Therapeutic Apheresis and Dialysis
10(5):449–462, Blackwell Publishing Asia Pty Ltd

2005 Japanese Society for Dialysis Therapy Guidelines for Vascular Access Construction and Repair for Chronic Hemodialysis

Seiji Ohira,[1] Hidemune Naito,[2] Izumi Amano,[3] Nakanobu Azuma,[4] Kiyoshi Ikeda,[5] Kazutaka Kukita,[6] Yasuo Goto,[7] Shinji Sakai,[8] Takahiro Shinzato,[9] Tokuichiro Sugimoto,[10] Yoshiaki Takemoto,[11] Hiroaki Haruguchi,[12] Ichiro Hino,[13] Toshiyuki Hiranaka,[14] Jun Mizuguchi,[15] Akira Miyata,[16] and Noriyoshi Murotani[17]

[1]Sapporo Kita Clinic, Sapporo, [2]Sano-Igawadani Hospital, Kobe, [3]Division of Nephrology and Blood Purification, Tenri Hospital, Nara, [4]Tokatsu Hospital, Chiba, [5]Kidney Center, Fukuoka Red Cross Hospital, Fukuoku, [6]Deapartment of Surgery, Sapporo Hokuyu Hospital, Sapporo, [7]Department of Radiology, Sendai Social Insurance Hospital, Sendai, [8]Shinrakuen Hospital, Niigata, [9]Daiko Institute of Medical Engineering, Nagoya, [10]Department of Nephrology, Mitsui Memorial Hospital, Tokyo, [11]Department of Urology, Osaka Municipal University, Osaka, [12]Department of Surgery & Kidney Center, Tokyo Women's Medical University, Tokyo, [13]Department of Radiology, Matsuyama Nishi Hospital, Matsuyama, [14]Osaka Vascular Access Center, Osaka, [15]Kawashima Hospital, Tokushima, [16]Department of Cardiovascular Surgery, Kumamoto Red Cross Hospital, Kumamoto and [17]Departments of Surgery and Dialysis, Chiba Social Insurance Hospital, Chiba, Japan

Abstract: The guideline committee of Japanese Society for Dialysis Therapy (JSDT), chaired by Dr Ohira, has published an original Japanese guideline, 'Guidelines for Vascular Access Construction and Repair for Chronic Hemodialysis'. The guideline was created mainly because of the existence of numerous factors characteristic of Japanese hemodialysis therapy, which are described in this report, and because we recognized the necessity for standardization in vascular access-related surgeries. This guideline consists of 10 chapters, each of which includes guidelines, explanations or comments and references. The first chapter discusses informed consent of vascular access (VA)-related surgeries, which often resulted in trouble between dialysis staff and patients. The second chapter describes the fundamentals of VA construction and timing of the introduction of hemodialysis with emphasis on the avoidance of catheter indwelling if at all possible. In the third chapter, arteriovenous fistula (AVF) construction and management are discussed from the viewpoint of the most preferable type of VA. The fourth chapter deals with arteriovenous grafts (AVG) which has recently increased in clinical applications. The factors which improve the AVG patency rate are discussed and postoperative management methods are emphasized to avoid possible complications. The fifth chapter deals with short and long-term vascular catheters. It is emphasized that these methods are definitely effective but, at the same time, are apt to be associated with several serious complications and might result in vascular damage. In the sixth chapter, superficialization of an artery is explained. This was originally for emergency use or backup but has been used permanently in 2–3% of Japanese hemodialysis patients. In the seventh chapter, methods for the use of VA are described and the buttonhole method is referred to as one of the options for patients who complain of intense pain at every cannulation. In the eighth chapter, the importance of continuous monitoring is stressed for maintaining appropriate function of VA. As a rule, the internal shunt type VA (AVF, AVG) places a burden on cardiac function. Thus, in the ninth chapter, it is stressed that VA construction, maintenance and repair should always be carried out with consideration of cardiac function which is not constant but variable. The 10th chapter forms one of the cores of this guideline and deals with repair and timing of VA. It is shown how to select a surgical or interventional repair method. In the final 11th chapter, VA types and resultant morbidity and mortality of hemodialysis patients are reviewed. **Key Words:** Chronic hemodialysis, Construction, Maintenance, Repair, Vascular access.

Received December 2005.
Address correspondence and reprint requests to Dr Seiji Ohira, Sapporo Kita Clinic, Kita ku, Kita 18 Jo, Nishi 2-21, Sapporo, Hokkaido 001-0018, Japan. Email: seiji.ohira@sk-clinic.or.jp
Presented in part at the 50th Annual Meeting of the Japanese Society for Dialysis Therapy held 24–26 June 2005 in Yokomaha City, Japan.

Vascular access (VA) is vitally important in chronic hemodialysis (CHD). Because CHD is carried out repeatedly, VA needs to meet the following conditions: (i) ease of cannulation; (ii) achieve adequate

TABLE 1. *Japanese Society for Dialysis Therapy 'Guidelines for the Construction and Repair of Vascular Access for Chronic Hemodialysis'*

Contents	
Preface	Creation of these guidelines
VA Working Group Committee, committee member list	
List of Committee and update meetings	
Glossary of terms and abbreviations	
Chapter 1	Informed consent
Chapter 2	Fundamentals of vascular access construction and timing of the introduction of hemodialysis
Chapter 3	Arteriovenous fistula construction and management
Chapter 4	Arteriovenous grafts construction and Management
Chapter 5	(1) Short-term vascular catheter
	(2) Long-term vascular vatheter
Chapter 6	Superficialization of an artery
Chapter 7	Vascular access methods of use
Chapter 8	Monitoring of vascular access function
	(1) Monitoring of arteriovenous fistula function
	(2) Monitoring of arteriovenous grafts function
Chapter 9	Vascular access and cardiac function: Vascular access construction and alteration considering patient cardiac function
Chapter 10	Timing and policy of vascular access repair
Chapter 11	Type of vascular access, morbidity and mortality rates
Conclusion	
References	

blood flow; and (iii) should have good long-term patency. In recent years, an increase in long-term dialysis patients, an increase in the introduction of elderly patients to dialysis and an increase in the introduction of patients with diabetic nephropathy and nephrosclerosis have become notable, thus increasing the number of cases in which new construction or maintenance repair in times of complication is difficult. Taking these conditions into consideration, the Japanese Society for Dialysis Therapy undertook the creation of 'Guidelines for the Construction and Repair of Vascular Access' (VA-GL, JSDT, 05) in December 2002. Recently completed, they were published in the Journal of the *Japanese Society for Dialysis Therapy*, Vol. 38, no. 9 (1). We would like to introduce those guidelines in the present paper and provide some explanation about them (Table 1).

I. SPECIAL CHARACTERISTICS OF CHRONIC HEMODIALYSIS IN JAPAN

Chronic hemodialysis in Japan can be summarized by the following: (i) an overwhelmingly large number of end-stage renal failure cases choose hemodialysis; (ii) patients continuing in the long-term are increasing; (iii) the introduction of elderly patients is increasing; (iv) patients with a high level of vascular damage associated with diabetic nephropathy have increased; (v) because kidney transplants are limited to 900–1000 cases yearly, hemodialysis patients awaiting transplant face this limitation, in other words, long-term use of VA is unavoidable; and (vi) in a comparison of hemodialysis therapy in other countries, blood flow was found to be lower. From the standpoint of VA, the previously mentioned conditions all come together creating a major problem in VA construction and repair. VA is both a hemodialysis patient's 'lifeline' and their 'Achilles heel'.

II. THE CURRENT STATE OF VASCULAR ACCESS IN JAPAN AND PROBLEMS BEING FACED

1. Frequency of the various types of vascular access

More than 90% of the stable hemodialysis patients in Japan have the most preferable form of VA, the native arteriovenous fistula (AVF) (2,3). However, at the introduction of dialysis, 30% made use of venous catheters (4,5). This is a simple yet effective method, but because complications such as infection, stenosis and thrombosis occur at a high rate, it is one method that should be avoided if possible. Synthetic arteriovenous grafts (AVG) make up only 5% of such treatments in Japan. But, with the increase in the number of cases in which VA construction or repair face complications, the use of AVG has recently increased. There are scattered cases in which it is slightly easier to use but basically we maintain that AVF should be used first. It is believed that the reason the National Kidney Foundation in the United States presented the DOQI Clinical Practice Guidelines for Vascular Access (6) in 1997 was an increased sense of impending crisis because of the introduction of the use of catheters, the high frequency of AVG use with accompanying high medical expenditures and complications, the increasing number of patients being hospitalized, and regional variation in the type of VA chosen. They

decided to increase the percentage of the use of AVFs (7). We must also bear this point in mind.

2. Specialization of vascular access construction and repair

VA construction and repair becomes possible after a certain level of knowledge is achieved and after a buildup of experience is obtained. Ota (8) has said, '. . . vascular access-related surgeries have been performed mostly by physicians coming from a variety of fields. A surgeon specializing in this type of surgery after having undergone the basics of vascular surgery is the most preferred, yet a great many find themselves starting pressured by the clinical necessity and with little confidence and continue on in this manner . . .' Because of the increasing numbers of difficult cases of VA construction and repair, the necessity for specialization of this procedure needs to be stressed (9).

3. Changes in vascular access repair methods

Whatever the form, over time, complications will arise in a VA constructed and used continuously for hemodialysis. Until now, these were mainly dealt with using surgery. But in recent years, interventional or endovascular therapy, both of which make use of a variety of catheters has become mainstream (10,11). This method has a low level of invasiveness but more than that, the merit of being able to salvage the affected vessels exists. However, the problems of patency and costs still remain. But while considering its appropriateness, we can look forward to improvement and development.

4. Who carried out cannulation and the method of cannulation

Who carries out the cannulation varies between facility, with physicians, nurses and technicians all carrying it out, depending on the institution. All physicians involved in the construction and repair of VA should have cannulation experience. In addition to the traditional method of varying the cannulation site, the 'buttonhole method' or method of limiting the cannulation site to one position has also shown success (12).

5. Vascular access guidelines of other countries

In 1977, the NKF-DOQI in the United States published the 'Clinical Practice Guidelines for Vascular Access' and a revised version in 2000 (6). In Canada, the Canadian Society of Nephrology (CSN) produced the 'Clinical Practice Guidelines for Vascular Access' (13) in 1999 and in 2002 the Kidney Organization of Australia released 'Caring for Australians with Renal Impairment: Vascular Access' (CARI) (14). These have been introduced in The Japanese Journal of Clinical Dialysis Vol. 21, No. 12 (7).

III. AN OUTLINE OF THE VASCULAR ACCESS GUIDELINES OF THE JAPANESE SOCIETY FOR DIALYSIS THERAPY

For details we would refer you to the references (1). Following are some explanations and outlines of problems faced.

CHAPTER 1

Informed consent involved in vascular access

This subject is not mentioned in the guidelines of other countries. It is however, important that patients have an understanding of the necessity and importance of vascular access. To allow construction at the appropriate time, this chapter was included. When explaining the necessity of dialysis therapy to end-stage renal disease (ESRD) patients who choose hemodialysis therapy, the explanation of VA necessary for this therapy should be included. This should be carried out in a cooperative manner between the nephrologist and the VA surgeon. The basic topics to be discussed are shown in Table 2. Taking into consideration the patient's condition and level of understanding, the appropriate choice should be attainable. To allow for the smooth introduction of HD, it is vitally important that the patient understands that the construction of VA is needed prior to the expected start date of dialysis. While we should avoid producing excessive anxiety in our patients, it is necessary to touch upon the complications accompanied by VA usage (Table 3). Recently, examples of AVG construction in virgin vessels have somewhat increased. In this case, a careful explanation is especially important. In any case, making the patient aware of the importance of VA beforehand makes it possible for patients to manage the VA for them-

TABLE 2. *Explanation for patients at the time of vascular access construction*

(1)	Purpose of vascular access construction
(2)	Vascular access construction method (surgical method) and pre-operation examinations
(3)	Anesthesia
(4)	Time required for surgery
(5)	What to be careful of following surgery
(6)	Actual usage (actual cannulation)
(7)	Patency rates for various vascular access
(8)	Importance of periodic examinations of function and shape
(9)	Anticipated vascular access complications
(10)	Repair methods for vascular access complications
(11)	Other

TABLE 3. *Complications associated with vascular access*

(1)	Inadequate blood flow
(2)	Stenosis (arterial/venal stricture)
(3)	Thrombosis (vascular access obstruction)
(4)	Infection of cannulation sites
(5)	Aneurysms
(6)	Vascular hypertension (sore thumb or sore hand syndrome)
(7)	Steal syndrome (ischemia)
(8)	Excess blood flow, high output cardiac failure
(9)	Recirculation
(10)	Cannulation difficulty, limited cannulation area
(11)	Other

selves. The explanation to the patient should not be limited to information the physicians deem important, information the patient desires or information we imagine they would want should also be a part of the explanation.

CHAPTER 2

The basics and timing of vascular access construction

Those patients diagnosed with ESRD should undergo examination by the VA surgeon as soon as possible and, as stated previously, the VA surgeon should explain the vital role VA plays in hemodialysis therapy. The VA surgeon should be in contact with the nephrologist, checking on the clinical condition of the patient, and when Ccr is 10–20 mL/min or serum creatinine (S.Cr) is 6–8 mg/dL, VA construction should be considered. On the first visit, the VA surgeon inspects and palpitates the vessels in the limbs of the patient in preparation for future VA construction. The first choice is an AVF. In case the Ccr and S.Cr values measured are dissociated, the Ccr value measured multiple times should be given preference. Incidentally, in the case of diabetic nephropathy with a tendency for overhydration, VA construction is generally required at a lower value. DOQI (USA) recommends 'construction at least 1 month prior to cannulation, but 3–4 months is preferred.' CSN (Canada) recommends construction when Ccr < 15–20 mL/min or S.Cr > 3–5 mg/dL. CARI (Australia) notes that the timing of construction is dependent upon the overall condition of the patient and the local factors of the vessels. Excluding cases where obesity causes the subcutaneous vein to be deeply imbedded, an appropriately constructed AVF should mature in 2–3 weeks at which time cannulation should be possible. Our guideline recommends that construction should be carried out at least 2–4 weeks prior to the first expected date of cannulation. Experience shows that the timing of the construction of the AVF is often influenced by the timing of the referral to the VA surgeon, the patient's own acceptance of dialysis, work, etc. The understanding and cooperation of the referring physician, the patient and the patient's family are essential to reduce the emergency introduction of catheter usage. In this guideline, 'to improve the future prognosis, the patient diagnosed with chronic renal failure based upon clinical progress as well as S.Cr 2–3 mg/dL and other observations, should be referred to a nephrologist by the general physician in a timely manner.' Furthermore, whether or not the patient has an understanding of the topics discussed in Chapter 1 plays an important role.

CHAPTER 3

Arteriovenous fistula construction and management

This chapter describes the fundamental topics of the most desired form, the AVF. It is necessary to take into consideration the overall condition of the patient, not just the observations of the site local to the AVF. For example, if dehydration, overhydration or edema is shown in the limbs, medical treatment should be undertaken and construction delayed until improvement in the symptoms is shown. Preoperative AVF vascular evaluation consists mainly of inspection and palpitation, but in the case of 'edema, collateral circulation pathway development, catheter or pacemaker placement in the subclavian vein on the side of construction, previous breast cancer surgery or a history of surgery in the neck or upper limbs, etc.', angiography should be carried out. The wrist or Tabatiere (anatomical snuff box) is the site of choice for AVF construction, but because of vascular condition, radiocephalic AVF in the forearm, AVF using the basilic vein of the forearm, cubital region AVF, upper arm AVF, etc., are other possible choices. When AVF construction in the wrist must be abandoned, there is no need to consider the cubital region right away, the middle forearm should be considered as a site for construction. The factors to consider in determining the location for construction are noted in Table 4. This guideline recommends anastomosis of the side of the artery with the end of the vein. Side to side anastomosis with closure of the distal end of the vein is considered functionally equivalent to the side (artery) to end (vein) anastomosis. Factors having an influence on the patency rates of AVFs constructed are (i) the patient's background (age, gender, comorbid disease, condition, etc.); (ii) history of catheter placement; (iii) cannulation timing; and (iv) experience of the surgeon. These factors should be emphasized in VA construction and management. There has been a great difference reported in the primary failure rates of AVFs, with 2–53% reported by Allon et al. (16) and 0.8–23.6%

TABLE 4. *Factors considered to determine site of construction*

(1) Artery diameter and degree of calcification
(2) Vein diameter and continuity
(3) Vascular paths and mutual relationship
(4) Patient's overall condition and life expectancy
(5) Presence/absence of peripheral circulatory disease
(6) Cardiac function

by Ohira et al. (17). These differences can probably be attributed to a complex combination of the four factors mentioned above. In those AVF that fail to mature after construction, examination to find the cause should be carried out approximately 2 weeks following surgery and appropriate action then undertaken. There are various opinions regarding the timing of cannulation. We have taken into consideration the results of Rayner et al. (5) to decide upon 14 days or more post surgery. Refer to Table 5 for the necessity of appropriate post surgery monitoring in addition to the basic methods.

CHAPTER 4

Construction and management of arteriovenous grafts

Because AVG is inferior to AVF with respect to patency, infection, etc, the consensus reached was that AVF should be the first choice for VA. In other words, those cases chosen for AVG construction are those cases in which AVF construction in the forearm was not possible. Furthermore, cardiac function must also be considered because of the burden placed upon the heart following AVG construction. The position of the graft (synthetic vessel) should be determined by the patient's condition, the surgeon's skill, the anticipated duration of dialysis (lifespan), etc, while the decision of a straight or curved graft should consider vascular condition and ease of cannulation. There are various opinions regarding the material and configuration of grafts. This guideline is mainly concerned with polytetrafluoroethylene (ePTFE) or polyurethane (PU) material. There was no remarkable difference regarding configuration. The goal of secondary patency rates for AVG were post surgery 1 year, 80%; 3 years, 60%; and 5 years, 40%. It is well known that the main reason for AVG occlusion is stenosis at the venous end of the graft. To prevent this, periodic monitoring should be carried out and treatment of the stenosis undertaken before occlusion occurs. If this routine is followed, the patency goals stated above can be obtained. (18)

CHAPTER 5

Vascular catheter placement

1. Short-term

Although useful for carrying out emergency hemodialysis, or when the current VA suddenly fails to function, considering the complications associated with this method, we want to emphasize its proper use in this guideline. We conclude that routine introduction to hemodialysis with this method is improper. Catheter placement should be carried out as a sterile procedure in a private room in a specialized department using a gown technique. As a rule, catheter insertion should be guided by ultrasound using the Seldinger method. The right internal jugular vein is the first choice for insertion but if that is not possible, the next choice should be the femoral vein. Use of the subclavian vein should be avoided because of the adverse effects it can have on AVF or AVG creation in the upper limbs later on. Indwelling of up to 3 weeks is permissible, but because fever and infection have been found to be unrelated to the length of indwelling, a longer period is possible if there are no signs of fever or infection (19). Naturally, during this period of catheter use, efforts should be made to establish a permanent VA through new construction or reconstruction. Heparin lock is one method to prevent coagulation within the catheter, a microinfusion of heparinized physiological saline solution is recommended. Because a high percentage of dialysis patients are carriers of *Staphylococcus aureus*, for those patients with nasal staphylococci, coating the nasal cavity with mupirocin ointment or povidone-iodine is recommended.

Although favorable results can be obtained with antibiotics in the treatment of catheter infection, in principle, removal is safer and catheterization using a different route established directly before the next dialysis session is better. Administration of antibiotics is required even after removal until the fever resides.

TABLE 5. *Arteriovenous fistula monitoring following construction*

(1) Post surgery monitoring of the access for thrill or bruit is vital.
(2) Immediately following surgery, vascular spasm can reduce blood flow in the access. In this case, intravenous injection of 2000–3000 units of heparin (or low molecular weight heparin) is recommended.
(3) Maturation of the AVF can be predicted with the blood flow rate measured at 24 h post surgery and at 3 weeks as well as measurement of the cross sectional area of the radial artery.

TABLE 6. *Cases for which arterial superficialization is suggested*

(1) Cases in which it can be predicted that the cardiac burden caused by the internal shunt cannot be borne. This method is recommended if left ventricular ejection fraction is 30–40% or less.
(2) Cases in which surgery to construct the access would be difficult due to damage of the superficial veins.
(3) Cases in which there are no appropriate veins for anastomosis.
(4) Cases in which steal syndrome has developed or there is the possibility of it developing.
(5) Cases in which venous hypertension has developed or may develop due to arteriovenous fistula construction.
(6) As a backup for patients in which vascular access trouble occurs repeatedly.
(7) Other

In cases in which difficulties occur in achieving adequate blood flow or return flow, obtaining adequate flow is better assured by establishing a different route than by replacement of the catheter over a guidewire. Venous catheters are a simple and effective form of VA, but their appropriate use taking into consideration the associated complications is strongly advised.

2. Long-term

This method is used for (i) patients in whom AVF or AVG cannot be constructed or repaired is not possible; (ii) the patient's clinical condition (arterial superficialization cannot provide adequate blood flow, patients with strong restlessness or body movement, patients complaining of strong pain upon cannulation); and (iii) VA for pediatric hemodialysis. The increase in elderly and long-term dialysis patients will lead to an increase in patients with vascular access loss as in (i) above, however, in principle, long-term vascular catheter use in patients carrying MRSA or other contagious bacteria (including active and inactive) should be avoided. When other methods of VA are not available, the benefits and risks for the patient should be cautiously considered when deciding whether or not to use this method. Knowledge regarding the endurance of the catheter itself in long-term venous catheter indwelling is lacking. It is recommended that after reviewing the condition of deterioration of the material, that the catheter, connectors, etc., be replaced on a 6-month to 1-year interval.

CHAPTER 6

Superficialization of an artery

Superficialization was not noted in the VA guidelines of other countries. At first, this method was used as a fallback as well as a backup when AVF or AVG became unusable, but in Japan, 2–3% of the CHD patients use this method permanently. This chapter was prepared for that reason. In VA-GL, JSDT 05, cases appropriate for this method are shown in Table 6. It is also possible to change to an AVF or AVG when cardiac function has improved. The brachial artery is chosen over 90% of the time as the artery for superficialization. (20) A nonarterialized vein is utilized as the return route. It has been reported that in 50% of cases, superficialization became unusable as a VA because of damage to the veins. (21) The importance of obtaining a vein for long-term use of this method is an obstacle. If a venous route is obtainable, the 3-year rate of use of the superficialized brachial artery is very favorable at 80–90%. Complications to be aware of include acute occlusion (peripheral circulation disorder), aneurysm and infection. Observation is possible in cases in which the brachial artery is obstructed, yet peripheral circulation disorder has not occurred. It is recommended that cannulation of the superficialized artery be carried out 3 weeks after surgery.

CHAPTER 7

Methods for the use of vascular access

Methods for use (cannulation methods) of AVF and AVG, as well as superficialization regarding infection, cannulation error and cannulation site are discussed. The guideline recommends that cannulation of AVF or AVG be carried out as has been recommended in the past, over as wide a range as possible. The buttonhole method is one method of interest and its application is shown in Table 7. Patients are under immense psychological and mental pressure regarding VA construction, repair and

TABLE 7. *Buttonhole method and cannulation techniques*

(1) Patients experiencing intense pain upon cannulation are appropriate for this method. Note: Home dialysis patients can also make use of this method.
(2) The constant route of the buttonhole method is achieved by placing a short post not reaching to the blood vessel surface in the route left behind by the needle removed following routine hemodialysis. This post is left in place for 14 days.
(3) In buttonhole cannulation, the scab formed at the entrance is removed and a dull arteriovenous fistula needle is passed through the constant route.

cannulation (9) and for those cases anxious at and/or having difficult a every cannulation, some form of care and/or treatment is necessary.

CHAPTER 8

Monitoring of vascular access functions

It is stressed that each facility should, based upon their own conditions, establish a monitoring program for AVF and AVG construction and use. Specifically, (i) physical findings; (ii) measurement of VA blood flow; (iii) measurement of recirculation rate; and (iv) when the VA shows functional and/or morphological disorders, ultrasonography, MR angiography and 3D-CT should be utilized to determine the extent and location prior to surgery. The blood flow can be measured by ultrasound dilution, Doppler or by the critline method. Each is non-invasive and effective. An AVF with a flow of less than 500 mL/min or a 20% or greater decrease from baseline shows a high possibility of a stenotic lesion. In an AVG, a flow of less than 650 mL/min or a 20% or greater decrease from baseline suggests the possibility.

An increase in venous pressure can be caused by several factors, but under the condition of proper cannulation by similar needles, a continuous increase can indicate improper function of the VA. In an AVG, because the graft itself will not alter its shape by blood pressure alone, venous pressure is affected most by stenosis in the area of anastomosis in the venous outlet. In Japan, the measurement of venous pressure is carried out by a method known as 'dynamic venous pressure' but this method is easily affected by the gauge of the needle, condition of the dialysis circuit and blood flow rate. Thus, this guideline recommends the more accurate 'static venous pressure'. Secondary patency rates of AVG have shown large improvements in recent years. This is due to the discovery of stenosis before occlusion by thorough periodic monitoring and prompt undertaking of the balloon catheter method or one of its variations. Angiography is an extremely effective method providing accurate information, it however, involves the injection of contrast agents and efforts should be taken to limit their usage to the lowest possible amounts.

CHAPTER 9

Vascular access and cardiac function—vascular access construction and change based on patient's cardiac function

Topics similar to this were not found in the guidelines of other countries. It is clear that internal shunt-type VA places a burden on cardiac function. The main points in this chapter are: (i) recognize which VA have an effect on cardiac function and those that do not; and (ii) because AVF and AVG might lead to heart failure in patients with impaired cardiac function, it is strongly advised that the patient's cardiac function be taken into consideration when undertaking new construction, repair or maintenance of VA. Thus, changes in the cardiac function of dialysis patients with AVF or AVG should be continuously checked, as well as whether or not the VA blood flow is relatively excessive or not. Abnormalities in cardiac function should be examined mainly by clinical findings, and an objective indicator using echocardiogram was tentatively determined as follows: (i) LVEF < 30%: marked decreased cardiac function; (ii) LVEF = 30–40%: borderline cardiac function; (iii) LVEF > 40%: relatively intact cardiac function; and (iv) LVEF > 60%: sufficiently intact cardiac function. Following the construction of AVF or AVG, the trend is for blood flow to increase with time. If that blood flow is clearly causing a decline in cardiac function then it is necessary to intentionally constrict or occlude the VA (22).

CHAPTER 10

Repair and timing policy of vascular access (23)

This chapter forms one of the cores of this guideline. Even with proper construction and use, whatever the type of VA, as time goes on, disorders in function and form will occur (Table 3). This chapter was created to give detailed and concrete guidance concerning stenosis, thrombosis, steal syndrome, infection, excessive blood flow, etc. Whatever the complication, there is no need to say that the correct diagnosis and evaluation are a necessity. Treatment should be carried out if the stenotic rate exceeds 50% and one or more of the following clinical abnormalities are present: (i) decreased blood flow, aneurysm; (ii) increased venous pressure; (iii) abnormally high BUN or increased recirculation rate; (iv) unexpected decrease in dialysis efficiency; or (v) abnormal physical findings. For the repair of the stenotic lesion, from the viewpoint of access preservation and invasiveness, balloon PTA is the best method. Note that surgical repair, PTA or one of its variations each have their special features and that one method or the other must be chosen. Surgical reconstruction is one option that should be considered in cases having required 2 PTAs within a 3-month period, to reduce the physical and mental stress placed upon the patient and because of the high cost of materials. As a rule, the choice of repair method should be made with the treatment and support of the physician with the most experience in

VA therapy (vascular surgeon, radiologist, nephrologist, etc.) within the facility or in the surrounding region. The repair should then be undertaken based upon efficiency and economic planning.

CHAPTER 11

Morbidity and mortality of vascular access type

The incidence of functional abnormalities varies between VA type. The effect of VA on morbidity and mortality are discussed in this chapter. The importance of making every possible effort to establish (prepare) the AVF, excelling in function and form, at the start of hemodialysis is reemphasized (24).

CONCLUSION

The aim for the production as well as a summary of the contents of the 'Guidelines for the Construction and Repair of Vascular Access' published by the Japanese Society for Dialysis Therapy have been introduced.

It is hoped that this guideline will become one milestone for VA construction and repair. Furthermore, an update of the guideline is planned, after the accumulation of knowledge based on actual practice.

REFERENCES

1. Japanese Society for Dialysis Therapy, Scientific Committee. Guidelines for the construction and repair of vascular access. *J Jpn Soc Dial Ther* 2005;38:1491–551. (In Japanese)
2. Japanese Society for Dialysis Therapy, Statistics Investigation Committee: Current conditions of chronic dialysis therapy in Japan. *J Jpn Soc Dial Ther* 2000;33:1–27. (In Japanese)
3. Agishi T, Haruguchi H. Current conditions of vascular access of maintenance hemodialysis patients in Japan. *J Jpn Soc Dial Ther* 2000;15:221–4. (In Japanese)
4. Ohira S, Tsuji Y, Itami N. Vascular access infection in chronic hemodialysis patients. *J Ass Dial Physicians* 2000;15:221–4. (In Japanese)
5. Rayner HC, Pisoni RL, Gillespie BW et al. Creation, cannulation and survival of arteriovenous fistulae. Data from the Dialysis Outcomes and Practice Patterns Study. *Kidney Int* 2003;63:323–30.
6. National Kidney Foundation. K/DOQI Clinical practice guidelines for vascular access: update 2000. *Am J Kidney Dis* 2001;37(Suppl 1):S137–S181.
7. Ohira S. Vascular Access Guidelines in other countries. *Jpn J Clin Dial* 2005;21:1571–6. (In Japanese)
8. Ota K. *Good-bye Shunt Trouble*, Enlarged edn. Tokyo: Tokyoigakusha, 2003. (In Japanese)
9. Ohira S, Imura T, Kon T. Psychological problems associated with vascular access complications. *Kidney Dial* 2005;58:452–6. (In Japanese)
10. Sato T, Kan K, Fukunari K, Koga N. Interventional therapy for vascular access complications. *Jpn J Clin Dial* 2003;19:999–1007. (In Japanese)
11. Ohira S. Surgical vs. endovascular approach. *Jpn J Clin Dial* 2003;19:1539–41. (In Japanese)
12. Toma S, Shinzato T, Fukui H et al. Timesaving method to create fixed puncture route for buttonhole technique. *Nephrol Dial Transplant* 2003;18:2118–21.
13. Canadian Society of Nephrology. Clinical practice guidelines for vascular access. *J Am Soc Nephrol* 1999;10:287–321.
14. Kidney Organization of Australia. Caring for Australians with renal impairment: vascular access. [Cited 27 Sep 2006.] Available from URL: http://www.cari.org.au/dialysis_va_archives.php
15. Vascular Access Society (Europe). Management of the renal patient; Clinical algorithms on vascular access for hemodialysis (VAS Guidelines). [Cited 27 Sep 2006.] Available from URL: http://www.vascularaccesssociety.com/guidelines
16. Allon M, Robbin ML. Increasing arteriovenous fistulas in hemodialysis patient; problems and solutions. *Kidney Int* 2002;62:1109–24.
17. Ohira S, Kon T, Imura T. Evaluation of primary failure in native AV-fistulae (early fistula failure). *J Jpn Soc Dial Ther* 2004;37:1959–66. (In Japanese)
18. Hiranaka T. Results of long-term use of an artificial venous shunt. *J Jpn Dial Ther* 2003;36:1259–64. (In Japanese)
19. Al-Wakeel JS, Milwalli AH, Malik GH et al. Dual-lumen femoral vein catheterization as vascular access for hemodialysis. *Angiology* 1998;49:557–62.
20. Haruguchi H, Sato Y, Teraoka S et al. Current status of arterial superficialization and its place in vascular access. *Kidney Dial* 2003;55(Suppl: Access 2003):18–22. (In Japanese)
21. Hiranaka T, Kitayama Y, Nakamura K et al. Clinical aspects in cases of brachial artery superficialization. *Kidney Dial* 1997;42(Suppl: Kidney Failure and Surgical Therapy'97):71–72. (In Japanese)
22. Ishikawa K, Doi K, Akashi M. Effectiveness of banding or closure in cases of cardiac failure due to access with excessive blood flow. *Kidney Dial* 2000;49(Suppl: Access 2000):100–4. (In Japanese)
23. Konner K, Nonnast-Daniel B, Ritz E. The arteriovenous fistula. *J Am Soc Nephrol* 2003;14:1669–80.
24. Schwab SJ. The hemodialysis catheter conundrum; Hating living with them, but can't live without them. *Kidney Int* 1999;56:1–8.

APPENDIX

'2005 Japanese Society for Dialysis Therapy—Guidelines for Vascular Access Construction and Repair for Chronic Hemodialysis'

This guideline consists of guidelines, explanations or comments and references. Here, only the guidelines are presented. For further information, the readers are referred to the literature (*Journal of JSDT* 38(9): 1491–1551, 2005).

Chapter 1: Informed consent related to vascular access

GL-1: The physician who carries out hemodialysis (dialysis physician) must provide a sufficient explanation to the patient and family about the necessity of vascular access (VA), which is indispensable for the initiation and continuation of hemodialysis, and methods for its construction and repair. In this process, the explanation of VA must be carried out while checking the degree of understanding of the patient.

GL-2: This explanation must be understood to be included in a process called informed consent,

which is carried out as the patient accepts the initiation of dialysis therapy.

GL-3: When the dialysis physician entrusts the construction of VA to an access surgeon, he has the responsibility to explain details concerning VA to the patient and family again. The items that must be included in the explanation include the following: (1) objective of the construction of VA; (2) methods for VA construction (surgical procedure) and preoperative examinations; (3) methods of anesthesia; (4) operation time; (5) points of attention after surgery; (6) methods for VA use (procedure of puncture); (7) patency rates of various VA; (8) necessity of periodic examinations of the function and form of the VA; (9) expected complications related to VA; (10) methods for the repair in VA complications; and (11) others.

GL-4: Items (1)–(6) are essential in the explanation to the patient, but the others might be omitted in an early stage of the disease in consideration of the degree of patients' understanding and be explained later after stabilization of the patients' physical and mental conditions. However, all items should be explained to a representative from the family.

GL-5: When a surgical procedure has been selected, an explanation of its necessity must be added. This is mandatory especially when AV-graft has been selected.

GL-6: The occurrence of various complications over time is unavoidable because of the nature of VA, which is used frequently over a long period, so that the items as follows must also be explained in advance: (1) insufficient blood flow; (2) stenosis; (3) thrombosis; (4) infection at the puncture site; (5) aneurysms and varices; (6) venous hypertension (sore thumb or sore hand syndrome); (7) steal syndrome (ischemic disorders); (8) excessive blood flow and resultant high output cardiac failure; (9) recirculation; (10) difficulty in puncturing, restricted puncture site; and (11) others.

GL-7: It is important to obtain the understanding and consent from the patient and family after explaining in as plain a language as possible and exchanging questions and answers. The access surgeon is required to carefully undertake these procedures before he constructs or repairs VA.

Chapter 2: Basic technique and time of construction of vascular access in the initiation of hemodialysis

GL-1: If a diagnosis of chronic renal failure has been made on the basis of the clinical course, serum creatinine level of 2–3 mg/dL or above, etc., the patient must be promptly referred to a nephrologist to improve the outcome.

GL-2: If hemodialysis has been selected as a treatment for end-stage renal failure the nephrologist should explain the role and importance of VA in this therapy and refer the patient to an access surgeon as promptly as possible.

GL-3: An access surgeon is required to have sufficient experience and expertise.

GL-4: An access surgeon must closely examine the patient by inspection, palpation, and ultrasonography of the forearm arteries and veins, record the course of the vessels, and make a plan for VA construction. In this process, sufficient evaluation of the states of the peripheral circulation and cardiac function is also necessary.

GL-5: Creating VA is usually considered when Ccr reaches 10–20 mL/min or serum creatinine level reaches 6–8 mg/mL. However, it must be noted that changes in the Ccr and those in serum Cr might be inconsistent. In patients with diabetic nephropathy, who are apt to show overhydration, the construction of VA is often necessary even at a lower serum Cr of 4–6 mg/mL.

GL-6: Of the VA for chronic hemodialysis, AVF should be selected as the first choice whenever possible in consideration of the patency, resistance to infection and the occurrence of various complications.

GL-7: AVF should be constructed at least 2–4 weeks before the initial puncture by anticipating the time of the beginning of hemodialysis from the results of various laboratory tests and clinical symptoms. It is desirable that initial puncture be carried out 3–4 weeks after the construction of AVG.

GL-8: AVF and AVG construction might induce cardiac malfunction. Thus, superficialization of the artery or intravascular catheter indwelling should be selected as a temporary measure in patients with markedly reduced cardiac function.

GL-9: Indications of vascular catheterization must be evaluated carefully because of possible serious complications. The catheter indwelling must be carried out immediately prior to use.

Chapter 3: Construction and management of arteriovenous fistula

GL-1: The surgical procedure and timing of surgery should be determined after thorough preoperative evaluation of general conditions and peripheral circulatory disorders.

GL-2: Make sure evaluation is carried out by physical exams (inspection, palpation, etc.) before surgery. These should include a check for (1) swelling of upper extremity; (2) hemiplegia; (3) contracture of elbow joint; and (4) skin changes.
GL-3: Ultrasonography is useful for determining the size and continuity of arteries and veins, but not essential for vascular evaluation.
GL-4: Preoperative angiography is recommended in the following cases: (1) remarkable edema of the planned side of operation; (2) abnormal development of vascular collaterals on the side of VA construction; and (3) past history of vascular catheterization or pace maker implantation via the subclavian vein on the planned side of operation.
GL-5: AVF of the wrist or the Tabaciere (anatomical snuff box) is the first choice, but the site of VA creation should be determined eventually by comprehensive evaluation of the patient's background, general conditions, and local conditions.
GL-6: If AVF construction in the forearm is judged to be difficult or impossible, then consider AVF in the elbow or upper arm. It is recommended that elbow AVF be constructed before graft implantation (AVG). AVF with basilic vein or its transposition is considered to be one of the possibilities.
GL-7: Concerning vascular anastomosis, side (artery) to end (vein) type is recommended in view of functional advantages.
GL-8: General practitioners should refer patients with chronic renal insufficiency to nephrologists as early as possible.
GL-9: VA should be constructed and managed in consideration of factors that affect the patency rate. These include: (1) patient's profile (age, sex, underlying disease, pathologic conditions, etc.); (2) history of intravascular catheterization; (3) timing of first puncture; and (4) different patency rate among access surgeons.
GL-10: In patients who show poor maturation of AVF after the surgery, it is desirable to examine its cause with precision within 2 weeks postoperatively and to carry out appropriate interventions.
GL-11: Appropriate postoperative monitoring is mandatory.

Chapter 4: Construction and management of arteriovenous grafts

GL-1: The indication of selecting AVG is for the patient in whom AVF is impossible to construct and who has sufficient cardiac function to tolerate hemodynamic changes after AVG creation.
GL-2: The site of graft implantation is determined based upon patient's condition, skill of the surgeon, and expected duration of hemodialysis. Straight, curved or looped graft might be chosen depending on implantation site.
GL-3: The materials of artificial vessels (grafts) are primarily ePTFE and PU, and the standard shape of graft is straight.
GL-4: As for intraoperative and postoperative management (1) grafting can be carried out under local anesthesia (including brachial nerve block); (2) no systemic heparinization is needed during the surgery; and (3) prophylactic administration of antibiotics is recommended before and after the surgery.
GL-5: Possible postoperative complications are as follows and they must be carefully observed and managed: (1) thrombosis; (2) venous stenosis; (3) infection; (4) steal syndrome; (5) excessive blood flow; (6) seroma; and (7) dilatation of the graft.
GL-6: Goals of the assisted or cumulative patency rate of dialysis AVG are at least 80%, 60%, and 40% in postoperative 1, 3, 5 years, respectively. These goals are attainable by careful and aggressive postoperative observations and repairs.

Chapter 5 (1): Short-term vascular catheterization

GL-1: Catheterization is carried out in patients who require emergency blood purification therapy.
GL-2: Catheterization can be carried out in a hospital room, but a particular room kept clean such as the room occupied by the patient alone is desirable in order to reduce the catheter-related infection.
GL-3: Catheterization is carried out by the Seldinger method. It is recommended that the procedure be carried out under fluoroscopic and echo guidance.
GL-4: The right internal jugular vein provides the best approach. If this vessel is unavailable for some reason, a femoral vein approach should be selected. Subclavian vein catheterization should be avoided because of possible serious complications such as hemorrhaging which is difficult to control, and resultant stenosis of the vein, which makes AVF construction difficult at the homolateral upper extremity.
GL-5: After catheter insertion, chest X-ray is mandatory to confirm the state of inserted catheter and complications.
GL-6: The duration of catheter dependence is preferably about 3 weeks at the longest but unless fever or other infectious signs and symptoms are noted, it might be indwelled more than 3 weeks.

GL-7: During intervals between hemodialysis, the catheter should be filled with heparin, or microinfusion of heparinized physiologic saline should be performed, but the latter has a greater antithrombotic effect.

GL-8: For the prevention of infections, the expected site for catheter indwelling must be cleaned, and catheterization must be carried out aseptically using the gown technique. Connecting and disconnecting the dialysis tube must be carried out by a skilled staff member. Only on the day of hemodialysis, dressing should be changed, and the exit of catheter should be observed to examine whether it is infected.

GL-9: Catheter infection might be successfully treated by antibiotics, but the removal of catheter is safer in principle.

GL-10: In the case of inadequate blood flow or difficulty in returning the blood, catheter insertion at another route is more reliable to obtain sufficient blood flow than catheter replacement using a guide wire.

Chapter 5 (2): Long-term vascular catheterization

GL-1: This is the catheterization maintained over a long period for blood purification therapy.

GL-2: This method is indicated, in principle, for (1) patients in whom AVF or AVG cannot be constructed; and (2) patients for whom this procedure is considered to provide the best VA from their clinical conditions. This procedure is one of the VAs suitable for children.

GL-3: Principles of catheter implantation and postoperative care are basically similar to short-term catheterization.

GL-4: After catheterization, patients should be examined periodically to evaluate catheter infection and the absence of complications. Particular attention is necessary in order to secure strict maintenance of cleanliness of the catheter and exit site.

GL-5: If complications are observed during catheter management, take measures according to the attached documents or manual of the catheter. It must always be borne in mind that catheter-related infections become rapidly aggravated and in that case removal of the infected catheter must not be delayed.

Chapter 6: Superficialization of the artery

Concept: This is a type of VA selected for patients in whom a conventional internal shunt (AVF or AVG) cannot be constructed for some reason. The superficialized artery is used as an outflow route (for obtaining blood), and puncture of a superficial subcutaneous nonarterialized vein is usually necessary at each hemodialysis session.

GL-1: Indications of this method are as follows: (1) patients who are not expected to tolerate the cardiac loading caused by an internal shunt. A left ventricular ejection fraction (LVEF) of 30–40% or less is considered to be the indication of this method; (2) patients in whom the construction of AVF or AVG is extremely difficult because of deterioration of superficial veins; (3) patients in whom AVF or AVG is expected to cause steal syndrome or patients who are now using AVF or AVG and have already manifested steal syndrome; (4) patients who are estimated to develop venous hypertension if an AVF is constructed or those who have developed venous hypertension; (5) as a backup VA in patients who have the history of frequent VA problems; and (6) this VA is occasionally selected also for patients who need blood purification therapy such as familial hyperlipidemia.

GL-2: The brachial artery is the first choice. Superficialization of the femoral artery should be selected when the construction of other VA has become difficult.

GL-3: In the surgery for superficialization of the artery, the depth, length and distance from skin incision must be carefully considered.

GL-4: The superficialized artery should be punctured 2 weeks or more after the surgery when the skin wound has cured completely.

GL-5: If a subcutaneous vein that can be punctured is not available, the following measures are recommended: (1) using a catheter indwelled in a central vein; (2) constructing an internal shunt using a deep vein (internal jugular vein, femoral vein) if cardiac function is not reduced; and (3) graft implantation if reduced cardiac function is not observed.

GL-6: In order to prolong the duration of usage, it is recommended to alter the puncture site in as wide a range as possible at each hemodialysis session.

GL-7: A major complication of this type of VA is a peripheral circulatory disorder. It must be detected as early as possible, before a serious complication occurs and if needed, the change to another type of VA considered.

GL-8: If a peripheral circulatory disorder is caused by arterial stenosis, consider repair by PTA or bypass surgery using graft material. Acute arterial obstruction should be treated as soon as possible by thrombolytic therapy or thrombectomy.

Chapter 7: Methods for the use of vascular access

GL-1: Prevention of infections: (1) observe the skin condition on the VA side and avoid puncture where the skin shows infectious signs such as redness, swelling or local tenderness; (2) before puncture, patients wash the extremity with the VA with soap and dialysis staff must wear gloves (aseptic ones if the VA is an AVG) after hand washing; and (3) skin for puncture must be carefully disinfected by means of disinfectants such as alcohol or povidone iodine which does not cause a reaction in the patient's skin.

GL-2: How to use the AVF: (1) appropriate waiting period is necessary; (2) avoid the area very close to anastomosis and select an area where the tip of puncture needle will not move even if the patient moves the arm with VA during hemodialysis; (3) in order to prevent the recirculation of blood, select the puncture site for the outflow route closer to the anastomosis site than the one for the returning route and separate the two needles as much as possible; (4) change the puncture site at each puncturing, distribute the puncture sites evenly in as wide an area as possible; (5) apply a lidocaine patch or use buttonhole puncturing in patients who complain of intense pain; and (6) the average puncture angle for AVF is about 25°.

GL-3: How to carry out buttonhole puncture: (1) a fixed puncture route for buttonhole method is created by removing the puncture needle after routine dialysis and placing a short post that only reaches near the surface of the arterialized vein in the same puncture route for 14 days; and (2) in buttonhole puncturing, remove the clot formed at the entry and insert a dull needle along the established fixed route.

GL-4: How to use the AVG: (1) for AVG using ePTFE, a longer waiting period is necessary after surgery than for AVF, while AVG using PU can be punctured on the next day after surgery; (2) avoid repeated puncturing of the same site and puncture the entire length of the graft evenly; and (3) for needle removal and hemostasis, withdraw the needle first and after the needle tip has left the skin, compress the puncture orifice of the graft from over the skin with appropriate pressure.

GL-5: How to use a superficialized artery: (1) this VA requires a longer waiting period than AVF after the surgery. Puncture should be started after the artery has firmly adhered to subcutaneous tissues; and (2) the methods for puncturing and hemostasis of the superficialized artery are basically the same as those in AVF.

Chapter 8: Monitoring of vascular access functions

1. Monitoring of arteriovenous fistula functions

GL-1: A reliable program to monitor AVF functions must be established. This program should be worked out based upon the specifics of each facility.

GL-2: Evaluate physical findings such as fistula thrill, murmur, palpation of the entire arterialized vein which might show stenotic sites, pillow state, time to obtain definite hemostasis, swelling of the limb with AVF, every week.

GL-3: The measurement of VA blood flow is useful for evaluating VA function and this is possible with the ultrasound dilution method, Doppler method or critline method each of which is not invasive.

GL-4: The recirculation rate should be measured for reference data if possible.

GL-5: If any malfunction is suspected to be present in VA, MR angiography, 3-D CT, and ultrasonography are effective for detecting the site of stenotic lesion.

GL-6: Angiography and digital subtraction angiography (DSA) are useful for determining the indication of angioplasty or surgical repair and also evaluating the outcomes.

2. Monitoring arteriovenous grafts function

GL-1: Establish a reliable program for monitoring AVG function.

GL-2: Evaluate physical findings in the same manner as in AVF.

GL-3: The measurement of AVG blood flow can be carried out usefully and non-invasively by the means described in the previous AVF section. It must be carried out periodically. Blood flow less than 650 mL/min or a decrease by 20% or more from the base line blood flow suggests the existence of stenosis.

GL-4: Measurement of the recirculation rate is useful for evaluating AVG function. If the result is 15% or higher by urea dilution method and 5% or higher by dilution method not using urea on two or more measurements, the cause must be thoroughly investigated.

GL-5: Measure venous pressure. Progressively increasing venous pressures reflect functional insufficiency of AVG and requires repair. Static venous dialysis pressure (i.e. venous pressure at zero blood pump flow) is more predictive of outflow stenoses than dynamic pressure measurements.

GL-6: Measure dialysis efficiency. An unexpected decrease in dialysis efficiency (URR, Kt/V) means AVG malfunction.
GL-7: MR-angiography, 3-D CT and ultrasonography are useful in detecting the sites of stenotic lesions.
GL-8: Angiography and DSA have the same significance as in AVF.
GL-9: Careful monitoring and meticulous repair will result in improved outcomes for AVG.

Chapter 9: Vascular access and cardiac function—Construction and change of vascular access in consideration of patients' cardiac function

GL-1: It is important to understand the difference between which VA affect cardiac function and which do not.
GL-2: In patients with impaired cardiac function, a type of VA which requires arteriovenous anastomosis (shunt) formation might make heart failure apparent or aggravated. Each patient's cardiac function must be evaluated thoroughly prior to construction, repair and maintenance of VA.
GL-3: Cardiac function can be evaluated by clinical manifestations, ECG and chest X-P as a basis along with echocardiograms and Holter ECG.
GL-4: In hemodialysis patients with AVF or AVG, whether their cardiac function has changed and whether the VA blood flow is relatively excessive must be investigated periodically by appropriate examinations.
GL-5: Cardiac function evaluated by echocardiograms is tentatively determined as follows: (1) Echocardiographic EF < 30%: marked decrease in cardiac function; (2) EF = 30–40%: borderline cardiac function; (3) EF > 40%: relatively intact cardiac function; and (4) EF > 60%: sufficiently intact cardiac function.

Chapter 10: Timing and principles of vascular access repairs

GL-1: Stenotic sites should be diagnosed and evaluated properly by (1) physical manifestation (inspection, palpation, auscultation); (2) clinical findings (insufficient blood flow, increased venous pressure and decreased dialysis efficiency); and (3) imaging studies (echo, angiography).
GL-2: The most appropriate method must be selected for treating stenosis. Stenosis of which the stenotic rate is 50% or higher in combination with the presence of one or more of the following clinical abnormalities described here should be treated: (1) blood flow decrease, venous wall dilatation; (2) progressive increase of venous pressure; (3) abnormally high BUN or increased recirculation rate; (4) unexpected decrease of dialysis efficiency; and (5) abnormal physical findings.
GL-3: PTA and its modified method is the first choice for treating stenosis, especially for central vein stenosis. However, surgical interventions should be also considered as one of the options in patients who have required PTA more than twice within 3 months.
GL-4: Cutting balloon angioplasty is recommended for not only resistant stenosis but also restenosis occurring within 3 months after a previous PTA.
GL-5: For thrombotic obstruction, treatment suitable for the situation must be selected. Thrombus formation is mainly caused by stenosis and also by hypotension, dehydration, hypercoagulability, trauma, excessive compression of punctured site or infection. Treatment should be carried out promptly within 48 h to avoid catheterization or to shorten the duration of catheter indwelling.
GL-6: Non-thrombotic obstruction might be treated by PTA if a guide wire can pass to the obstructed site.
GL-7: Venous hypertension must be diagnosed and evaluated by angiography and/or CT. Treatments include surgical intervention, and PTA with or without stent placement, which is non-invasive and might be considered as a first choice. Extremely advanced venous hypertension will at times, require closure by surgery.
GL-8: Steal syndrome and its severity are diagnosed by the Fontaine classification. Stage I: a decrease in wrist-brachial pressure index accompanied by a cold sensation and/or pallor of fingers; Stage II: exacerbation of pain during hemodialysis or exercise, Stage III: pain of fingers felt also during rest; and Stage IV: ulceration and necrosis noted in fingers.
GL-9: Steal syndrome can be treated by arterial dilatation by PTA and surgical banding. If not serious, PGE1 administration might relieve the symptoms and signs.
GL-10: Excessive blood flow (large shunt) which has caused cardiac malfunction must be repaired. Therapeutic choices are (1) surgical banding; (2) interposition of graft; and (3) closure of the VA.
GL-11: Infection related to VA must be diagnosed promptly. The risk of infection is highest in intravascular catheterization followed by AVG and AVF in this order. Prolonged indwelling of the catheter, patients carrying MRSA in the nose or

skin, patients with hypoalbuminemia, elderly and diabetics all increase infection risk.

GL-12: Treatment of infection: (1) AVF: at least 2 weeks administration of antibiotics is necessary. If there is extensive infection or septicemia, at least 4 weeks are necessary. If uncontrollable, the VA must be closed surgically. (2) AVG: for local infections, the administration of antibiotics based on the results of culturing, incision of the lesion and partial graft resection are needed. If septicemia is present, in addition to the administration of the appropriate antibiotics, the access should be closed and the entire graft removed. As a rule a thrombosed graft with infectious signs is also an indication of total removal.

GL-13: VA repairs should be carried out on the basis of not only medically but also economically reasonable planning. In the selection of treatments, direct procedure or guidance should, as a rule, be requested of physicians who are the most experienced in VA-related treatment (e.g. vascular surgeons, radiologists, and dialysis specialists) in the facility or the region.

Chapter 11: VA type and resultant morbidity and mortality

GL-1: The incidence of functional abnormalities of VAs (stenosis, thrombosis or occlusion, infection, etc.) differs significantly among VA types (AVF, AVG, superficialization, intravascular catheterization, external shunt, etc.). Consequently, the morbidity varies with VA type.

GL-2: VA type affects the 1-year survival rate.

GL-3: It is extremely important to construct or prepare, as much as possible the AVF, excelling in form and function, before it is time to begin hemodialysis therapy.