BRS VASCULAR ACCESS Special Interest Group

Clinical Practice Recommendations for Use of Buttonhole Technique for Cannulation of Arteriovenous Fistulae

THE RENAL ASSOCIATION FOUNDED 1950 British Renal Society Patient Safety

BRITISH RENAL SOCIETY MULTI-PROFESSIONAL TEAM

Foreward

Vascular access remains the Achilles heel of haemodialysis. On a population basis, arteriovenous fistula remains the gold standard. It offers a reduced risk of infection, longer duration of an individual access and the potential for more reliable haemodialysis, but there are still challenges faced to maintain vascular access and minimise harm.

Whilst an arteriovenous fistula is not possible in all patients, there remains the challenge to reduce harm to individuals and reduce the burden to the system. There has therefore been a focus on how an arteriovenous fistula is used – i.e. the cannulation technique.

Whilst buttonhole as a technique has been described for many years, in the UK interest has increased only over the last few years. There is evidence of benefit for individuals around reduced pain, better patient involvement and improved longevity of access. However there remain significant concerns about infection risk and the logistic challenges of establishing buttonhole sites.

This guidance is therefore welcome. It provides practical guidance from centres in the UK with extensive experience of using buttonhole cannulation, both within in-centre programmes and home haemodialysis populations. They have been developed by consensus of a multi-professional team and are intended to support the uptake of buttonhole technique and increase understanding to mitigate associated risk.

I would like to congratulate the faculty, ably led by Katie Fielding and Mick Kumwenda, both on the content of the guidance and also producing a true multi-professional document.

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Background

Buttonhole cannulation is a technique used to cannulate arteriovenous fistulae used for haemodialysis. It has recently undergone resurgence in the haemodialysis community due to a number of identified benefits when using it for repetitive, frequent cannulation.

Some of the identified benefits of buttonhole technique include:

- Prolonged arteriovenous fistula life span (1- 4) and reduction in interventions to prolong arteriovenous fistula life span (2)
- Prevention and reduction of aneurysm development (2,3,5,6)
- Reduced frequency of infiltration and haematoma formation following cannulation (2,3,7- 9)
- Reduced pain during cannulation (3,6,7,9)
- Reduced bleeding at the end of haemodialysis treatments (7)
- Promotes self-cannulation (6,7,10)

In the UK, both buttonhole and rope ladder technique are cannulation techniques recommended by the Renal Association, as both techniques are associated with prolonged fistula life span (11).

Buttonhole technique involves cannulating an arteriovenous fistula vein in exactly the same place each time. As this consistent cannulation is difficult to achieve, the technique has progressed to involve development of a collagen track that can be used to guide the needle to enter the vein at exactly the same place each time. Development of this track requires cannulation in the same manner each time using sharp needles, preferably by the same individual. Once this track has been developed, blunt or dull needles are used to ensure damage does not occur to this track during cannulation. The scab formed from the previous cannulation has to be removed prior to next cannulation.

Whilst buttonhole technique is associated with the identified benefits outlined above, it is also associated with an increase in infection rates (1,3,5- 8,10-16). However, what causes the increase in infections is unclear and individual units have varied experiences (6,14). Some units have abandoned buttonhole technique due to the associated increase in infection rates (8,12), whilst others have instigated practices to minimise the infection risk in order to continue with buttonhole technique (5,13-16). Within the UK, a similar picture has evolved with some units escalating concerns to RA-BRS Patient Safety. It became obvious that further investigation was needed to identify strategies to minimise the risk.

Methodology

A meeting was arranged between dialysis units who were identified as having success with buttonhole technique. Some of these units had overcome 'spikes' in buttonhole associated infections. Present at this meeting were experienced haemodialysis nurses, specialist vascular access nurses, home haemodialysis nurses, nurse educators, nephrologists and a passionate industry representative. This meeting identified some similarities in good clinical practice in the prevention of infections associated with buttonhole technique, some of which are supported by research findings. These recommendations were borne out of this meeting and identify practices that aim to prevent infections associated with buttonhole cannulation. As can be seen, not all the answers are available yet and there are still many points that require further investigation.

Through this work, the following areas of good practice have been identified as key in preventing infections associated with buttonhole technique:

A) Screening and Selection of Patients to Undergo Buttonhole Cannulation
B) Track Development and Cannulation for Buttonhole Cannulation of Arteriovenous Fistulae
C) Disinfection Procedure and Scab Removal Prior to Buttonhole Cannulation of Arteriovenous Fistulae
D) Mupirocin use with Buttonhole Cannulation of Arteriovenous Fistulae
E) Patient Information, Engagement and Training in Buttonhole Cannulation
F) Training, Education and Monitoring of Healthcare Staff Performing Buttonhole Cannulation on Arteriovenous Fistulae

These have provided the structure for the recommendations.

Summary of Clinical Practice Recommendations

Recommendation A: Screening and Selection of Patients to Undergo Buttonhole Cannulation

1) All patient undergoing buttonhole cannulation should undergo screening for MRSA and MSSA including their arteriovenous fistula site, a minimum of every 3 months.
2) Decolonisation should occur for patients who are positive for MRSA.
3) Patients should be individually risk assessed by the renal team before undertaking buttonhole cannulation.
4) Use of specific buttonhole sites should be reviewed in certain situations and cessation of use of sites considered.
5) Root cause analysis should be undertaken in all bacteraemias episodes in haemodialysis patients.

Recommendation B: Track Development and Cannulation for Buttonhole Cannulation of Arterio- Venous Fistulae

1) Track Development

i. The depth and direction of needle insertion need to be consistent during the track development phase, to allow a consistent collagen track to develop.
ii. A tourniquet may or may not be used during track development, with decisions made on an individual basis. However, tourniquet use should be consistent with either use at all times or not at all.
iii. Buttonhole track development should ideally occur with established arteriovenous fistulae only, to ensure the vein does not change over time. The period of time between first cannulation and established arteriovenous fistulae is not set and should be set on an individual basis.
iv. Track development on the arterial and venous needle site can occur at different times, dependant on the maturity of each site.
v. When the sharp needle glides in place with no resistance, smooth/blunt needles can be attempted. This should occur after 6-12 cannulations using sharp needles.
vi. If the track is not established and blunt needles unable to be inserted after 12 sessions of sharp needle cannulation, further assessment of the buttonhole sites should occur with consideration as to whether different sites need to be developed.

2) Buttonhole Sites

i. Avoid developing buttonhole sites on dips, curves, aneurysms on the fistula vein or any area with abnormal skin integrity.

ii. 1 patient can have 3-4 active buttonhole sites at one time, to allow rotation of sites. This is particularly useful for patients who dialyse more than 3 times a week.

3) Buttonhole Cannulation

i. The arm and hand position should remain consistent through track development and further blunt needle cannulation to ensure alignment of the track and vein.
ii. Communication should continue following the track development phase, to ensure all cannulators are aware of the track direction.
iii. The blunt needle should glide down the track and not require excessive force to cannulate. The force applied during cannulation can be minimised by holding the tubing rather than the needle wings during cannulation.
iv. The external steel shaft of the needle should never be 'wetted' with sterile or non-sterile solutions prior to insertion.
v. On insertion of the needle, 1-2mm of steel should be visible to prevent hubbing of the needle site.
vi. Once inserted, it is not recommended that a blunt needle is rotated.

4) Troubleshooting Buttonhole Cannulation

i. If the blunt needle is not entering the vein smoothly, check the arm and hand position of the patient and track direction to ensure the cannulation technique and track position remains consistent at all times.
ii. If one blunt needle will not enter the vein, cannulation should be attempted with a second blunt needle.
iii. If a second blunt needle cannot be inserted, **it is not advised that a sharp needle is used in the track.** A sharp needle cannulation can be performed at least 2 cm above the buttonhole site. If space is not available above the buttonhole site, then a site at least 2cm below the buttonhole site can be used.

Recommendation C: Disinfection Procedure and Scab Removal for Prior to Buttonhole Cannulation of Arteriovenous Fistulae

1) All patients should wash their hands and fistula limb with soap and water prior to cannulation.
2) 0.5% - 2% chlorhexidine gluconate with 70% isopropyl alcohol should be used to clean the cannulation sites. If the patient is allergic to chlorhexidine, then Povidone Iodine solutions or Octenilin should be used to disinfect prior to cannulation.
3) The recommended contact and drying time for the disinfectant following cleaning, should always be strictly adhered to.

4) Cannulation sites should be disinfected immediately before and after scab removal.
5) Softening of scabs prior to removal is not recommended.
6) Sterile tweezers or sterile picks which are supplied with the dull/blunt needles or separately should be used to remove the scab.
7) To prevent infectious complications, the complete whole scab should be removed prior to cannulation of the buttonhole site.

Recommendation D: Mupirocin use with Buttonhole Cannulation of Arteriovenous Fistulae

1) Topical 2% mupirocin ointment / cream should be applied to the cannulation sites of all patients undergoing buttonhole technique, who are considered to have a high infection risk. The ointment / cream should be applied following needle removal and cessation of bleeding from cannulation site, after each haemodialysis treatment and left in place for approximately 12 hours.
2) All patients receiving 2% mupirocin ointment / cream regularly should undergo nasal screening for mupirocin resistant *Staphylococcus Aureus.*
3) Patients who develop mupirocin resistance must not continue to use 2% mupirocin, until mupirocin sensitivity is restored. Each case should be risk assessed and consideration given as to whether buttonhole technique should be discontinued or an alternative antibacterial used.

Recommendation E: Patient Information, Engagement and Training in Buttonhole Cannulation

It is critical that patient engagement with the care and management of their vascular access should take place as early as possible, ideally in the preparation stages before starting haemodialysis.

Recommendation F: Training, Education and Monitoring of Healthcare Staff Performing Buttonhole Cannulation on Arteriovenous Fistulae

1) All healthcare staff (registered or unregistered) who are learning to cannulate arteriovenous fistulae must have a theoretical understanding of:
    i. What an arteriovenous fistulae is including relevant anatomy and physiology
    ii. Understand different cannulation techniques, including associated risks and complications
2) Following theoretical teaching, all healthcare staff (registered or unregistered) that are learning to cannulate arteriovenous fistulae should have a period of supervised clinical practice of arteriovenous fistula cannulation, using experienced cannulators to supervise learners.

3) An assessment of competency of cannulation of arteriovenous fistulae should occur for all healthcare staff (registered or unregistered), prior to performing this skill independently.
4) All healthcare staff (registered or unregistered) who perform arteriovenous fistula cannulation should be:
    i. Reassessed every 2 years
    ii. Receive an annual theoretical update on arteriovenous fistula care.
5) Regular monthly audits should occur of cannulation practice, to ensure everyday practice adheres to infection control and cannulation policy.

Recommendation A: Screening and Selection of Patients to Undergo Buttonhole Cannulation

1) All patient undergoing buttonhole cannulation should undergo screening for MRSA and MSSA including their arteriovenous fistula site, a minimum of every 3 months.
2) Decolonisation should occur for patients who are positive for MRSA.
3) Patients should be individually risk assessed by the renal team before undertaking buttonhole cannulation. The following factors should be considered as to whether buttonhole technique is safe to use or should be avoided:
    i. MSSA and MRSA positive patients (until negative from decolonisation)
    ii. Patients with mupirocin-resistant strains of *Staphylococcus Aureus*
    iii. Patients with a history of reoccurring infections, particularly vascular access infections
    iv. Patients with a prosthetic heart valve, pacemaker or history of endocarditis
    v. Patients on immunosuppressive agents
    vi. Patients with poor personal hygiene
    vii. Patients with poor adherence to recommended cleaning techniques (e.g. refuse to wash arm prior to cannulation; self-cannulate and do not adhere to correct procedure)
    viii. Patients with skin conditions that leads to scratching of the area around the buttonhole cannulation sites
    ix. Patients where track formation does not occur promptly or is problematic, leading to prolonged use of sharp needles and risk of multiple track formation
    x. Patients considered a high infection risk due to other factors
4) Use of specific buttonhole sites should be reviewed in the following situations and cessation of use of sites with these issues should be considered:
    i. Hubbing of the site
    ii. Sharp needle cannulation required regularly to cannulate the buttonhole site
    iii. Signs of infection at the site
    iv. Enlarging entry site or signs of tissue damage
    v. Prolonged bleeding from buttonhole site
    vi. Significant pain/discomfort during insertion
5) Root cause analysis should be undertaken in all bacteraemias episodes in haemodialysis patients.

Rationale for Recommendation A

Rationale for Recommendations A:1-2

Screening of renal dialysis patients for MRSA was recommended in 'Saving Lives' (17). Whilst recommendations have been updated, renal dialysis patients continue to be considered at high risk of infections and screening for MRSA is still recommended in this population (18). Introduction of screening for MRSA and subsequent isolation and decolonisation of identified patients has been associated with a reduction in bacteraemias (19), especially in high risk areas including Intensive Care Units (20,21) and dialysis units (22,23). Therefore, screening of dialysis patient undergoing buttonhole technique is crucial in preventing infections. Not only does this allow decolonisation and appropriate isolation, but also allows high risk patients to be 'de-selected' from the use of buttonhole technique.

Evidence for screening of MSSA is less obvious, as some studies have shown that screening, decolonisation and other techniques are less effective at preventing MSSA bacteraemias (24). Therefore, recommendations for MSSA screening are less clear. However, Tacconelli et al's (23) reviewed the effect of decolonisation of dialysis patients for all *Staphylococcus Aureus* positive screens and found decolonisation to be effective in all cases. Considering this and the higher risk of infection of buttonhole technique compared to other cannulation techniques, screening for MSSA leading to a risk assessment and deselection of 'high-risk' patients, may prevent infections associated with buttonhole technique.

Rationale for Recommendation A:3

Whilst some studies highlight the increased risk of infections associated with buttonhole technique and elude to careful patient selection (6-8, 15), the issue of screening for infections and criteria to exclude patients from buttonhole technique are not discussed. At present, due to lack of evidence, clinical judgement should be used to risk assess each individual patient.

Rationale for Recommendation A:4

The issues identified in this recommendation have been associated with poor outcomes with buttonhole cannulation. Hubbing (described later in the document) and sharp needle cannulation into established buttonhole tracks have both been associated with an increase in infections (25,26). Concern has also been raised that repetitive cannulation in the same area during buttonhole cannulation can lead to problems with skin integrity over the arteriovenous fistula, increasing the haemorrhage risk. As with any cannulation technique, close monitoring of the skin should always occur to identify any degradation in skin integrity.

Rationale for Recommendation A:5

Root cause analysis of all bacteraemia episodes in patients who undergo buttonhole cannulation will allow identification of the cause of the infection. This will guide further practice in preventing infections and identifying patients at high risk, in who buttonhole technique should be discontinued or avoided.

Points for Future Consideration

Whilst there has been extrapolation of evidence into the buttonhole context for this guidance, there have been few studies into screening and selection of patients. The following points are recommended as requiring further investigation:

1) Should decolonisation occur for MSSA positive patients?
2) What is the best decolonisation regime?
3) How many times should you decolonise with a re-occurring positive patient?
4) What factors increase a patient's risk of developing an infection associated with buttonhole technique?

A screening tool for selecting or deselecting patients from buttonhole technique is required, which could eliminate some infections. Royal Berkshire renal unit has developed one such tool (Appendix 1), which has further been adapted for use by Oxford renal unit (Appendix 2). However, the recommended content of an accurate screening tool still needs to be validated.

Recommendation B: Track Development and Cannulation for Buttonhole Cannulation of Arterio- Venous Fistulae

1) Track Development

i. The depth and direction of needle insertion need to be consistent during the track development phase, to allow a consistent collagen track to develop. This is best with the following recommendations:
   a) Track development should ideally involve only one cannulator.
   b) If 1 cannulator is not feasible, then track development can occur between a maximum of 3 cannulators. In this instance, systems need to be in place to ensure communication between all cannulators, to ensure each cannulator implements the same technique, using the same angle and depth each time.
   c) If the patient is to self-cannulate, if feasible, the patient should be supported to be the cannulator during the track development phase.

ii. A tourniquet may or may not be used during track development, with decisions made on an individual basis. However, tourniquet use should be consistent, with either use at all times or not at all.

iii. Buttonhole track development should ideally occur with established arteriovenous fistulae only, to ensure the vein does not change over time. The period of time between first cannulation and established arteriovenous fistulae is not set and should be decided on an individual basis. Factors that can indicate an established arteriovenous fistula ready for track development include (this is not an exhaustive list):
   a) The vein length, depth and diameter is not expected to mature and change rapidly.
   b) Adequate vein length to insert 2 needles reasonable distance apart – what this distance is will vary dependant on the fistula type, but further maturing of the vein to allow cannulation higher up the vein should not be expected at this stage. As a minimum, each needle should be 5cm apart and at least 5cm from the anastamosis.
   c) Both needle sites adhere to the ‘Rule of 6’ (flow greater than 600mls/min, diameter of 0.6cm and no deeper than 0.6cm (32))
   d) Ability to cannulate both sites without problem, allowing the needle to enter the vein in one uninterrupted movement.
   e) Both sites can be cannulated with the needle gauge required to provide the desired blood flow rate. For majority of patients this will be 14g or 15g needles.

iv. Track development on the arterial and venous needle site can occur at different times, dependant on the maturity of each site. If the arterial site is

mature, but the segment of vein for the venous site still requires further maturation, the arterial buttonhole site can be established whilst performing rope ladder technique further up the vein.

v. When the sharp needle glides in place with no resistance, dull/blunt needles can be attempted. This should occur in 6-12 cannulations using sharp needles.
vi. If the track is not established and blunt needles unable to be inserted after 12 sessions of sharp needle cannulation, further assessment of the buttonhole sites should occur with consideration as to whether different sites need to be developed.

Rationale for Recommendation B:1

Buttonhole cannulation relies on consistent development of a collagen track of scar tissue that the needle follows to the arteriovenous fistula vein during the cannulation (6, 27). This ensures the needle enters the vein at the same place during each cannulation (6,27). The track development phase is crucial in ensuring a consistent track is developed (15). During this phase sharp needles are used to develop the track, but this needs to be done in exactly the same manner each time (15). A single cannulator is recommended to avoid potential inconsistencies with track alignment (28). However it is acknowledged this is difficult to achieve in busy in-centre units, so a method of communication amongst staff is vital to minimise false track formation (12). Excellent communication amongst staff is essential and can be in the form of photographic images or drawings (3). Clearly defined information on both the depth (angle from skin to hub) and the direction of needle insertion is required e.g. comparing the fistula vessel and needle position to a clock face (27,28). A maximum of 3 nurses can be used during track formation, which still allows consistent tracks to be formed. If there are plans for self-care or home haemodialysis then the patient could be encouraged to form the tracks (2). Other aspects that may also alter the arteriovenous fistula vein need to be consistent during the track formation phase i.e. arm placement, hand placement, use of tourniquet.

False tracks can occur if there have been multiple cannulators (27) or the original angle of entry is not followed (9). It is thought false tracks could be reservoirs for infection (15) and result in cannulation of the vessel wall at differing points, resulting in area puncture, increasing the risk of aneurysm and stenosis formation.

2) Buttonhole Sites

i. Avoid developing buttonhole sites on dips, curves, aneurysms on the fistula vein or any area with abnormal skin integrity.

ii. 1 patient can have 3-4 active buttonhole sites at one time, to allow rotation of sites. This is particularly useful for patients who dialyse more than 3 times a week.

Rationale for Recommendation B:2i

Skin integrity can be compromised over aneurysms. Haemorrhage is a significant risk with arteriovenous fistulae (29) and should not be exacerbated through repetitive use of aneurysmal sites for cannulation.

Rationale for Recommendation B:2ii

Use of multiple buttonhole sites provides a back-up site in case there are problems with citing one of the blunt needles. This particularly works well for patients who are undertaking more than 3 sessions per week, as it enables sites to rest and avoid soreness at the site (6, 27).

3) Buttonhole Cannulation

i. The arm and hand position should remain consistent through track development and further blunt needle cannulation to ensure alignment of the track and vein.
ii. Communication should continue following the track development phase, to ensure all cannulators are aware of the track direction.
iii. The blunt needle should glide down the track and not require excessive force to cannulate. The force applied during cannulation can be minimised by holding the tubing rather than the needle wings during cannulation.
iv. The external steel shaft of the needle should never be ‘wetted’ with sterile or non-sterile solutions prior to insertion.
v. On insertion of the needle, 1-2mm of steel should be visible to prevent hubbing of the needle site.
vi. Once inserted, it is not recommended that a blunt needle is rotated.

Rationale for Recommendation B:3i-ii

To ensure successful blunt needle insertion, the blunt needle needs to glide down the track. To allow this to occur the cannulation needs to copy exactly the technique used during the track development phase (15). Therefore, conditions for cannulation need to remain consistent. Visual communication aids can support this consistency (27). These aspects require consideration before attempting a blunt needle cannulation, as miscannulation is a frequent complication of buttonhole cannulation (2).

Rationale for Recommendation B:3iii

Whilst blunt needles are used to minimise the damage to the collagen track, excessive force should not be used with a blunt needle as this can still damage the track (25).

Rationale for Recommendation B:3iv

Introducing another solution onto the external needle shaft prior to insertion provides another vector for infection and so should be avoided. Whilst claims have been made that this can make the needle slide in easily, there is no evidence at present to suggest this is correct.

Rationale for Recommendation B:3v

Hubbing is when the hub of the needle is pushed into the skin causing the needle entrance to stretch, becoming concave and over granulated. The scab becomes difficult to remove, increasing the infection risk (25).

Rationale for Recommendation B:3vi

Rotating the needle 180^0 after cannulation can stretch the buttonhole site, which is not recommended (9, 30). This can lead to development of a conical track which may result in future miscannulation (27), oozing during treatment and an increased risk of infection (9).

4) Troubleshooting Buttonhole Cannulation

i. If the blunt needle is not entering the vein smoothly, check the arm and hand position of the patient and track direction to ensure the cannulation technique and track position remains consistent at all times.
ii. If one blunt needle will not enter the vein, cannulation should be attempted with a second blunt needle.
iii. If a second blunt needle cannot be inserted, it is not advised that a sharp needle is used in the track, but a sharp needle cannulation performed at least 2 cm above the buttonhole site. If space is not available above the buttonhole site, then a site at least 2cm below the buttonhole site can be used.

Rationale for Recommendation B:4

Miscannulation is common complication of buttonhole cannulation, especially when using blunt needles (27). Breaks in cannulation into the site can make the track harder to cannulate, with sites often harder to cannulate after a 2 day break from haemodialysis. Changes in tissue condition, which can particularly be altered by fluid

status in a haemodialysis patient, can also alter the track making it problematic to cannulate. Difficulties with placing a blunt needle have the potential for increased sharp usage which is not recommended (26). It is not recommended to put a sharp needle into an established track due to the potential for cutting the established track and creating false tracks, which in turn makes placing a blunt needle even more difficult (27). Prolonged intermittent usage of sharp needles and extensive needle probing to overcome the misalignment will damage the existing track and create false tracks, which is also associated with an increased infection risk (26). If other troubleshooting methods fail, placing a sharp needle at least 2cm above the buttonhole site avoids trauma to the established track.

Points for Future Consideration

Not all advice included in these recommendations has yet been clarified by research. However, these are good practice points identified by experienced renal nurses across multiple units, who are experienced at performing buttonhole cannulation. Points for further investigation, consideration or basis for further projects could include:

- Is there a technique that assists with blunt needle insertion, reducing missed cannulation? Once such recommended practice was twisting the needle, but there is concern this may stretch the buttonhole site.
- Why does the transition onto blunt needles fail in some individual patients?
- What are the major reasons for missed cannulations?
- Does inserting the needle bevel up or bevel down alter the cannulation and is this different for buttonhole cannulation?

Recommendation C: Disinfection Procedure and Scab Removal Prior to Buttonhole Cannulation of Arteriovenous Fistulae

1) All patients should wash their hands and fistula limb with soap and water prior to cannulation.
2) 0.5% - 2% chlorhexidine gluconate with 70% isopropyl alcohol should be used to clean the cannulation sites. If the patient is allergic to chlorhexidine, then Povidone Iodine solutions or Octenilin should be used to disinfect prior to cannulation.
3) The recommended contact and drying time for the disinfectant following cleaning, should always be strictly adhered to.
4) Cannulation sites should be disinfected immediately before and after scab removal.
5) Softening of scabs prior to removal is not recommended.
6) Sterile tweezers or sterile picks which are supplied with the dull/blunt needles or separately should be used to remove the scab.
7) To prevent infectious complications, the complete scab should be removed prior to cannulation of the buttonhole site.

Rationale for Recommendation C

The first line of defence to prevent access infections is proper preparation of the sites prior to cannulation. With buttonhole technique the key points need to be good disinfection of the cannulation sites pre and post scab removal and the correct and careful removal of the scab at the buttonhole site (13,15,16). Washing of the arm prior to cannulation (13,15,16, 31) and disinfection of the cannulation site before and after scab removal (1,13,15,16) is thought to reduce infectious complications, although no research has been conducted to clarify this.

The solution used to disinfect cannulation sites is also believed to be important in preventing infections. NKF KDOQI guidelines (32) recommend 2% chlorhexidine gluconate / 70% isopropyl alcohol as this has a rapid (30 seconds) and persistent (up to 48 hours) antimicrobial activity on the skin. 0.5% chlorhexidiene / 70% isopropyl alcohol is used in some centres (1,14), with no cited problems with infections. These centres use mupirocin on needle sites post dialysis (14). Povidone iodine can be used to disinfect skin prior to cannulation, but needs to be applied for 2-3 minutes for its full bacteriostatic action to take effect and must be allowed to dry prior to cannulation (15). Therefore, whilst used routinely by some units (13), this is a less pragmatic disinfectant but can be used if the patient is allergic to chlorhexidine.

However, it is important to ensure when using products for skin preparation that manufacturers advice is adhered to which should include technique of application, contact time and drying times to effectively kill bacteria (15,31). Octenilin has been used by 1 unit when chlorhexidine sensitivity developed, with good results (33). Water or saline has no disinfectant properties and is not a recommended.

Complete whole scab removal is recommended (13,15) to prevent particles, which contain bacteria, from entering the blood stream. It is important that this step should not be performed hastily (13). Soaking of scabs to soften prior to removal is thought to cause the scab to rupture into multiple pieces and so is not recommended. Scab removal needs to occur with a blunt, sterile object to prevent complications from utilising invasive tools, which can include scraped, ragged or torn tissue at the mouth of the tunnel (13) leading to wide tunnel mouths and infections from using non-sterile tools (16). Wide tunnel mouths may encourage entry of bacteria into the track and may result in large, often bulbous, scabs post treatment (31,34).

Points for Future Consideration

Whilst the above recommendations have been able to be made on best available evidence, there are some aspects that still require further investigation or clarification, as outlined below:

- It is unclear whether 0.5% or 2% chlorhexidine (both with 70% isopropyl alcohol) is the best cleaning solution to use pre cannulation of arteriovenous fistulae. Whilst 2% is recommended in many general guidelines, it is unclear whether the repetitive use on arteriovenous fistulae may cause complications related to either skin necrosis or sensitivity (29). Work needs to be done on what is the optimal cleaning solution for regular use on arteriovenous fistulae.
- Octenilin has been identified by one unit as an appropriate cleaning solution for patients with chlorhexidine allergy (33). Further investigation needs to occur to identify if this could be suitable alternative disinfectant to chlorhexidine.
- Covering the scabs with disinfectant soaked gauze for 1-2 minutes prior to scab removal may be associated with prevention of infections related to buttonhole cannulation. However, this is of yet unproven and requires further investigation to clarify whether this makes a difference.

Recommendation D: Mupirocin use with Buttonhole Cannulation of Arteriovenous Fistulae

1) Topical 2% mupirocin ointment / cream should be applied to the cannulation sites of all patients undergoing buttonhole technique, who are considered to have a high infection risk. The ointment / cream should be applied following needle removal and cessation of bleeding from cannulation site, after each haemodialysis treatment and left in place for approximately 12 hours.
2) All patients receiving 2% mupirocin ointment / cream regularly should undergo screening for mupirocin resistant *Staphylococcus Aureus.*
3) Patients who develop mupirocin resistance must not continue to use 2% mupirocin, until mupirocin sensitivity is restored. Each case should be risk assessed and consideration given as to whether buttonhole technique should be discontinued or an alternative antibacterial used.

Rationale for Recommendation D

The routine application of mupirocin ointment or cream post dialysis to all patients with native arterio venous fistulae on buttonhole cannulation method has proved successful at preventing bacteraemia episodes (14). However, there is concern that application of mupirocin ointment or cream regularly to all patients, will lead to the development of mupirocin resistant *Staphylococcus Aureus* in individuals (35). Therefore, resistance to mupirocin should be monitored. Mupirocin application should be discontinued as soon as resistance is identified.

Points for Future Consideration

The following aspects are not yet clarified and could be points for further investigation, consideration or basis for further projects:

- Nesrallah et al (14) recommend the use of topical 2% mupirocin cream use for all patients undergoing buttonhole technique. However, it is unclear whether long term use will lead to problematic mupirocin resistance. This risk needs to be assessed and until ascertained, use for all patients cannot be recommended.
- Whilst mupirocin use can be justified for high risk patients, definition of which patients are considered high risk requires further work. This could partially be ascertained through the screening process recommended in ‘Screening and Selection of Patients to Undergo Buttonhole Cannulation’. However, causes of

bacteraemias associated in buttonhole technique need to be ascertained to identify high risk patients (14).

- Alternatives to 2% mupirocin ointment / cream need to be evaluated for patients with mupirocin resistant *Staphylococcus Aureus.* Inadine gauze (14), Octenilin and Naseptin cream are alternatives that require evaluation.

Recommendation E: Patient Information, Engagement and Training in Buttonhole Cannulation

It is critical that patient engagement with the care and management of their vascular access should take place as early as possible, ideally in the preparation stages before starting haemodialysis. The ideal time to begin this process is when a patient starts pre dialysis education. Patient information on buttonhole cannulation techniques is widely available; however there is less existing literature on strategies for engaging patients in the care of not only their buttonhole, but also taking on a personal responsibility for their arteriovenous fistula, which is their lifeline to successful dialysis treatment. The literature referred to is therefore very much sourced from the patient perspective, for example online patient educational programmes and patient information booklets and resources. (36, 37)

Patients who have an increased awareness, and more importantly, are engaged with the clinical staff in their care of their fistula, as well as their buttonholes, can be expected to have a better survival outcome for their access (38).

Specific recommendations:

- Pre-dialysis clinic discussions should be held to outline vascular access options. The patient's involvement in this choice and the implementation of that access are critical (39).
- Educational material should be available for all patients who are about to begin dialysis. This should be written at a level that is generally understood by the patient and be available in alternative language formats. This material needs to be augmented by education from clinical staff, making adjustments appropriate to individual patient's skills and understanding (40).
- Prior to any fistula surgery, it is critical that the patient and the clinical staff ensure, where at all possible, that the patient's fistula is created in a position that could enable self-cannulation in the future (39).
- When the buttonhole track is about to be formed it is important to again involve the patient to ensure that they can easily manipulate the needles themselves to gain access. If the patient is keen to self-cannulate then they should be encouraged and assisted in creating the track themselves. Training programmes for self-cannulation should be structured to work at the pace set by the patient, allowing them to build their expertise and confidence (40).
- Formation of the track process offers an increased amount of one-on-one time for the nurse with the patient. This offers an opportunity to engage in conversations about the understanding of the fistula and how it works, how to assess changes in the buttonholes over time and also the importance of the

skin site preparation process, especially the appropriate drying times for the solution chosen.

- Once the patient has an established track the nursing staff should encourage patient engagement in discussing the sensations during needling, recalling the positioning of the limb and hand that is optimal for them and to note any changes in the fistula's location or thrill (40).
- Continuing careful assessment of the buttonhole sites is critical for sustainable vascular access and the engaged patient will be best placed to assess and note any changes or difficulties with cannulation, thus facilitating timely and appropriate intervention (40).

In order for patients' to increase their engagement with their vascular access, there needs to be a multi-disciplinary approach to support clinical staff in this challenging task (41,42). Some examples of methods of engagement developed by some centres are as follows:

- Having the patient empowered to observe how long the cleaning solution has been on the access sites and to inform the nurse that there has been sufficient time past to initiate cannulation.
- Based upon a patient's knowledge of their fistula and buttonhole track, the clinical team should encourage the patient to attempt the cannulation themselves. Nurses should emphasise the fact that only the patient is truly aware of the sensation of the needle going down the track, and so they are best suited to do subtle alterations of the limb position to allow the needle more easily slide down the track (37).
- Patient anger in the dialysis unit can be a sign of frustration that they are out of control of their treatment. This could be channelled into them taking increased personal responsibility by communicating to them that they are probably better placed to outperform the professional staff as they understand their body best.

Points for Future Consideration

The following aspects could be points for further investigation, consideration or basis for further projects:

- Very little evidence is available that identifies the benefits of engaging patients in their vascular access care, how to engage them in their vascular access care and what support they may need. Further work needs to be done to provide this evidence base.

- Like staff, patients require education to learn how best to care for their vascular access and cannulate their arteriovenous fistula. However, this information and education needs to be tailored to patients' needs, rather than using staff education packages. Consideration needs to be given to what is the best way to do this and what content is required to provide this support to patients on:
    - Vascular access information and care
    - Cannulation of arteriovenous of fistula.

  Whilst many individual units have their own ideas, there is little coherence on this across renal units and minimal work on identifying patient needs in this area.

- Patients require on-going support to continue cannulating their arteriovenous fistula, including support with troubleshooting and monitoring of adherence to procedures. However, the best way to provide this to patients requires further investigation.

Recommendation F: Training, Education and Monitoring of Healthcare Staff Performing Buttonhole Cannulation on Arteriovenous Fistulae

1) All healthcare staff (registered or unregistered) who are learning to cannulate arteriovenous fistulae must have a theoretical understanding of:
    i. What an arteriovenous fistulae is including relevant anatomy and physiology
    ii. Understand different cannulation techniques, including their risks and complications
2) Following theoretical teaching, all healthcare staff (registered or unregistered) that are learning to cannulate arteriovenous fistulae should have a period of supervised clinical practice of arteriovenous fistula cannulation, using experienced cannulators to supervise learners.
3) An assessment of competency of cannulation of arteriovenous fistulae should occur for all healthcare staff (registered or unregistered), prior to performing this skill independently. No-one should cannulate an arteriovenous fistula independently, without this assessment.
4) All healthcare staff (registered or unregistered) who perform arteriovenous fistula cannulation should be:
    i. Reassessed every 2 years
    ii. Receive an annual theoretical update on arteriovenous fistula care.
5) Regular monthly audits should occur of cannulation practice, to ensure everyday practice adheres to infection control and cannulation policy.

Rationale for Recommendation F

Rationale for Recommendations F:1-3

Education and knowledge of healthcare staff (both registered and unregistered) performing cannulation of arteriovenous fistulae is crucial to ensure safe cannulation that minimises complications and optimises arteriovenous fistula life span (2). The cannulator will choose where the needles are inserted, how they are inserted and whether they adhere to recommended policy, all of which dictates the success of the cannulation and preservation of arteriovenous fistula function (2). This process involves clinical decision making, which not only requires knowledge, but also clinical experience, the opportunity to reflect on experience and mentorship from experienced staff (43). To develop the skill of cannulating multiple, varying arteriovenous fistulae, healthcare staff require knowledge and the opportunity to practice the skill through teaching and clinical support. This enables staff to develop

cannulation skills that will preserve vascular access function (2,44). Bonner and Greenwood's (45) research highlights cannulation as a skill that requires expertise to develop and Copperthwaite et al (46) found that a competency education programme (including vascular access care) improved the quality of nursing care in haemodialysis. If cannulation skills are not developed, central venous catheter use can increase (2,47). O'Brien et al (12) hypothesised, following their analysis of infectious episodes related to buttonhole technique, that expertise was required to utilise buttonhole technique successfully and minimise complications.

Rationale for Recommendations F:4-5

Once this skill and procedure are learnt, the procedure also needs to be maintained. Often once a skill is learnt, cultural behaviours and personal experiences (known as hind-sight bias) start to influence clinical decision making, not only in positive ways but also in destructive ways (48, 49). Training and re-training of cannulators is essential to prevent degradation of cannulation techniques and prevent life threatening infections related to buttonhole cannulation (10,12). Labriola et al (13) found that re-training of staff in buttonhole procedures to ensure strict adherence to the procedure reduced the number of buttonhole related infectious events significantly. Therefore, not only is initial training of cannulators important to prevent complications, including bacteraemias, but continuing education of cannulators and monitoring of clinical practice is required. This could ensure expertise development and prevent variations in procedures, thus minimising the complications associated with cannulation.

Points for Future Consideration

The following aspects are not yet clarified and could be points for further investigation, consideration or basis for further projects:

- The exact content of education packages and competency assessments, to ensure consistency between units.
- Development of monitoring systems to audit adverse incidents in relation to cannulation. This requires consideration of how this is monitored, what is monitored and how we define certain adverse incidents. Aspects that could be monitored include venous needle dislodgement, number of missed cannulations and haematomas. This is not an exhaustive list. Consideration needs to be given as to how monitoring and audit can occur between renal units, not just within.

Conclusion

These recommendations aim to identify and summarise best practice of buttonhole cannulation of arteriovenous fistulae. If buttonhole technique is performed correctly it has many benefits including prolonging fistula lifespan. Whilst an increased infection risk with buttonhole technique is recognised within the renal community, some units are able to use this technique successfully with minimal infections. The elements identified as best practice within these recommendations aim to promote the correct use of buttonhole technique and minimise infection risk to ensure all the benefits are optimised. However, consensus of opinion between units on how best to perform buttonhole technique has not yet been reached. Whilst common successful practices have been identified and encompassed in the recommendations, a number of variations in practice have also been identified which require further investigation. It will be intriguing to discover how practice continues to develop from implementation of these recommendations. Buttonhole technique along with these recommendations can be considered a work in progress. The challenge is to explore the most effective way to employ this technique.

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Appendix 1 – Screening Tool in Use at Royal Berkshire Renal Unit

Royal Berkshire NHS
NHS Foundation Trust

Criteria/checklist for use of buttonhole technique in AV fistulae

Patient Name		Date	Completed by:

Criteria present: (Please tick)		Yes	No
Metallic Heart Valve			
Pacemaker			
Previous MSSA/MRSA bacteraemia			
Previous endocarditis			
Significant structural valvular heart disease			
MSSA / MRSA positive			
Clinical judgement (Other)			

On the basis of the above this patient is / is not (delete as applicable) suitable for using buttonhole needling technique.

Please record this decision in patient records on CV5 and keep a copy of this in patient notes

Appendix 2 – Screening Tool in Use at Oxford Renal Unit

Oxford University Hospitals NHS
NHS Trust

Please file in patient record on completion and note that patient is suitable/unsuitable on proton.

Criteria/checklist for use of buttonhole technique in AV fistulae

Patient Name		**Date**	**Completed by:**

Criteria present: (Please tick)		**Yes**	**No**
Metallic Heart Valve			
Pacemaker			
Previous MSSA/MRSA bacteraemia			
Previous endocarditis			
MRSA positive (at last swab)			
Active eczema or psoriasis or other skin condition			
Immunosuppression			

A 'YES' to any section means that the patient is not suitable.

On the basis of the above this patient is / is not (delete as applicable) suitable for using buttonhole needling technique.

Please record this decision in proton (on access screen) keep a copy of this in patient notes

Appendix 3 - Acknowledgments

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