a merged result
Tukey test was used. Analysis of agreement was performed using Cohen's kappa. Microsoft Excel 2016 (Microsoft, USA) was used as a database for collecting and grouping data. Statistical analysis and randomisation of participants were performed using IBM SPSS Statistics, version 27 (IBM Corp., Armonk, NY).

3.4.3 | Integration of results

The results from both qualitative and quantitative analyses were merged into a final common result to answer the aim of the study (Plano Clark, 2019). Qualitative and quantitative results were integrated using a convergence coding matrix (File S2, S3) to search for agreement, partial agreement, silence or dissonance (Farmer et al., 2006).

3.5 | Ethical considerations

The Swedish Ethical Review Authority gave ethical approval (No. 2020- 04539) for the study. Written informed consent was provided before participation. Information was given as an introductory text to the survey and through a letter to the first-line managers. Consent was given by answering the survey or by sending the local guidelines.

4 | RESULTS

One registered nurse from each of 37 (52%) different haemodialysis units in Sweden answered the questionnaire. These units were evenly distributed all over the country, with 18 (90%) out of 21 regions represented. Participating nurses were mostly women with several years of experience from one or more dialysis units (Table 2). Participating units were located at small, medium-sized and university hospitals and at locations other than hospitals. Dialysis units differed in both size (number of physicians, nurses, and patients) and the number of AVFs compared to other types of vascular access (Table 3).

4.1 | Quantitative results

4.1.1 | Choice of cannulation technique

In 34 (92%) answering units, the cannulation technique was chosen by the nurse. In the other three dialysis units, the decision was made in consultation between the nurse and/or patient, physician and enrolled nurse. Nurses stated that the choice of cannulation technique was based on different factors (Figure 3).

The most commonly used cannulation technique was BHb. It was used to some extent in all 37 (100%) participating units. BHs was used in 28 (76%) units to some extent, but RL (18 units, 49%) and AP (7 units, 19%) were used less. The nurses were also allowed to...
rate their opinions about the different cannulation techniques on a Likert scale. BHb got a significantly higher rating than the other techniques. BHs and RL received equivalent ratings, and AP received a significantly worse rating (Table 4).

### 4.1.2 Patient information

Patients are most often informed orally about the different cannulation techniques. Only 1–2 units provide written information about cannulation techniques. All 37 units inform the patient orally about BHb, 30 units (81%) inform orally about BHs, and 29 units (78%) about RL. Information about AP is only mentioned in 13 (35%) of the units. Written information is only given by 1–2 (3%–5%) of the units regardless of the cannulation technique. The patient is sometimes, but not very often, involved in the choice of cannulation technique. The responding nurses expressed that the majority of patients are not involved and do not have an opinion about the decision (Figure 4).

### 4.1.3 Local guidelines

Written local guidelines that describe different cannulation techniques are common, but they contain different amounts of information in different units. Unwritten guidelines are less common, but some of the information is shared between colleagues this way. The responding nurse tended to know the content in their unit’s local guidelines (Figure 5).

### 4.1.4 Coherence within and between units

Nurses from the same units had significantly similar answers compared with nurses from different units. The units with several participating nurses had a mean kappa of 0.32 ± 0.05 for the questions compared with 0.11 ± 0.06 in the control group from different hospitals (p < .001). There were no differences in coherence among nurses from hospitals of the same size or different size.

### 4.2 Qualitative results

Three categories and one main category emerged from the qualitative analysis of the questionnaire and the local guidelines. The three categories are presented below. The main category was seen in all categories and is the connection between these categories and the goal for both nurses and dialysis units (Figure 6).

#### 4.2.1 Choice of good cannulation technique

Three cannulation techniques were described and defined in the analysed local guidelines: BH, RL and AP. BH was described as a technique in which the cannulator uses the same tunnel track and same angle when inserting the needle every time. Some units also described the creation of tunnel tracks and the change to blunt needles.

**Buttonhole, cannulation in the same tunnel track each dialysis. (Unit 2)**

That means use of sharp needles on the same site until creation of a tunnel track. Thereafter, blunt needles can be used. (Unit 20)

The definition of RL differed between units. Most of the local guidelines stated that the needle is cannulated at a new spot each time.
and the whole length of the AVF is used. Other guidelines described RL as a technique in which the patient has, for example, three cannulation sites that are used to vary between using a sharp needle. Both descriptions of RL are referred to in both local guidelines and in answers from nurses.

The majority of local guidelines recommended BH as the first-choice cannulation technique for AVFs. Most guidelines also recommended changing from sharp to blunt needles as soon as possible when the track is formed. However, some units did not differentiate between sharp and blunt needles when describing the BH technique. The aim is to use buttonhole for all AV-fistulas. (Unit 23)

The recommendations for BH in the local guidelines are based on several advantages: the risk of infiltration is less, it is an easy technique to use, the cannulation is less painful and it may lead to prolonged patency, fewer pseudoaneurysms and less stenosis. Some units recommend BH if the cannulation route is short, if the patients can cannulate themselves, if the AVF is placed on the upper arm, or if the patient has an autogenous graft.

The use of BHb has been found in several studies to increase AVF patency and decrease the risk of pseudoaneurysm and stenosis. (Unit 29)

### TABLE 4  Nurses' rating their opinion of the different cannulation techniques

<table>
<thead>
<tr>
<th>Cannulation technique</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>p-value (95% CI) vs. BHs</th>
<th>p-value (95% CI) vs. BHb</th>
<th>p-value (95% CI) vs. RL</th>
<th>p-value (95% CI) vs. AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BHs (n = 28)</td>
<td>4.5 ± 1.3</td>
<td>1–6</td>
<td>.001 (-1.89 to -0.35)</td>
<td>.998 (-0.88 to 0.77)</td>
<td>&lt;.0001 (1.52-3.48)</td>
<td></td>
</tr>
<tr>
<td>BHB (n = 37)</td>
<td>5.6 ± 0.6</td>
<td>4–6</td>
<td>.001 (0.35-1.89)</td>
<td>.003 (0.29-1.84)</td>
<td>&lt;.0001 (2.68-4.56)</td>
<td></td>
</tr>
<tr>
<td>RL (n = 27)</td>
<td>4.6 ± 1.2</td>
<td>2–6</td>
<td>.998 (-0.77 to -0.88)</td>
<td>.003 (-1.84 to -0.29)</td>
<td>&lt;.0001 (1.57-3.54)</td>
<td></td>
</tr>
<tr>
<td>AP (n = 15)</td>
<td>2 ± 1.6</td>
<td>1–6</td>
<td>&lt;.0001 (-3.48 to 1.52)</td>
<td>&lt;.0001 (-4.56 to -2.68)</td>
<td>&lt;.0001 (-3.54 to -1.57)</td>
<td></td>
</tr>
</tbody>
</table>

Note: The rating in mean is compared between cannulation techniques. Rating from 1 (worst) to 6 (best). Abbreviations: AP, area puncture; BHb, buttonhole blunt; BHs, buttonhole sharp; CI, confidence interval; RL, rope ladder; SD, standard deviation. The significance of bold values indicates that the p-value < .05.
One unit claimed in their local guidelines that BH is an option only if the physician takes part in the decision. Another unit stated that it is important to be careful when using BH if the patient has a pacemaker, has had valve surgery or has an upper arm AVF.

Buttonhole might be chosen after special consideration along with the physician. (Unit 3)

The use of BHb on all patients was a common intention among the nurses who answered the questionnaire. Some nurses specified that BHb should be the technique for all patients with dialysis three times (or more) a week. If the cannulation segment is short, the patient has a fear of needles, and/or cannulates themselves, the technique is extra beneficial. However, it is not always possible to create a tunnel track and another technique has to be chosen. Other units avoid BHb if the AVF is superficial, the patient has signs of poor hygiene, or the patient expresses that they prefer another technique.

We aim for buttonhole with blunt needles for everyone. (Nurse 1)

The technique [BHb] is used for patients that self-cannulate, if they have a short cannulation segment.
The nurses described BH as the most preferable technique because it is easy to use and seems to cause less harm to the vessel. Some local guidelines described and recommended BHs. However, when and how this technique is recommended differs. Some units stated that BHs should be used on vessels for which BHb does not work, such as thin and superficial AVFs. Other units advised not to use BHs too long because this technique often leads to a larger tunnel track and increased risk of oozing during dialysis.

Sharp needles should not be used for too long as they have a cutting edge and might increase the puncture site. This might lead to oozing. (Unit 28)

Some units stated that BHs is only allowed during the creation of a new tunnel track or if re-cannulation of an old track is necessary. Re-cannulation should then only be done by the nurse who created the tunnel track the first time, if possible. Other units dissuaded cannulators from BHs and described an increased risk of bleeding, oozing, infections, false tunnel tracks, pseudoaneurysms and a need to force the blunt needle down the tunnel track.

When we compared the answers from the nurses, we noted a difference among the routines regarding BHs. Some nurses indicated that their unit never uses BHs except for the creation of new tunnel tracks. Other nurses described BHs as the most common technique in their unit and the main alternative if a track cannot be created. Between these two extremes is a continuum comprising both those who cannulate using BHs once or twice if BHb does not work, and those who cannulate several patients during shorter or longer periods when a tunnel track cannot be created or BHb does not work for some other reason. Some nurses also described that BHs is used on those with dialysis scheduled only once or twice a week because the tunnel track is hard to create. Other indications for BHs that were mentioned are superficial or deep AVFs, in rare cases when BHb does not work, such as thin and superficial AVFs. Other units stated that BHs should be used on vessels for which BH does not work, it is important to re-evaluate and possibly change the technique. This cannulation technique [AP] should be avoided as it increases the risk of aneurysms. (Unit 7)

A couple of nurses summarised it as follows: All cannulation techniques have pros and cons. The choice of cannulation technique depends on the appearance and function of the AVF, the experience of the nurse and whether continuity can be established. It is also important that all nurses in the unit know the technique and are able to cannulate the patient, and that the patient is satisfied. If this does not work, it is important to re-evaluate and possibly change the technique.

Each cannulation technique has pros and cons. Different fistulas and different patients have their
own singularity. It is all about experience of the cannulating nurse and about continuity regarding those who needle the patient. (Nurse 25)

4.2.2 | Preventive care and complications

BHb was preferred by the majority of the responding nurses because it is easy to insert the needle and the risk of complications is low. For example, BHb causes less infiltration (even though the patient moves around), shortens bleeding time after dialysis, results in minor pain and less injury to the vessel, and prolongs AVF patency. BHb was also preferred when patients needle themselves, as the patient has fewer worries about the cannulation and the nurses feel more confident when using BHb.

I think BHb is the best technique due to a lower risk of complications, easy cannulations and longest AVF patency. (Nurse 10)

However, the nurses pointed out the importance of a well-functioning tunnel track, which is created by continuity among cannulators. They also conveyed that a false tunnel track can easily be formed if the technique is used incorrectly. It is also important to be aware of and prevent hubbing, as these increase the risk of infection.

Good tunnel tracks in which blunt needles are used are easy to use for both the patient and nurse. With less/no pain during cannulation, the patient may be involved in the treatment and can prepare a lot and also cannulate themself. (Nurse 7)

When using blunt needles, so-called false tracks might be created. (Nurse 32)

Other complications that may lead to a change in cannulation technique are re-cannulation and pain. The need for re-cannulation often arises because the inserted blunt needle does not enter the vessel. Some of the responding nurses also described exceptional cases of patients that experience increased pain when using blunt needles.

When blunt needles do not work because good tunnel tracks are impossible to create, despite few cannulators, buttonhole sharp is used. Sometimes, you have to give up on blunt needles if the patient experiences needling as painful. (Nurse 14)

Some units mentioned the so-called trampoline effect in their local guidelines. To solve cannulation difficulties such as this, some units recommended correcting the angle of the needle, whereas other units recommended the use of BHs for a period of time to re-open the tunnel track. A third option is to create a new tunnel tract approximately 2 cm from the previous track.

Sometimes, it is hard to change to blunt needles. The needle may bounce on the vessel wall and will not enter the vessel. The angle of the needle might then be corrected a little, so, the vessel flap is found and the needle can enter. If the problem continues, sharp needles should be used for a while. The same nurse that created the tunnel track should re-establish the track. (Unit 12)

Some nurses experience BHs as an easier technique to use because the sharp needle prevents re-cannulations. They stated that an immediately successful needle insertion might relieve anxiety for worried patients. A couple of nurses also experienced BHs preventing more AVF-related complications than RL. However, there is a higher risk of infiltration when using BHs. One nurse therefore described the use of plastic cannulas for BHs in their unit.

Patients may feel uncomfortable if the needle is not successfully inserted on the first attempt. Then, it is easy to use a sharp needle. (Nurse 11)

Rope ladder is used less, as we prefer BH sharp. Our experience is that this technique conserves the fistula. (Nurse 15)

As the risk of complications, such as oozing, destroyed cannulation track, and necrotic scabs, is increased when using BHs, one nurse described how, if the patient wants this technique, they inform them of the increased risks and document in the patient record that the information was given.

Only patients who refuse blunt needles are cannulated using buttonhole with sharp needles. In these cases, we describe in the medical record that the patient is informed about the increased risk of complications, for example oozing and necrotic scabs. (Nurse 27)

The risk of complications as an influencing factor on the choice of cannulation technique was also described in local guidelines. For example, AP was explained as increasing the risk of aneurysm and vessel wall weakness, BHs increasing the risk of pseudoaneurysms, and RL and BHb decreasing the risk of aneurysms.

Sharp needles used in buttonhole tracks increase the risk of pseudoaneurysms. This technique should, therefore, not be used. (Unit 29)

RL was described by one of the nurses as a well-functioning technique as long as the needling is spread along the whole cannulation route. The whole length of the AVF will then mature evenly. Other nurses stated that the risk of aneurysm increases because RL often tends to be AP instead. RL is also experienced as a more painful technique than BH, and the risk of infiltration is higher. It may also be more difficult to use RL if the vessel is deep, hard to palpate or tortuous.
My experience is that rope ladder often tends to be an area puncture. As time passes, the cannulation route shrinks and an aneurysm develops. (Nurse 9)

Several of the answering nurses advised against AP because it increases the risk of displeasing ‘camel humps’ forming on the AVF. A couple of nurses added that AP is sometimes used anyway if the anatomy of the patient is limited, and no other technique is working.

Area puncture is used on patients in whom the needleling segment, or something else, lead to obstacles to using another cannulation technique, for example aneurysm. (Nurse 24)

To facilitate cannulation, the nurse should find good sites for needling and measure the depth of the AVF. Several local guidelines recommended the use of portable ultrasound. Ultrasound was most often recommended for new AVFs, but it can also be used for other ambiguities.

Ultrasound can be used to image the access if the fistula function is uncertain or when to choose an appropriate cannulation site. (Unit 7)

Use the ultrasound and palpate the AV-fistula to find the optimal cannulation site. (Unit 10)

4.2.3 | Who is taking care of good cannulation technique?

Different professions were mentioned in the local guidelines, and they all had different access assignments. These assignments look a little bit different in different parts of the country. One example is the access nurse or access group. This nurse/group of nurses decide who the first cannulator of the AVF should be, who should create the tunnel track, decide where to cannulate and draw an AVF plan. In some units, the access group/nurse is also the one who cannulates the new AVF.

The access nurse is often the person to whom other nurses report deviations, cannulation difficulties and low AVF-flow. In some units, the access nurse, in consultation with physicians and a vascular surgeon, is mentioned as the one who decides which cannulation technique and needle size should be used for the patient.

Appropriate puncture sites are decided in consultation with the access nurse. (Unit 23)

In some other units, the primary nurse is responsible for the care of the AVF (e.g., measure fistula flow, plan for new tunnel tracks and plan for new needle sites).

The primary nurse is responsible for planning and performance of the needling. (Unit 19)

Experience was also mentioned as important. Some units expressed that only skilled nurses with good cannulation technique should cannulate a new AVF. Other units advocated the discussion of issues surrounding AVF and cannulation with a more experienced colleague.

Some local guidelines stated that a physician should decide when to cannulate the AVF. A couple of units also declared that the physician should be involved in the choice of cannulation technique, especially if the patient has an increased risk of infection and BH is considered. The majority of local guidelines stated that the physician should be contacted when AVF complications are suspected.

In case of a suspected infection, fistula failure, or poor fistula flow, consult a physician. (Unit 21)

Patient participation was encouraged in some of the local guidelines and some of the answers from the nurses. One example was to involve the patient in the cannulation plan or let the patient choose the type of anaesthesia. Nurses stated that patients’ thoughts and ideas may affect the cannulation and where to place the needle.

One patient has his own ideas about how it should be. No one dares to question. (Nurse 18)

4.3 | Integration of results

To determine the extent to which the choice of cannulation technique in AVF is based on the quantitative and qualitative results, they were merged together (File S3). Five meta-themes were found during the integration. Agreement was found in all meta-themes except ‘patient’, for which only partial agreement was found. Some meta-themes also contained silence. However, where silence appeared, at least two other areas from different parts of the analysis agreed. How the five meta-themes connect to each other is shown in Figure 7. The choice of cannulation technique was based on the experience of the nurse in consultation with their colleagues, influenced by guidelines and recommendations, as well as the patient’s thoughts, feelings, and ideas. Guidelines were also influenced by the nurse and patient, and the patients were influenced by both guidelines and nurses. Nurses are interested in AVF cannulation and keen on the wellbeing of the patients and their AVFs. This dedication to good cannulation technique helps them strive for fewer complications and healthy AVFs. The data collected in this study showed that the choice of cannulation technique in Sweden is based on the individual patient, but the ambition is to use BH for the majority of patients.

5 | DISCUSSION

The process of choosing a cannulation technique is based on the nurse, local guidelines and patient and is driven by a dedication
for good cannulation technique and healthy AVFs. The choice is influenced by factors such as anatomic condition, self-cannulation, experienced-based knowledge and possibility of continuity. In the units that participated in this study, the individual choice for cannulation technique is most often BH.

Sweden has a high frequency of BH use (Staaf et al., 2021). This was confirmed during this study, as nurses were asked to describe why and how different cannulation techniques were chosen. Their descriptions were confirmed through both the analysis of local guidelines and the closed-ended answers from nurses in the survey.

National guidelines on vascular access have been developed in some countries, including Spain, United Kingdom, Japan and USA (BRS/VASBI, 2018; Ibeas et al., 2017; Kukita et al., 2015; Lok et al., 2020). Sweden does not have any national recommendations on what cannulation technique to use. The national guidelines included in this study only described prerequisites, such as how to examine the AVF before cannulation and type of disinfectant. The reference made to local guidelines may have been responsible for the differences between dialysis units in this study.

A good cannulation technique has been described as preserving the function of the AVF, preventing infections and other complications (Viecelli et al., 2020), and being quick and easy to use (Wilson & Harwood, 2017). However, good cannulation technique is not exactly the same as successful cannulation. A successful cannulation evaluates only the individual needling attempt as successful or not (van Loon et al. 2010; Wilson & Harwood, 2018). A good cannulation technique, though may lead to successful or failed cannulation but should be used during every dialysis session, as it causes a minimum of damage to the AVF (BRS/VASBI, 2018) and may have positive effects in both the short- and long-term. This desire for the cannulation technique to prevent both direct and indirect complications in the patient was found in both the local guidelines and the nurses’ descriptions of the different cannulation techniques in this study.

Even though both nurses and local guidelines have good cannulation technique as their main goal, evidence is lacking on how good cannulation technique is performed. Comparisons between different cannulation techniques are few and difficult to compare due to different methods, different hygiene routines and poorly described definitions of investigated techniques (Fielding et al., 2021; Gallieni et al., 2019; Pinto et al., 2021). The majority of the local guidelines provided for this study and most of the nurses in this study recommended BH as the standard technique. They confirmed this choice by explaining that this technique prevents complications and prolongs patency in both the short- and long-term. Nurses also

**FIGURE 7** Qualitative and quantitative results merged into a final common result. The choice of cannulation technique may be seen as a process affected by the nurse in consultation with colleagues, the patient, guidelines, and recommendations. The different interactions in this process (nurse—patient, nurse—guidelines, guidelines—patient) are affected by the factors shown in the rectangles. The whole process is influenced by a dedication to good cannulation technique and healthy AVFs and the ambition of choosing a cannulation technique based on both the individual patient and BH.
described BH as easy to use. All of this is in line with the description of a good cannulation technique.

AP was described as the opposite of a good cannulation technique. Both nurses and local guidelines stated that this technique leads to aneurysms and should be avoided. RL can be seen as a technique between BH and AP. RL was described as preventing complications and prolonging patency, but the risk of infiltration was increased and nurses described it as a harder technique to perform. Therefore, BH is most often the first choice. All nurses in the unit should also be able to cannulate all patients without changing the technique. Schmidl et al. (2018) stated that BH requires a special skill compared with RL but, as BH is used in all participating units, everyone knows this skill and practices it daily.

The main reason that international guidelines recommend RL and dissuade nurses from routine use of BH is an increased risk of infection (Lok et al., 2020; Polkinghorne et al., 2013; Schmidl et al., 2018). Some local guidelines in this study mentioned infections when describing AVF complications, and some units advised against using BH if the patient has an increased risk of infection. However, it does not seem like infections are a common complication, as they are so infrequently described compared with other complications, such as aneurism, infiltration, cannulation difficulties and pain. This may be due to the low infection frequency regardless of cannulation technique, and the higher incidence of other complications as previously reported by Swedish dialysis units (Staaf et al., 2021). Even though infection is not mentioned very often, the majority of local guidelines described the units’ hygiene protocol.

Most of the local guidelines in this study did not refer to any international guidelines or studies. This may be due to the research in the area of cannulation being inadequate and local units using their experience-based knowledge to create their own recommendations. As this knowledge is created, it forms a little differently in different units, and misunderstandings may grow from a couple of nurses to the local guidelines. One example of this is that some units described that BH should be avoided if the patient had an AVF in the upper arm, whereas other units described that BH is preferable for an AVF in the upper arm. Another example is the definition of RL. Most of the participating units and nurses described RL as new cannulation sites each time, systematically spread over the whole AVF. In contrast, some units and nurses described RL as a type of BHs technique in which they rotate between several cannulation sites. The creation of new techniques like this has both pros and cons, and it is important to be aware of these differences, so, they can be scientifically tested. New ideas may be better than the usual technique. However, this way of combining RL and BHs is not unique to these units in Sweden. The technique has been described and tested in Portugal and is called ‘multiple single cannulation technique’ (MuST) (Peralta et al., 2021).

Another example of experience-based knowledge is BHs. This technique is favoured by some nurses with the notion that it prevents complications and the patient is satisfied because the needle goes smoothly, as the sharp needle avoids re-cannulation and the trampoline effect. These positive effects from BHs have also been described in an Italian study comparing BHs and BHb (Morselli et al., 2015). Another positive effect of BHs that is mentioned in this study is that new or less-experienced nurses prefer BHs over RL because they do not have to decide where to cannulate; somebody else already has chosen a good site and the nurse only has to concentrate on needling.

BHs is not used and favoured by everyone. The experience-based knowledge in these units is probably mixed with knowledge from the literature (e.g., Ball, 2010; Parisotto & Pancirova, 2018). These units recommend never using sharp needles in BH tracks because they want to protect their AVF and not ruin the created tracks.

In the units that participated in this study, the nurse had the main responsibility for the choice of cannulation technique. This was also reported in earlier studies (Wong et al., 2014). However, it is not the preferences of a single nurse that control the decision. The nurse often makes the choice of cannulation technique in consultation with colleagues. This was also described by Harwood et al. (2016). Nurses often sought out a more experienced colleague when cannulation was difficult. As nurses also learn to cannulate from each other, it is understandable that they use the same kind of technique, especially as nurses prefer to use the same technique they learned when they were new on dialysis (Harwood et al., 2016). However, our results from the comparison between and within units show that, even though nurses within the same unit act significantly more similar through the cannulation process than nurses in different units do, they also approach each process individually, probably due to personal preference, such as the type of tourniquet and whether the needle tube is primed before cannulation.

During the survey, the nurses described that patients were neither involved in nor had an opinion on the choice of cannulation technique most of the time, but in both the written answers and the local guidelines, there are signs of the nurse trying to adapt the cannulation technique for the patient. For example, if one technique is painful or the patient is afraid of needles, the nurse tries to adjust the technique. Nurses also described how patients are only informed orally about the different cannulation techniques. To increase patient participation, it may be possible to create written patient information in the spoken language, such as the newly produced material for haemodialysis patients in the United Kingdom or Spain (BRS/VASBI, 2018; Fielding et al., 2020; Roca-Tey et al., n.d.). This would be in line with person-centred care and quality improvement.

### 5.1 Methodological considerations

The use of both data and method triangulation is one of the strengths of this study. In this way, the research question was illuminated from different views and the answer offered a broader perspective than if only a qualitative or quantitative method or one type of data had been used. The different perspectives in this mixed methods study exhibiting conformity also increased the validity of the result.

This study also has some limitations. For example, the response rate was just over 50%. However, as the responding nurses and units
were spread over the whole country and include hospitals of different sizes, the results may still provide a comprehensive description of the phenomenon. This is strengthened by the fact that nothing new appeared during the last analysed questionnaires or local guidelines. In addition, during self-assessment, most people tend to rate more to their own advantage than the actual value. To obtain a more descriptive narrative on the matter, qualitative interviews should have been used.

Parts of the results may also be difficult to generalise because BH is more common in Sweden than in most other countries. However, the description of the process of choosing a technique may be recognisable to other dialysis providers in other countries.

6 | CONCLUSION

The incentive for the nurse in choosing a cannulation technique is to individualise needling to the patient while adjusting it to local recommendations to achieve a good cannulation technique and healthy AVFs. The majority of Swedish dialysis nurses and dialysis units describe BHb as their standard needling technique because BHb is considered a good cannulation technique that is easy to use and prevents complications.

7 | RELEVANCE TO CLINICAL PRACTICE

Our results provide insights into why cannulation techniques are chosen differently in different dialysis units. They also highlight some shortcomings in the local guidelines, such as the lack of references. This may raise awareness of the importance of evidence-based guidelines and create opportunities for knowledge exchange across unit and region boundaries. Raising awareness of the process underlying the choice of cannulation technique may make the decision more individualised if patient participation can be increased. The study may also help nurses remember the importance of staying up to date and reflecting on and sometimes questioning their own way of working. Raising awareness of the different parts of cannulation may also lead to increased understanding of the clinical importance in achieving good cannulation technique and care of AVFs.

This study highlights the need for further studies on both cannulation technique and prerequisites, such as tourniquet and hygiene routines, as the lack of evidence may be one of the reasons for some of the differences between the units in this study.

ACKNOWLEDGMENTS

The authors thank Marika Wenemark for advice and support during the creation of the questionnaire, the four nurses who took part in the creation of the survey, and all nurses and dialysis units for their participation.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable due to privacy/ethical restrictions.

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REFERENCES


SUPPORTING INFORMATION
Additional supporting information can be found online in the Supporting Information section at the end of this article.