Scottish Renal Nursing Strategy Group

Best Practice Statement

for the care of
Arterio-Venous Fistula and Graft

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Introduction to the statement

Over the last few years, there has been an increase in the prevalence of renal replacement therapy (RRT) for patients who reach established renal failure. The Scottish Renal Registry report of 2006 indicates that the prevalence of new patients starting renal replacement therapy has continued to increase. The annual take-in rate is approximately 600 per year. Co-morbidity has risen considerably requiring increased nursing intervention. There are ten adult renal units in Scotland with nine satellite or annexe units. In addition there is one paediatric renal unit.

The Scottish Renal Nursing Strategy Group has committed to looking at ways in which the services can be developed. The largest growth area is haemodialysis. The philosophy of this group is to identify nursing priorities for renal services within Scotland to provide clear direction for nurses working within the specialty. The strategy will be developed in collaboration with representatives from all Scottish Renal units and in consultation with relevant national groups.

The purpose of this best practice statement is to guide all haemodialysis nursing and technical staff in the best way to manage and preserve vascular access. Poor vascular access for haemodialysis may contribute to increased risk of infection, unnecessary repeated admissions to hospital and potentially increased mortality.

The National Service Framework for Renal Services suggests that:

- all children, young people and adults approaching established renal failure are to receive timely preparation for renal replacement therapy, so the complications and progression of their disease are minimised, and their choice of clinically appropriate treatment options maximised (standard 2)

- all children, young people and adults with established renal failure are to have timely and appropriate surgery for vascular or peritoneal access, which is monitored and maintained to achieve maximum longevity (standard 3)

Scottish Renal Association and NHS Quality Improvement Scotland (NHS QIS) standards require that:

- 70% of established patients should have functioning arterio-venous fistula or graft
- 60% of new starts should have functioning arterio-venous fistula

if known to renal service for more than 3 months.

Why fistula first

The arterio-venous fistula (AVF) remains the gold standard access to haemodialysis, showing better survival and lower complication rates than grafts and catheters (Brunori et al, 2005). The presence of a catheter and/or its complications may affect the longevity of a native fistula through its earlier utilisation or less favourable maturation (Rayner et al, 2003). The Dialysis

Outcomes Quality Initiative (DOQI) guideline 3 states that in order to determine which type of access is most suitable to the individual patient, an evaluation of the patient's venous, arterial and cardiopulmonary systems must be performed. Previous placement of central venous catheter is associated with central venous stenosis. Central venous catheters should be discouraged as permanent vascular access. In the absence of factors associated with contraindications for the formation of AVF, this would be the first preference for vascular access (DOQI, 2000).

Premature cannulation of a fistula may result in a higher incidence of infiltration with associated compression of the vessel by haematoma and permanent loss of the fistula (DOQI guideline 9, 2000).

The AVF/graft should be:

- patent
- palpable with bruit present
- clean and free from signs of infection
- able to deliver adequate haemodialysis

The success of vessel access is best assessed by its capability to supply and return blood to the general circulation at acceptable flow rates, its duration of effective function, the degree of patient discomfort and limitation, and the rate and severity of complications.

Section 1: **Pre-dialysis preparation and care**
Key point: Frequent monitoring of fistula parameters is required.

Statement	**Reason for statement**	**How is it being achieved**
Referral for vascular access at the pre-dialysis stage should be made when the patient is approximately six months to one year away from dialysis. Progression can be dependent on individual disease progression (O'Hare et al 2007).	To enable planned intervention ensuring best permanent access with fewer complications. This will also allow for any remedial intervention if required.	By implementation of local patient pathway and audit.
The site of fistula should be identified and all other co-morbidities should be considered.	To reduce inconvenience to the patient and facilitate easier care of fistula site. To facilitate easier access of the fistula during cannulation. To identify optimum site for a fistula.	By maintaining and supporting, open communication between patient, nursing staff and surgeon. Staff are able to identify best possible fistula sites.
Patients requiring vascular access for haemodialysis should have their veins preserved and not utilised for any intervention before access is created.	If vessels are accessed frequently for venepuncture the vessel becomes fragile and may not be sustainable as adequate vascular access for haemodialysis.	Once it is identified that the patient requires access surgery, all healthcare workers should be advised that vessels on "fistula" arm are not used for venepuncture/cannulation or for blood pressure. The patient/advocate should be advised of care of vessels. During inpatient stay a local means of identification is applied to indicate that this arm should not be used for venepuncture/cannulation or blood pressure measurement.

Key challenge: Ensuring reasons for failure to progress to theatre are documented and action plan is implemented.

Section 2 Pre-operative preparation and care

Key points: Minimum of urea, electrolytes, full blood count and clotting screen must be checked before theatre.
Fistula mapping may be implemented at time of surgery.

Statement	Reason for statement	How is it being achieved
The patient should be educated regarding access formation using a selection of evidenced based material tailored to suit the individual needs of the patient.	To empower the patient to make informed decisions about the forthcoming procedure and encourage participation in recommended treatment (CSBS, standard 12, 2002).	Designated person provides information, advice and support for patient and carer where appropriate before access formation. A record is kept of information distributed to patients in the pre-dialysis period.
Peri-operative care should be implemented as per local protocol.	To ensure patient suitability and safety during peri-operative period.	Implementation of local protocol (appendix 1 & 1a). Staff involved in the peri-operative period are familiar with local protocol minimum should include: • general health review • bloods • drugs • blood pressure

Section 3 Post-operative preparation and care

Statement	Reason for statement	How is it being achieved
Post-operative care - following surgery, all patients will require monitoring of their fistula/graft.	Early detection of complications. To maintain AVF/graft patency.	Observations are performed in accordance with local protocol and the needs of the individual patient (appendix 2 & 2a). Patency of fistula should be documented.
The patient is given available advice following AVF/vein graft surgery.	To ensure that staff and patient are aware of the appropriate after care following access formation.	Local development of post-operative guidelines. Clear and concise information and advice should be given regarding continuing care and maintenance of fistula patency (Oder,TF et al 2003).

Key challenges: Ensuring comprehensive training and education of staff.

Ensuring that relevant information regarding care of vascular access accompanies all patients to non-renal areas.

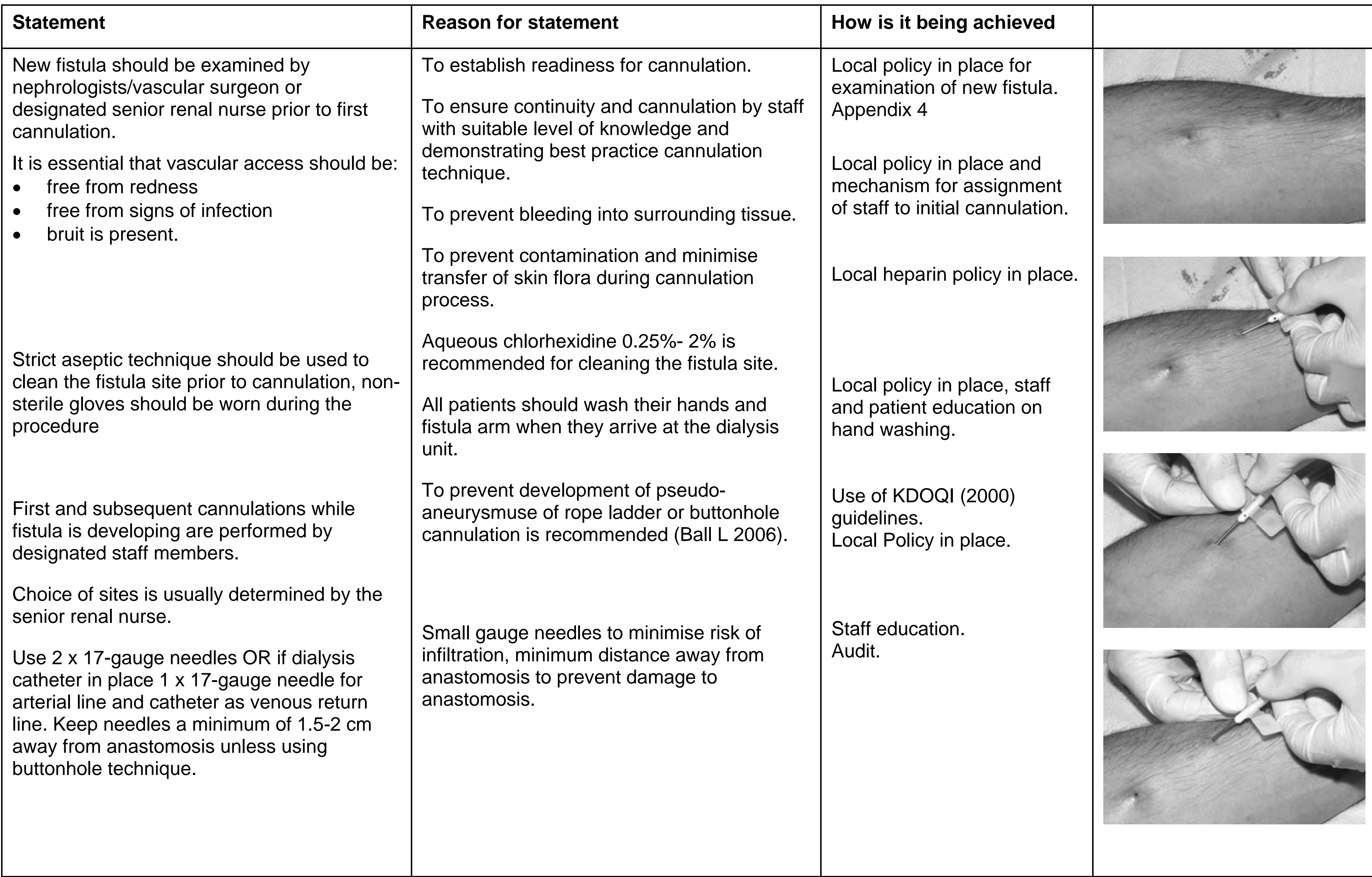
Section 4 **Access Surveillance**

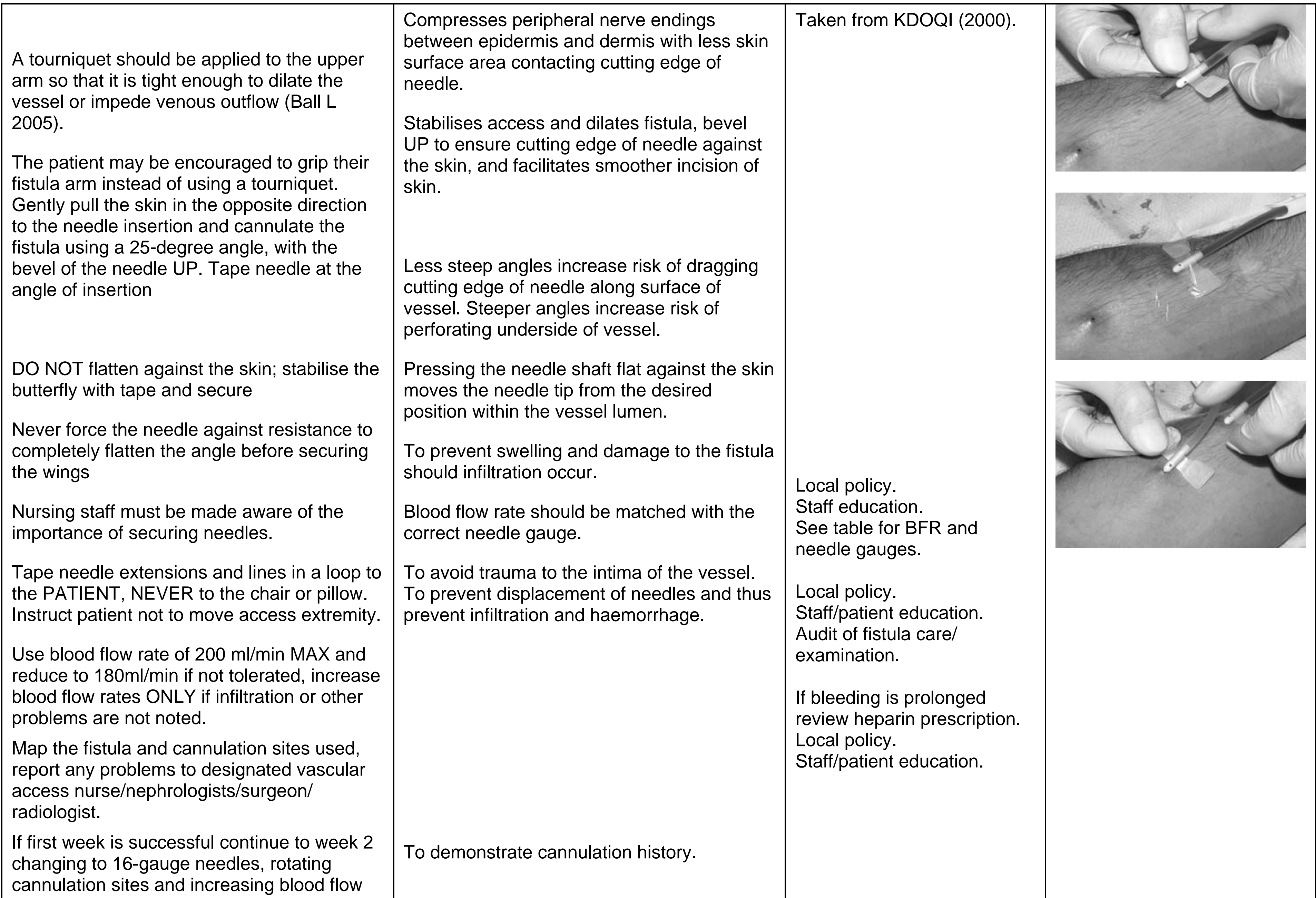
Key points: Patient should be assessed pre-operatively and post operatively.
There are different stages in the process and to ensure adequate surveillance these steps should be followed.

Statement	Reason for statement	How is it being achieved
All patients should have vascular assessment prior to surgery.	To assess patency, vessel size and suitability for creation of vascular access.	• attend designated vascular clinic • duplex scan • pre-admission assessment • date for surgery.
All new vascular access should be reviewed within 48 hours of surgery by appropriate health professional.	To assess success of surgery.	**Pre-dialysis patients**: • follow-up, 48 hours post-surgery as per local protocol. **Established dialysis patients**: • review within 48hrs of surgery by senior nurse or nephrologist. **All patients**: • follow-up, vascular access clinic within six weeks (Konner K et al 2003). • repeat Duplex scan if required.
Cannulation difficulties may occur in newly established fistula.	Re-assessment of vascular access may be required.	• discuss with dialysis nurse difficulties experienced during cannulation • refer to vascular access nurse or nephrologist • duplex scan • re-refer to surgeon.
Routine surveillance of vascular access should be undertaken and documented. Beathard G 2003).	Early detection and treatment of potential problems with established vascular access.	**Pre-dialysis patients**: • routinely assess at low clearance clinic, only referred back to vascular access nurse if complication occurs. **Established dialysis patients**: • minimum 6 monthly blood flow monitoring/re circulation/transonic • routine monitoring of arterial and venous pressure • highlight any complication to vascular access nurse/nephrologists • interventional Radiologist. www.vascularaccesssociety.com/guidelines
Patients with unexpected non-functioning vascular access.	Rescue vascular access without delay.	• emergency admission protocol • immediate referral to vascular access nurse/nephrologists • refer to surgeon or interventional radiologist. Appendix 3

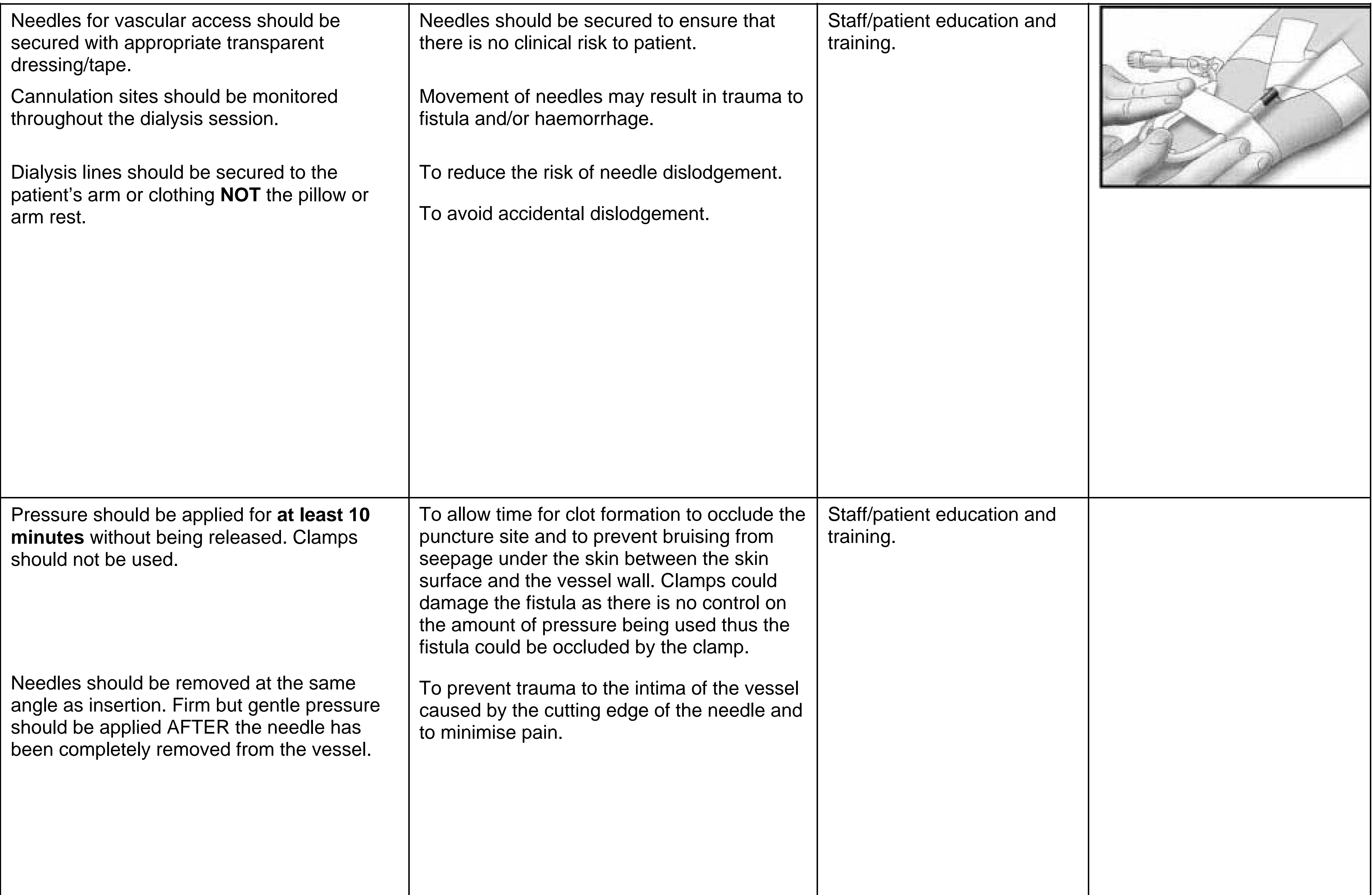
Key challenge: Ensuring that relevant information regarding care of vascular access accompanies all patients to non-renal areas.

Section 5 Cannulation

Statement	Reason for statement	How is it being achieved	
New fistula should be examined by nephrologists/vascular surgeon or designated senior renal nurse prior to first cannulation.	To establish readiness for cannulation.	Local policy in place for examination of new fistula. Appendix 4	
	To ensure continuity and cannulation by staff with suitable level of knowledge and demonstrating best practice cannulation technique.	Local policy in place and mechanism for assignment of staff to initial cannulation.	
It is essential that vascular access should be: • free from redness • free from signs of infection • bruit is present.	To prevent bleeding into surrounding tissue.	Local heparin policy in place.	
Strict aseptic technique should be used to clean the fistula site prior to cannulation, non-sterile gloves should be worn during the procedure	To prevent contamination and minimise transfer of skin flora during cannulation process. Aqueous chlorhexidine 0.25%- 2% is recommended for cleaning the fistula site. All patients should wash their hands and fistula arm when they arrive at the dialysis unit.	Local policy in place, staff and patient education on hand washing.	
First and subsequent cannulations while fistula is developing are performed by designated staff members. Choice of sites is usually determined by the senior renal nurse.	To prevent development of pseudo-aneurysmuse of rope ladder or buttonhole cannulation is recommended (Ball L 2006).	Use of KDOQI (2000) guidelines. Local Policy in place.	
Use 2 x 17-gauge needles OR if dialysis catheter in place 1 x 17-gauge needle for arterial line and catheter as venous return line. Keep needles a minimum of 1.5-2 cm away from anastomosis unless using buttonhole technique.	Small gauge needles to minimise risk of infiltration, minimum distance away from anastomosis to prevent damage to anastomosis.	Staff education. Audit.	

A tourniquet should be applied to the upper arm so that it is tight enough to dilate the vessel or impede venous outflow (Ball L 2005).	Compresses peripheral nerve endings between epidermis and dermis with less skin surface area contacting cutting edge of needle.	Taken from KDOQI (2000).	
The patient may be encouraged to grip their fistula arm instead of using a tourniquet. Gently pull the skin in the opposite direction to the needle insertion and cannulate the fistula using a 25-degree angle, with the bevel of the needle UP. Tape needle at the angle of insertion	Stabilises access and dilates fistula, bevel UP to ensure cutting edge of needle against the skin, and facilitates smoother incision of skin. Less steep angles increase risk of dragging cutting edge of needle along surface of vessel. Steeper angles increase risk of perforating underside of vessel.		
DO NOT flatten against the skin; stabilise the butterfly with tape and secure	Pressing the needle shaft flat against the skin moves the needle tip from the desired position within the vessel lumen.		
Never force the needle against resistance to completely flatten the angle before securing the wings	To prevent swelling and damage to the fistula should infiltration occur.		
Nursing staff must be made aware of the importance of securing needles.	Blood flow rate should be matched with the correct needle gauge.	Local policy. Staff education. See table for BFR and needle gauges.	
Tape needle extensions and lines in a loop to the PATIENT, NEVER to the chair or pillow. Instruct patient not to move access extremity.	To avoid trauma to the intima of the vessel. To prevent displacement of needles and thus prevent infiltration and haemorrhage.	Local policy. Staff/patient education. Audit of fistula care/ examination.	
Use blood flow rate of 200 ml/min MAX and reduce to 180ml/min if not tolerated, increase blood flow rates ONLY if infiltration or other problems are not noted.		If bleeding is prolonged review heparin prescription. Local policy. Staff/patient education.	
Map the fistula and cannulation sites used, report any problems to designated vascular access nurse/nephrologists/surgeon/ radiologist.			
If first week is successful continue to week 2 changing to 16-gauge needles, rotating cannulation sites and increasing blood flow	To demonstrate cannulation history.		

rate. Week 3: as week 2 or if tolerated well increase to 14/15-gauge needles and required BFR. Infiltration guidelines: • if the fistula infiltrates let it rest for 1 week then go back to smaller gauge needles. Notify vascular access nurse/nephrologist • if it infiltrates a second time rest for 2 weeks and then reduce needle size. Notify vascular access nurse/nephrologist • if infiltration occurs a third time notify designated vascular access nurse/co-ordinator/nephrologist/radiologist/ surgeon.	To reach optimum delivered blood flow and dialysis adequacy. To prevent further damage to fistula, and allow healing. Consecutive infiltration could signify a problem with the fistula which requires radiological or surgical intervention.	Local policy. Accurate documentation at all stages. Appendix 5	

Needles for vascular access should be secured with appropriate transparent dressing/tape. Cannulation sites should be monitored throughout the dialysis session. Dialysis lines should be secured to the patient's arm or clothing **NOT** the pillow or arm rest.	Needles should be secured to ensure that there is no clinical risk to patient. Movement of needles may result in trauma to fistula and/or haemorrhage. To reduce the risk of needle dislodgement. To avoid accidental dislodgement.	Staff/patient education and training.	
Pressure should be applied for **at least 10 minutes** without being released. Clamps should not be used. Needles should be removed at the same angle as insertion. Firm but gentle pressure should be applied AFTER the needle has been completely removed from the vessel.	To allow time for clot formation to occlude the puncture site and to prevent bruising from seepage under the skin between the skin surface and the vessel wall. Clamps could damage the fistula as there is no control on the amount of pressure being used thus the fistula could be occluded by the clamp. To prevent trauma to the intima of the vessel caused by the cutting edge of the needle and to minimise pain.	Staff/patient education and training.	

Section 6 Patient Information

Statement	Reason for statement	How is it being achieved
All patients should be informed about simple emergency procedures and how to best care for their dialysis access.	Patient must be aware of what action to take in event of haemorrhage. Patient plays an important role in the development and preservation of the fistula and in early detection of complications. Complications may include the following: • infection • haemorrhage • thrombosis • ischaemia • parasthesia (Steal syndrome)	Patient should be provided with information regarding their access site through easily understood verbal and written communication. A record is kept of information given to patients.

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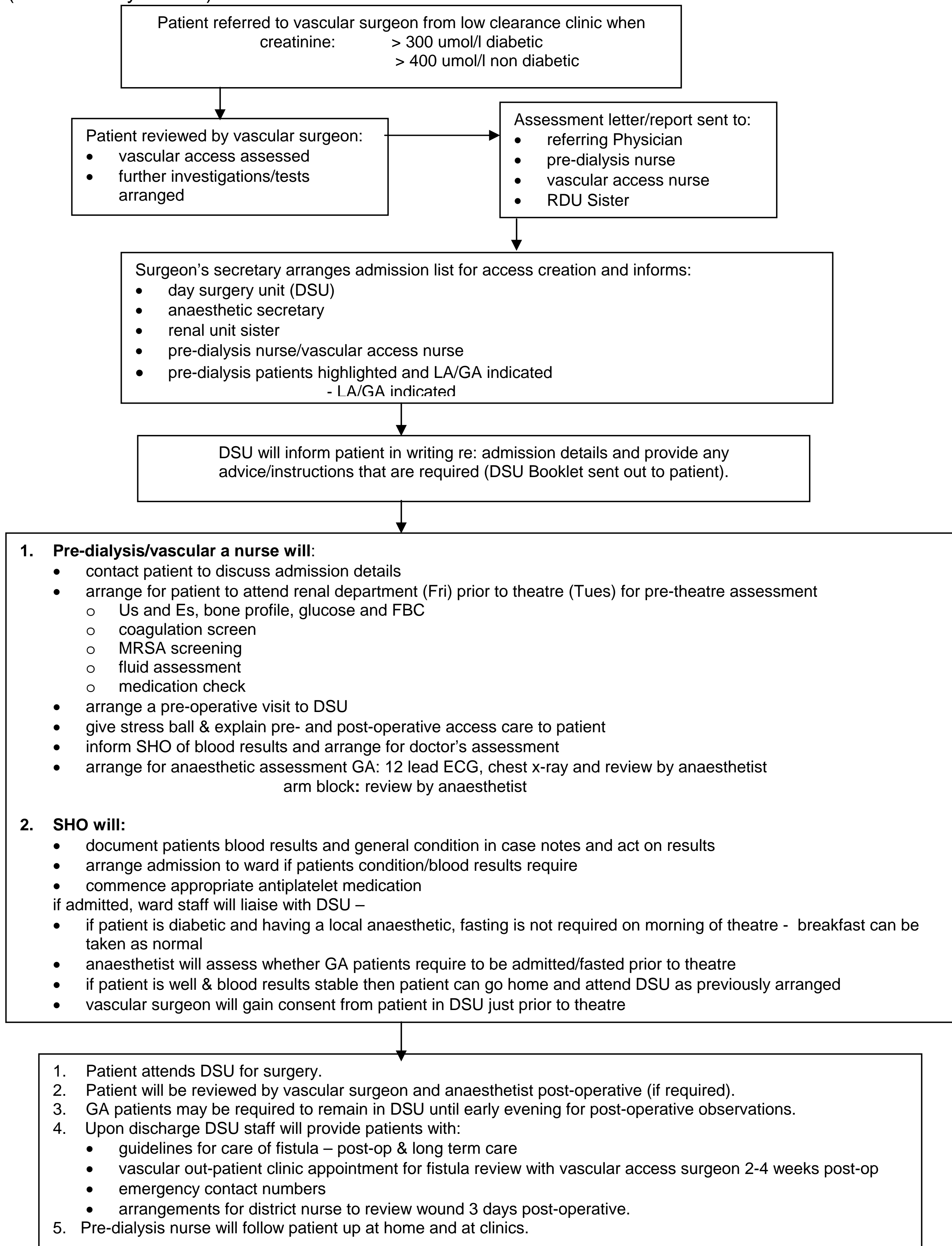
Appendix 1 Vascular access creation – Pre-dialysis patients

(LA/GA - Day Cases)



Appendix 1a

NAME ______________________ I.C No. ______________ D.O.B ___________

Pre-theatre check:

Date _______________ Date of Surgery _______________

BP _______ T _______ Pulse _________ Wt _________

Pre-dialysis nurse	**Y**	**N**	**Date**	**Comments**
Patient phoned and informed of theatre arrangements				
Medical admissions informed				
Us and Es/FBC/bone profile /haematinics				
Coagulation screen				
MRSA screen				
Fluid assessment				
Medication check				
12 lead ECG				
Chest x-ray				
Anaesthetist review				
SHO informed of blood results				
SHO assessed and documented patients condition				
Patient allowed home				
Patient admitted to ward				
Case notes sent to DSU				
Admission details to DSU explained				
'Stress Ball' given				
Day surgery unit				
Care of fistula guidelines given				
Vascular out patient appointment arranged				
District nurse referral				
Pre-dialysis nurse informed of admission post-operative				

Surgeon ______________________ Anaesthetist ________________________

SHO _____________________ Pre-dialysis nurse ___________________

DSU nurse ______________________

Appendix 1a Example of fistula creation checklist (Crosshouse Hospital, Kilmarnock)

Appendix 2 Example of local protocol on post-operative care

Specific: Post-operative care of a patient following AVF formation and graft insertion for access to haemodialysis.

1. Carry out all basic nursing care as for any patient following general anaesthetic.
2. Blood pressure and pulse recordings every 15 minutes for the first hour. Nurses should be aware that there is an increased risk of the patient's access clotting if their blood pressure drops:
    - if satisfactory record observations every half hour for 2 hours
    - if patients observations are stable then 2-hourly recordings until discharge
    - if the patient's blood pressure drops consult vascular surgeon.
3. Observe and record fistula bruit every 15 minutes for the first hour. Listen with a stethoscope:
    - monitor bruit/thrill every half hour for a further 2 hours
    - monitor bruit/thrill every 2 hours until discharge
    - if the bruit/thrill is quieter/softer than before, contact vascular surgeon immediately
    - surgeon or theatre nurse should pass information to the receiving nurse as to how and where the bruit/thrill can be felt or heard. Some bruit/thrill may not be heard through the theatre dressing.
4. Observe wound for signs of bleeding every 15 minutes for 1 hour.
    - then observe every half hour for 2 hours
    - then observe every 2 hours until patient is discharged
    - if evidence of bleeding consult vascular surgeon immediately.
5. Observe for signs of coldness or parasthesia in patient's hand. Steal syndrome can be an early complication of AVF/graft formation. Consult vascular surgeon immediately.
6. Observe for signs of numbness (after the block has worn off) or extreme pain.
7. Give patient advice and education literature before discharge. Record that this has been done.

Appendix 2 and 2a Example of local protocol on post-operative care (Queen Margaret Hospital, Dunfermline)

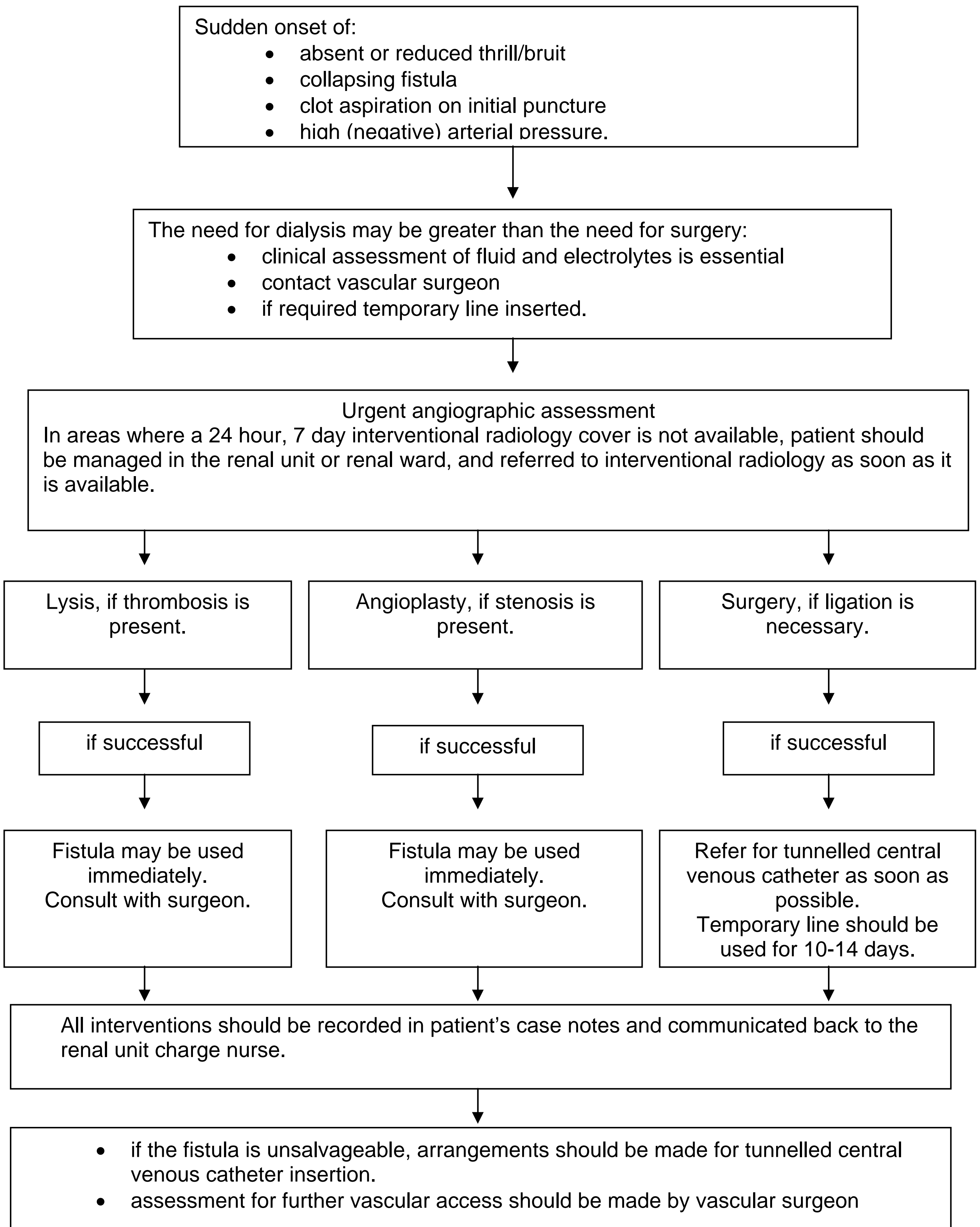
Appendix 2a

NAME:
UNIT NO: **Date Commenced:**

Update	No	Actual/potential problems	Desired outcomes	Nursing actions
	2.	Care of newly formed fistula Type of formation:	AVF remains patent. Colour, sensation and movement maintained in limb below area where fistula was formed. Bruit maintained.	1. Patency of fistula is determined by following actions: a) fistula is checked ¼ hourly for first 2 hours, hourly for 6 hours, 2 hourly for 12 hours, 4 hourly for remainder of time in hospital. b) arm does not remain bent. c) no BP cuff is to be attached to arm where fistula has been created. d) no bloods to be taken from arm where fistula was created. e) patient advised against lying on appropriate arm. f) vital signs monitored regularly. 2. Observe colour, sensation and movement of limb regularly. 3. If any deterioration inform medical staff immediately. 4. Patient is given appropriate information / literature at all times.

Appendix 2 and 2a Example of local protocol on post-operative care (Queen Margaret Hospital, Dunfermline)

Appendix 3 Management of non-functioning vascular access



Appendix 4 Cannulation of new AVFs and grafts

Purpose:

To successfully cannulate new AVF and to prevent infiltration.

Policy:

Newly created primary AVFs shall be allowed to develop for at least 8 to 12 weeks prior to cannulation. Initial attempts to perform dialysis via new fistulas shall proceed with caution. Without exception, fistulas shall not be progressed faster than these guidelines without consultation with vascular surgeon, vascular access nurse or nephrologist. All healthcare professionals are responsible for implementing this policy.

Procedure:

1. Obtain order from vascular surgeon or nephrologist to begin cannulation of fistula 8 to 12 weeks after creation. All new fistulas should be examined by surgeon, nephrologist and designated staff member before cannulation is initiated.

2. Only staff identified as demonstrating best cannulation practice techniques should be assigned to cannulate newly developing fistulas.

3. Always use a tourniquet, even with well-developed fistulas. No exceptions.

4. Explain procedure to patient.

5. Educate patient on:
   - checking the access daily for a thrill and for signs and symptoms of infection
   - performing fistula exercises to promote maturation process
   - understanding that haematoma could occur most likely during the first two weeks of using the access
   - for infiltrations, provide written materials about icing, elevation, and heat application.

Types of cannulation techniques to use for AVF	Technique	Advantages	Disadvantages
Rope ladder	Cannulate the entire length of the fistula, ensuring subsequent needle insertions are 2cm above the former cannulated site.	Prevent aneurysm formation.	If the AVF is small then it is difficult to move up and down sites. Often the same sites are cannulated.
Regional or area puncture (not advised).	To cannulate same or close to same area as before. One or two areas of the fistula are regularly used.	Less infiltration. Easy for staff to identify needle sites.	Thinning of skin causes increased bleeding time. Infection due to skin breakdown. Increased risk of aneurysms.
Buttonhole cannulation.	Create a track so blunt needles can eventually be used in order to facilitate dialysis.	Less infiltration. Less pain. Reduced bleeding times.	Same person needs to cannulate the AVF in order to ensure exact track formation. Takes time and 2 experienced nurses to develop track.

Cannulation of graft	Technique
Cannulation of grafts is very different to AVF. The graft is made of a synthetic material and Is tougher than native vessels.	Cannulate at a 45% angle, bevel up. Force the needle through the skin and graft and straighten the needle when flashback is seen.

Appendix 5

Blood flow rates (BFR) are recommendations and can be modified based on centre-specific guidelines.

Only increase BFR if no evidence of infiltration or other problems noted. Report any cannulation or BFR problems to the charge nurse.

Week two:

- if the first week is successful, cannulate with 16 gauge needles, rotating cannulation sites if not using buttonhole.
- blood flow rate recommended: 300 ml/min.

Week three:

- either repeat procedure for week 2, or may attempt to progress to prescribed BFR and needle gauge. When increasing BFR, recommend matching needle gauge to BFR as shown in chart below**,**
- recommended needle placement: arterial retrograde (toward the arterial anastomosis), venous antegrade (toward the venous anastomosis). (this policy may vary based on policies and procedures of specific units)

Infiltration instructions

If the fistula infiltrates, let it "rest" for one week and then go back to smaller gauge needles. Notify charge nurse, vascular access nurse or nephrologist.

If the fistula infiltrates a second time, wait another two weeks and then go back to smaller gauge needles. Notify charge nurse, vascular access nurse or nephrologist.

If the fistula infiltrates a third time, notify surgeon and nephrologist.

RECOMMENDED: It is important to match needle gauge to blood flow rate.

BLOOD FLOW RATE	RECOMMENDED NEEDLE GAUGE
<300 ml/min	17-gauge
300 – 350 ml/min	16-gauge
>350-450 ml/min	15-gauge
> 450 ml/min	14-gauge

Note: These are minimum recommended gauges for the stated BFR settings. Larger needles, when feasible, will reduce (make less negative) pre-pump arterial pressure and increase delivered blood flow.

Appendix 6 Patient information - care of your fistula/graft

Following Theatre:

- for 24 hours following your anaesthetic it is important to adhere to the following instructions:
  - do not drive
  - do not operate machinery, cookers or kettles
  - avoid alcohol and do not take sleeping tablets
  - do not make important decisions or sign legal documents

- if you feel any discomfort following surgery, painkillers may be taken as prescribed – paracetamol/panadol

- you may be given some medication that helps to prevent your fistula/graft from clotting, it is very important that you take this medication as prescribed

- if any bleeding occurs, apply pressure with a clean cloth. If bleeding continues beyond 15 minutes, contact the Ward or attend your nearest A&E department

- your top theatre bandage can be removed 24-hours following surgery leaving a small white dressing over your wound

- keep this dressing clean and dry. If it gets wet or dirty please contact the pre-dialysis nurse.

- following surgery it is very important that you check your fistula/graft twice daily. This is done by placing your other hand gently on top of the dressing to feel a slight buzzing sensation. This means that your fistula/graft is working properly**.** If you do not feel this please contact the ward, pre-dialysis nurse or vascular access nurse for advice immediately.

- a district nurse will visit and assess your wound 3 days after surgery

- your stitches are self-dissolving, therefore do not need to be removed

- observe your wound regularly for any signs of redness, swelling or leakage

- ensure hands are washed prior to touching your fistula/graft wound

- once your dressing is removed you may bath/shower as normal, avoid using soap or talcum powder over the wound until the wound is completely healed

- you will be required to attend an outpatient clinic 2-4 weeks following surgery just to ensure there are no problems with your fistula/graft. You will receive an appointment through the post following discharge from the DSU.

- gentle hand exercises may be commenced once all dressings have been removed. These will help strengthen and build up the vein in your fistula/graft. Commence by squeezing your stress ball gently for several minutes 2-3 times/day. Increase the frequency of these exercises over the next few weeks.

Glossary

Term	Definition
adequacy	Refers to how well dialysis replaces the function of the kidneys.
anastomosis	An artificial connection between two tubular organs eg two blood vessels.
arterio-venous fistula	A surgical connection between an artery and a vein, usually in a limb, to create arterial and venous access for haemodialysis. It can be a direct anastomosis between the artery and vein.
asepsis	The complete absence of bacteria, fungi, viruses or other micro-organisms that could cause disease.
autogenous	Originating in the body of the patient.
bruit	A sharp or harsh systolic sound heard on auscultation that is due to turbulent blood flow in a peripheral artery. Bruits can be heard over arterio-venous fistulae.
cannula	A hollow tube designed for insertion into a body cavity or blood vessel.
cannulation	Insertion of a cannula.
co-morbidity	The presence of one or more disorder or disease in addition to the primary disease.
DOQI	The national kidney foundation Dialysis Outcomes Quality Initiative. Established in 1995 in the USA.
duplex imaging	A diagnostic technique used to study the flow in blood vessels.
end stage renal failure (ESRF)	The most advanced stage of kidney failure, which is reached when the glomerular filtrate rate falls to 5mls/min (normal GFR =120ml/min).

extravasation	The leakage and spread of blood or fluid from vessels into the surrounding tissues eg following injury.
glomerular filtration rate (GFR)	The rate at which substances are filtered from the blood of the glomerulus into the bowman's capsule of the nephron. It is calculated by measuring the clearance of specific substances and is an index of renal function.
haematoma	An accumulation of blood within the tissues that clots to form a solid swelling.
haemodialysis	A technique of removing waste materials or poisons from the blood using the principle of dialysis. Haemodialysis is performed on patients whose kidneys have ceased to function.
heparin	An anticoagulant which acts by inhibiting the action of the enzyme thrombin in the final stage of blood coagulation.
infiltration	The abnormal entry of a substance into tissue eg blood.
intima	The inner layer of a wall of an artery or vein.
patency	The condition of being open eg blood flow present.
protocol	Correct procedure (should be evidence-based).
thrombosed	Affected by thrombosis.
thrombosis	A condition in which the blood changes from a liquid to a solid state and produces a blood clot.
tourniquet	An instrument for the compression of a blood vessel by application around an extremity to control the circulation and prevent the flow of blood to or from the area.
venepuncture	The puncture of a vein for any therapeutic purpose.

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Wider reference group

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Dr I Shilliday	Consultant	Monklands Hospital, Airdrie
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Dr K Simpson	Consultant	Glasgow Royal Infirmary
Dr C Brunton	Consultant Aberdeen	Aberdeen Royal Infirmary,
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Dr S Lambie	Consultant	Raigmore Hospital, Inverness
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Ms L Buist	Consultant	Western Infirmary, Glasgow
Ms Alison Wilkinson	Patient Representative	Ninewells Hospital, Dundee