Renal Failure in the Elderly

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9.1 Introduction

Among the elderly, defined as those over 65 years of age, kidney disease is common with between 11% and 30% having chronic kidney disease (CKD) [1]. CKD has been associated with increased risk of death and disability as well as increased surgical risk. A proportion of those with CKD progress to end-stage renal disease (ESRD), at which point kidney replacement therapy is required to sustain life. Among elderly patients with CKD, the cause of kidney disease, severity of albuminuria and glomerular filtration rate (GFR) are associated with the likelihood of progression to acute and chronic kidney failure. Dialysis as a form of kidney replacement therapy for treatment of ESRD is a great triumph of modern medicine, saving lives and providing meaningful improvements in quality of life for many patients. When introduced on a wide scale in the 1970s, ESRD patients treated with dialysis through the Medicare entitlement program were typically young, carefully selected, and did not suffer from multiple other medical comorbidities [2]. Over time, though, the population undergoing kidney replacement has changed, and contemporary reports in the United States suggest that patients over 65 years of age are at least half of incident ESRD patients, with the very elderly, those over 80 years of age, representing a significant and growing fraction of the population [3]. Many elderly patients with ESRD have four or more chronic health conditions when they reach ESRD, and many are not considered candidates for kidney transplantation,

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suggesting that dialysis will be the patient's kidney replacement therapy for the rest of their lives [4]. ESRD patients in general are fragile, with death rates 8–16 times higher than in the general population [5]. The general challenges of caring for elderly patients, compared to younger patients, have been well documented; these include generalized weakness, increased susceptibility to disease, inability to tolerate adverse environments or minor traumas, loss of agility, and age-related physiological changes in addition to attitudes and beliefs of older adults and their caregivers [6]. Further, within the traditional cohort of elderly patients defined as those over 65 years, there are distinctions between the "young elderly" between 65 and 80 years and the "very elderly" older than 80 years, in terms of comorbidities, frailty, dementia, and institutionalization status [7]. Despite these patient characteristics, dialysis access strategies for the elderly share many features with younger patients. This chapter aims to review the indications and potential modalities for renal replacement therapy (RRT) among the elderly with kidney failure. Further, RRT should be planned in a patient-centered fashion, accounting for patient anatomy, surgical history, medical comorbidities, and patient preferences. We will review the outcomes of vascular interventions in elderly ESRD patients and highlight approaches that may be used to attenuate the risk of contrast. Last, we will focus on individualizing decisions for the elderly with advanced CKD receiving either a dialysis access or other vascular procedures.

9.2 Indications for Renal Replacement Therapy

As in the population as a whole, the most common causes of ESRD in the elderly are diabetes and hypertension. Indications for RRT in the elderly are similar to those in younger patients. Historically, fluid overload and signs or symptoms of uremia, despite the poorly understood nature of the uremic syndrome and its somewhat subjective evaluation, were also considered to be indications for dialysis. As such, it is theoretically appealing to postulate that earlier initiation of RRT can remove these toxins and may be associated with decreased morbidity or mortality, as some observational studies suggested [8]. However, after correcting for lead-time bias, this advantage disappears [9]. The question of timing of initiation of hemodialysis (HD) was also explored in the Initiating Dialysis Early and Late (IDEAL) study, which randomized patients to early or late initiation of dialysis, based on estimated GFR (eGFR) [10]. Patients who started HD early at a target eGFR between 10 and 15 mL/min had similar survival and clinical outcomes as patients who started HD late at a target eGFR between 5 and 7 mL/min, or who started HD due to the development of symptoms associated with kidney failure including fluid overload or uremia. While elderly patients per se were not the target population for this study, the average age of participants in the study was 60 years and the overall findings did not differ between patients who were younger than 60 years and those who were older. Of note, there was substantial cross-over among those randomized to the delayed dialysis initiation so that nearly three-quarters of the group started dialysis at eGFR above 7 mL/min. The degree of cross-over limited the inferences one could draw regarding the impact of delayed start on patient outcomes.

Other authors have noted that assessing kidney function in elderly patients is difficult since the serum creatinine level can be spuriously low due to falling muscle mass, despite steadily declining eGFR as patients age. Further clouding the clinical picture, symptoms associated with uremia are nonspecific, and include anorexia, weight loss, weakness, nausea, and difficulties with sleep and cognition [11].

Given this background, a trial of dialysis in elderly patients may be considered in selected patients who have been well informed of the possible risks and benefits of dialysis, and can cooperate with the treatment and can receive it safely. Recent guidelines published by the Renal Physicians Association (RPA) offer recommendations that incorporate patient preferences and prognostic survival assessments to help guide physicians and patients in the decision-making process [12]. Indications for trials of dialysis include uremia or worsening of congestive heart failure, refractory to maximal medical management. In cases of acute kidney injury, as opposed to chronic kidney disease, when there is a possibility of reversibility of acute kidney failure, dialysis should be offered. Further, patients with atypical presentations of ESRD should be evaluated for treatable causes of kidney failure regardless of patient age. Occasionally, there can be the worry that this attempt at acute treatment may transition inappropriately to a long-term commitment to dialysis. However, while elderly survivors of AKI seem to require more time for total recovery and recover function less completely, they can recover function and generally deserve a trial of dialysis [11]. Ultimately, though, as well described in recent guidelines, “The initiation of dialysis therapy remains a decision informed by clinical art, as well as by science….” [13]

9.2.1 Choice of Dialysis Modality: Hemodialysis (HD) Versus Peritoneal Dialysis (PD)

As in younger patients, the choice of dialysis as kidney replacement therapy in the elderly is influenced by the availability of infrastructure and staff, the burden of comorbidities, specific anatomic contraindications to a particular modality, patient and caregiver ability to adhere to the requirements of the chosen modality, and patient or physician preference. Possible advantages of PD over HD in the elderly include preservation of residual kidney function, avoidance of fluid and electrolyte shifts, more liberal diet, avoidance of vascular access, and decreased transportation time, since this is typically a home modality. On the other hand, HD may be a better choice for patients with hernias, diverticulitis, history of abdominal surgery or other intra-abdominal pathology, morbid obesity, or psychosocial inability to adhere to PD requirements. The requirement for bulky and heavy dialysate consumables is another consideration, which may represent an unanticipated difficulty for elderly patients with limited storage space and physical strength; the employment of home-care assistants may overcome these challenges [14].

Peritoneal dialysis is in general used less frequently than hemodialysis, with approximately 9% of the prevalent US dialysis population using peritoneal dialysis and the balance using hemodialysis. In the elderly, defined as those over 65 years, PD is used even less frequently, with only 7% of the population using PD, though this fraction is growing [15].

There is controversy regarding the possible survival advantage of one modality over the other in elderly patients. In general, there appears to be a benefit to using PD instead of HD initially, but this benefit appears to be lost over time. This has historically been attributed to slower loss of residual kidney function in patients on PD, but more recent analyses have suggested that this effect is overstated and may be due to selection bias [16] or the use of tunneled dialysis catheters (TDCs) in HD patients [17]. In one prospective cohort study of 174 elderly patients older than 70 years in the United Kingdom, the annual mortality and hospitalization rates in PD and HD patients were similar (26.1 vs. 26.4 deaths per 100 person-years and 1.9 vs. 2.0 admissions per person-year, respectively) [18]. Contrary to the reports in younger patients, Windelmayer and colleagues found 16% higher mortality rates for elderly patients that start on PD compared to HD in the first 90 days after dialysis initiation. Mortality rates between 91 and 180 days were equivalent, but were 45% higher after 181 days. This effect was particularly pronounced in those with diabetes [19]. A larger study from Korea with longer follow-up also demonstrated higher mortality in elderly patients started with PD, as compared to patients started with HD, with PD being associated with a 20% higher hazard of mortality. An accompanying meta-analysis again suggested higher mortality with PD, though the magnitude of the increased hazard was only about 10%, but still statistically significant [20]. The possibility of increased mortality rates with PD in elderly patients must be considered and balanced against any possible benefits.

9.3 Selection of Hemodialysis Access: AVF Versus AVG Versus TDC in the Elderly

9.3.1 Kidney Disease Outcome Quality Initiative (KDOQI) Guidelines

The current Kidney Disease Outcome Quality Initiative (KDOQI) guidelines, last updated in 2006, state that patients should have a functional permanent access at the initiation of dialysis therapy. The KDOQI guidelines suggest that a working fistula should have the following characteristics, sometimes called the “Rule of 6s”: blood flow adequate to support dialysis (generally greater than 600 mL/min); a diameter greater than 6 mm, with location accessible for cannulation and discernible margins to allow for repetitive cannulation; and a depth of approximately 6 mm [13]. Accordingly, patients should be referred for arteriovenous fistula (AVF) creation at least 6 months before the start of HD. This is in preference to AV grafts (AVG) due to a belief that AVF are superior to AVG due to improved survival, lower costs, better patency, and reduced risk of infection or other complications. This time frame is suggested to allow for both initial access evaluation as well as additional time for revision to ensure that a working fistula is available at initiation of dialysis therapy [13]. Of note, this recommendation is based on expert opinion; a recent meta-analysis was unable to identify any studies that compared early to late referral for access creation [21].

An additional challenge is accurately predicting when dialysis will need to be initiated [22]. A liberal policy of early surgical referral provides more opportunities for successful access creation and can reduce the likelihood of starting HD with a tunneled dialysis catheter (TDC). This is an important consideration in the elderly, who have a lower rate of maturation compared to younger patients [23]. However, this may also be associated with a higher rate of unused AVF due to unexpectedly slow kidney function decline or competing mortality [24]. One study in the United States Department of Veterans Affairs system focused on patients with GFR less than 25 mL/min. In this group, 25% initiated HD over the ensuing year, while a far lower percentage of elderly patients received permanent access. The majority of elderly CKD patients survived without requiring dialysis, and many died before initiating dialysis [25]. A decision analysis model suggests a GFR threshold of 15–20 mL/min; though due to competing mortality risks, later referral at a lower GFR level would be appropriate for elderly patients [26]. Similarly, another resource suggests using a GFR threshold of 20 mL/min at which point a patient should be referred for AV fistula creation [27]. Ongoing work to establish clinically valid prediction rules for the progression to ESRD may help to individualize the approach to access placement.

Compared to AVF creation, AVG placement is considered to be the second best option in patients that have not yet started hemodialysis, but is better than initiating HD through TDC, according to the KDOQI guidelines. This ranking appears to be valid in the elderly, and is supported by data from analysis of data from administrative databases and the US Renal Data system (USRDS) [28, 29]. There is a concern, though, that successful maturation of an AVF may be a marker of overall improved medical status, and not of an effect of the access type [30, 31]. This selection bias may lead to an overestimate of the benefit of AVF over AVG [32]. More recent analyses that account for the influence of selection suggest that AVF and AVG may be equivalent in certain populations, especially the elderly [33–35].

Finally, dialysis through a TDC is considered inferior to both AVF and AVG due to the tendency for patients receiving HD through TDC to suffer increased rates of mortality, infection, and hospitalization compared to patients receiving AVF or AVG [36]. Further, catheters are associated with less efficient dialysis, the development of central venous stenosis, and an increased number of procedures required to maintain a functioning vascular access, leading to increased expense [37, 38]. This dynamic has also been demonstrated in the elderly [34]. The reasons for this increase in adverse outcomes in TDC patients have been postulated to be related to increased risks for catheter-related septicemia and also sterile inflammation even in the absence of infection [39].

The medical rationale for trying to avoid catheters is clear; however, from the patient's perspective, TDC has the distinct advantage of being in many ways the least invasive procedure, as it does not require surgery, a maturation period, or being cannulated thrice weekly with large-gauge needles, as AVF and AVG require [40]. This is especially relevant for elderly patients who may be struggling with multiple other medical challenges [41].

9.3.2 Transitioning Patients from TDC to an Internal Access

Despite KDOQI's goal of 50% AVF as a patient's incident vascular access, in 2010 approximately 80% of patients initiated HD through TDC, with approximately 16% started through AVF, and the balance through AVG. This distribution has remained largely unchanged since 2005, and is also seen among elderly patients [42]. Particularly in the elderly, the challenge of facilitating a transition from catheters to an internal access is complicated by the heavier burden of medical comorbidities that this patient population suffers. Extended TDC dependence after HD initiation is more likely to occur in elderly patients and may be related to longer time to maturation, increased need for secondary procedures, and higher primary failure rates [43].

Because of the known disadvantages of prolonged TDC dependence, AVG placement may be more attractive than AVF creation due to higher maturation rates and shorter time to maturation, leading to earlier TDC removal. However, these advantages need to be balanced against more frequent use of secondary procedures to maintain patency, as demonstrated in one study using administrative data from the USRDS [44]. In the elderly, who have short life expectancy, the longer-term risks of AVG use, including infection, limited primary patency, and potentially higher rates of ischemic steal syndrome, may not be as relevant as for younger patients. Recently, analytic tools to predict mortality rates among ESRD patients on HD have been developed, which may assist clinicians with tailoring vascular access options to particular patient needs [45]. As such, further research is necessary in order to better characterize the role of AVF and AVG, and determine the relative trade-offs, and whether different recommendations should exist based on patient age and preference.

9.3.3 Outcomes of Vascular Interventions in Elderly ESRD Patients

9.3.3.1 General Considerations

Both end-stage kidney disease and increasing age are well-known risk factors after many vascular surgical interventions, including repair of infrarenal abdominal aortic aneurysms (AAAs), carotid artery stenting (CAS) and carotid endarterectomy (CEA), and treatments for lower extremity arterial insufficiency [46–48].

Regardless of the presence of ESRD or advanced age, patients with symptomatic or ruptured aortic aneurysms are nearly always managed with either endovascular or open surgical intervention [49]. In these cases, although the perioperative risks are heightened due to the presence of ESRD and elderly status, the alternative of observation and medical management frequently leads to free rupture and death.

Similarly, symptomatic 50–99% stenosis of the extracranial internal carotid artery is usually treated, with some considerations for medical comorbidities and advanced age. Carotid endarterectomy (CEA) is generally the first option, and is preferred in the elderly, with carotid artery stenting (CAS) being reserved for patients with challenging anatomy or with severe cardiac or pulmonary comorbidities [47].

However, the majority of patients undergoing interventions for abdominal aortic aneurysms and extracranial carotid artery occlusive disease are asymptomatic, and in this population, the increased perioperative risk associated with ESRD and elderly status suggests that observation and medical management can sometimes be appropriate.

9.3.3.2 Asymptomatic, Intact Abdominal Aortic Aneurysms

In general, asymptomatic, intact abdominal aortic aneurysms larger than 5.5 cm should be considered for elective repair. At smaller diameters, the long-term benefit of early repair appears to be outweighed by the perioperative risk. At diameters between 4.0 and 5.4 cm, the UK Small Aneurysm Trial showed that compared to observation, early open surgical repair offered no long-term benefit in survival, while also subjecting patients to approximately 6.8% increased risk of mortality in the first 6 months after randomization [50]. Endovascular abdominal aortic aneurysm repair (EVAR) is associated with lower perioperative risks, leading some to suggest that repair at smaller sizes may be appropriate [51]. On the other hand, more recent publications suggest that patients with overall poor life expectancy and those that cannot safely tolerate a minimally invasive procedure should not undergo AAA repair, though the pre-operative identification of these patients can be difficult [52].

Elderly patients with ESRD over age 65 at HD initiation certainly suffer from abbreviated life expectancy, with a median survival of less than 2 years. Among patients who underwent AAA repair, an analysis of the United States Renal Data System (USRDS) found 1557 patients, 261 who had undergone open surgical repair and 1296 who had undergone EVAR between 2005 and 2008. The 30-day mortality after EVAR was lower than after open aortic repair (OAR) (10.3% vs. 16.1%). This perioperative survival advantage associated with EVAR was quickly lost; survival estimates were similar at 66.5% at 1 year (EVAR, 66.2%; OAR, 68%) and 37.4% at 3 years (EVAR, 36.8%; OAR, 40.0%). Median survival was 25.3 months after EVAR and 27.4 months after OAR [53].

Of note, current European Society for Vascular Surgery clinical practice guidelines state that AAA patients who undergo repair should have life expectancy of at least 3 years, which is longer than the median survival of patients who underwent AAA repair in the USRDS [54]. Meanwhile, American College of Cardiology Foundation/American Heart Association guidelines articulate a life expectancy of 2 years [55]. Ideally, criteria can be developed to assist with selecting patients with the necessary life expectancy, but in the absence of extenuating clinical circumstances, delaying prophylactic repair of asymptomatic AAAs in elderly ESRD patients until the AAAs reach a fairly large size threshold may be an appropriate strategy.

9.3.3.3 Asymptomatic Carotid Artery Occlusive Disease

In asymptomatic patients with 60–99% stenosis of an extracranial carotid artery, the benefit of carotid revascularization in asymptomatic patients can confer durable reduction in the risk of stroke, but this is dependent on excellent surgical technique. Perioperative stroke and death rates need to be less than 3%. However, it is also predicated on the patient's life expectancy, particularly in asymptomatic patients who are only expected to derive the full preventive advantages if they anticipate a life expectancy of at least 3 years [47]. This life expectancy may not be realized in patients with multiple medical comorbidities, particularly elderly patients with ESRD [41]. Although such patients have been shown to have potentially acceptable perioperative outcomes after CEA, long-term survival is poor, leading to calls for a conservative, nonoperative approach to the management of asymptomatic carotid disease for this population [56].

The development of CAS has been presented as an alternative to CEA for certain high-risk patients. Current guidelines define "high risk" as patients with medical risk factors, principally cardiac and pulmonary comorbidities, in addition to challenging anatomy like a high carotid bifurcation, the presence of a tracheal stoma, or extensive scar tissue due to radiation therapy or previous surgery [47]. In the Carotid Revascularization Endarterectomy Versus Stenting Trial, CAS appeared to be associated with lower rates of post-operative cardiac complications, but higher rates of stroke [57]. As such, the use of CAS as opposed to CEA or medical management in asymptomatic patients is still controversial, with specialty guidelines offering varying recommendations [58]. Society for Vascular Surgery guidelines recommend that CAS be reserved for high-risk patients with symptomatic carotid artery stenosis. Asymptomatic patients are best managed with CEA or medical management if they are at high risk for open surgery or if they have limited life expectancy [47].

For a patient with asymptomatic carotid artery stenosis, the relationship between perioperative risk, life expectancy, and the ongoing risk reduction after a successful intervention was recently described mathematically. The investigators of this decision analysis created a generalized model, identifying a critical life expectancy that was a function of perioperative complication rates and the absolute risk reduction that could be expected after successful surgery. As applied to patients with ESRD who have a short life expectancy, in order for either CEA or CAS to be superior to medical management, the intervention would need to be associated with either very low periprocedural complication rates or have very high absolute risk reduction [59].

These challenges were highlighted in a recent analysis of USRDS data, which focused on asymptomatic patients who underwent CEA and CAS. In this study, 2131 asymptomatic patients underwent carotid revascularization (1805 CEA, 326 CAS). Perioperative combined stroke or death rate was similar at 10.1% after CEA and 10.9% after CAS. Median survival after surgery was approximately 2.0 years for CAS and 2.5 years for CEA. Age over 70 years at the time of surgery was predictive of mortality in multivariate Cox proportional hazards modeling. While the rates of stroke with medical therapy alone could not be ascertained in the study, the remarkably short survival after both CEA and CAS is sobering, and is clearly lower than the 3-year guidance offered in contemporary guidelines [60]. As with intact, asymptomatic aortic aneurysm disease, criteria can be developed to assist with selecting asymptomatic, elderly ESRD patients for carotid revascularization. However, in the absence of extenuating clinical circumstances, medical management may be preferable in this population.

9.3.3.4 Lower Extremity Peripheral Arterial Occlusive Disease

Lower extremity peripheral arterial occlusive disease is more prevalent in patients with ESRD, compared to the general population, with rates of approximately 25% in two large prospective studies, in addition to significantly higher rates of cardiovascular morbidity and mortality [61]. Patients with ESRD who undergo lower extremity revascularization are more likely to suffer post-operative morbidity and mortality compared to patients with normal kidney function [62]. An analysis of the Dialysis Mortality and Morbidity Study in the USRDS showed post-operative mortality rates of 12.6% and 7.5% for bypass and angioplasty, respectively [63].

Given these challenging results, some authors have questioned whether lower extremity revascularization is worthwhile in patients with ESRD [64]. The countervailing concern, though, is the fate of the patient in whom limb salvage is unsuccessful. In an analysis of Medicare data from the 1990s, the rate of amputation was 6.2 per 100 person-years. Further, two-thirds died two years post-operatively after an amputation [65]. Clearly, while outcomes after lower extremity revascularization are challenging, amputation is associated with adverse health outcomes, as well.

In general, both endovascular techniques and open surgical revascularization can be used for limb salvage. In the Bypass versus Angioplasty In Severe Ischaemia of the Leg (BASIL) trial, which was a randomized controlled trial (RCT) that compared a balloon-angioplasty-first strategy versus bypass-surgery-first strategy, outcomes in terms of amputation-free survival were broadly similar, though balloon angioplasty was associated with lower costs [66]. However, among patients who survived at least 2 years, bypass surgery was associated with improved survival, leading to the suggestion that bypass surgery should be offered to patients who could be expected to survive at least 2 years [67]. In order to assist with patient selection, a survival model based on BASIL data was created. Elderly status and impaired kidney function were among the most important predictors of mortality [68]. Extending these findings to the elderly ESRD population with symptomatic peripheral arterial disease would suggest that an endovascular-first strategy that spares the patient some perioperative morbidity may be preferable due to the relatively short survival we expect in this patient population.

9.4 Strategies to Prevent Contrast Nephropathy

Contrast-induced acute kidney injury (CI-AKI) has been defined as an acute decrease in kidney function after intravascular administration of an iodinated contrast medium. The change in kidney function manifests as an increase in serum creatinine level of 25% or 50% relative to baseline, or an absolute change in serum creatinine level of 0.5 mg/dL within 2–5 days [69]. Pre-existing renal functional impairment is likely the most important risk factor for developing CI-AKI and the elderly, many with multiple medical comorbidities including diabetes, are certainly at high risk of chronic kidney failure [70].

A single-institution patient series reviewed outcomes after percutaneous coronary interventions. In their analysis of 8357 patients, hypotension, intra-aortic balloon pump, congestive heart failure, chronic kidney disease, diabetes, age greater than 75 years, anemia, and volume of contrast used were identified as risk factors for the development of CI-AKI [71]. While clearly an unmodifiable risk factor, advanced age needs to be recognized as a marker for increased risk of CI-AKI, and appropriate precautions taken to prevent AKI [72].

The mechanism for CI-AKI is not well defined, and is thought to be associated with a combination of renal vasoconstriction, acute tubular necrosis, reactive oxygen species production, and possibly direct toxicity on renal tubular cells. Regardless, the osmolality of the contrast agent appears to be a key modifiable risk factor, and there have been multiple efforts to create nonionic contrast agents, in addition to reducing their osmolality [73]. A recent meta-analysis of 25 trials demonstrated that CI-AKI after intra-arterial injection of contrast was less frequent with use of the iso-osmolar agent iodixanol (Visipaque), as compared to nonionic low-osmolar agents [74]. Iso-osmolar nonionic agents like iodixanol typically have osmolality of 290–320 mOsm, while low-osmolar nonionic agents like iohexol (Omnipaque) and iopamidol (Isovue) have osmolality around 600 mOsm. Finally, the osmolality of older, high osmolar ionic agents like iothalamate (Conray) is around 1600 mOsm; these agents are rarely used in contemporary practice.

The use of pre-exposure volume expansion is widely accepted. Guidelines published by the Kidney Diseases Improving Global Outcomes (KDIGO) initiative recognize the danger of volume depletion in patients who are already at elevated risk of AKI, like the elderly. The use of intravenous volume expansion with isotonic sodium chloride solution or sodium bicarbonate solutions is recommended over using hypotonic sodium chloride solutions, no intravenous volume expansion, or oral hydration alone [75].

N-acetylcysteine (NAC) is related to the amino acid cysteine and acts as a free-radical scavenger, producing antioxidant and vasodilatory effects. It has been studied as a prophylactic agent against CI-AKI in multiple observational and randomized studies with conflicting results [75, 76]. The results of ten randomized controlled trials were recently reviewed in a meta-analysis, which demonstrated that the combination of N-acetylcysteine (NAC) and sodium bicarbonate isotonic solutions reduced the occurrence of CI-AKI overall but not dialysis-dependent kidney failure. While the effect of NAC is not seen consistently across available studies, oral NAC is inexpensive and relatively safe. As such, current specialty guidelines offer cautious endorsement of the use of oral NAC in addition to isotonic intravenous volume expansion in order to prevent CI-AKI [69, 75].

Several investigator teams have studied prophylactic intermittent hemodialysis (IHD) for contrast-media removal. One major RCT demonstrated a benefit from prophylactic hemodialysis in patients with pre-existing chronic kidney disease. This study randomized 82 patients to normal saline intravascular fluid expansion either with or without a 4 h session of hemodialysis immediately after coronary angiography. Baseline creatinine was 4.9 mg/dL in both groups. Patients randomized to HD were noted to have lower peak serum creatinine levels (6.7 mg/dL vs. 5.3 mg/dL), less need for temporary kidney replacement therapy (35% vs. 2%), and lower need for long-term dialysis after discharge (13% vs. 0%) [76, 77]. Multiple authors have challenged the study's conclusions due to the small sample size and the fact that the renal outcome of serum creatinine concentration was directly impacted by the study intervention of prophylactic hemodialysis. Furthermore, the majority of the studies that have been published have not found any benefit from prophylactic kidney replacement therapy. A recent meta-analysis demonstrated that prophylactic HD held no advantages over standard medical therapy in terms of need for permanent kidney replacement therapy or progression to ESRD. In fact, HD appeared to actually increase the risk of CI-AKI [78].

There are other ungraded recommendations from KDIGO that are particularly relevant to the elderly population.

- Clinicians should assess kidney function in order to identify patients with pre-existing, but perhaps underappreciated, chronic kidney disease.
- Alternative imaging methods in patients at increased risk of CI-AKI should be considered.
- The lowest possible dose of contrast medium should be employed in patients at risk of CI-AKI.

The KDIGO recommendations are summarized in Table 9.1.

9.4.1 Considerations for Individualizing Care of Older Patients with ESRD

Dialysis dependence is associated with marked reduction in health-related quality of life (HRQoL) compared to age-matched controls, a finding seen in both North American and international populations [79]. Cross sectional studies have suggested that peritoneal dialysis is associated with improved HRQoL compared to hemodialysis in the general population [80]. While this finding suggests that peritoneal dialysis may be the preferred modality for many patients, it may be related to selection bias, and in any case is difficult to apply to the elderly population, who frequently have difficulty adhering to the self-care requirements. Further, any initial advantage in HRQoL may not be sustained; an observational study focused on

Table 9.1 KDIGO clinical practice guideline for acute kidney injury management associated with radiocontrast administration

Recommendation	Strength of recommendation
Assess the risk of CI-AKI and, in particular, screen for pre-existing impairment of kidney function in all patients who are considered for a procedure that requires intravascular (i.v. or i.a.) administration of iodinated contrast medium	Not graded
Consider alternative imaging methods in patients at increased risk of CI-AKI	Not graded
Use the lowest possible dose of contrast medium in patients at risk of CI-AKI	Not graded
We recommend using either iso-osmolar or low-osmolar iodinated contrast media, rather than high-osmolar iodinated contrast media in patients at increased risk of CI-AKI	1B
We recommend i.v. volume expansion with either isotonic sodium chloride or sodium bicarbonate solutions, rather than no i.v. volume expansion, in patients at increased risk of CI-AKI	1A
We recommend not using oral fluids alone in patients at increased risk of CI-AKI	1C
We suggest using oral NAC, together with i.v. isotonic crystalloids, in patients at increased risk of CI-AKI	2D
We suggest not using theophylline to prevent CI-AKI	2C
We recommend not using fenoldopam to prevent CI-AKI	1B
We suggest not using prophylactic intermittent hemodialysis (IHD) or hemofiltration (HF) for contrast-media removal in patients at increased risk of CI-AKI	2C

Adapted from [75]
Grading scale:
Level 1: "strong"
Level 2: "weak" or discretionary
Quality of supporting evidence: A (high), B (moderate), C (low), or D (very low)

elderly patients found that while initial HRQoL was higher in the PD population, this advantage was not evident at 6 and 12 months after dialysis initiation [18].

For hemodialysis patients, in particular, the causes for reductions in quality of life are likely multifactorial. Pain and depressive symptoms can drive lower mental health scores, and also lead to shortened hemodialysis treatments, increased utilization of emergency services, and hospitalizations [81]. In the recently published Frequent Hemodialysis Network trial, 245 patients were randomized to standard thrice weekly dialysis or a more frequent schedule of dialysis six times per week, with shorter daily sessions. The more frequent schedule was associated with improved self-reported general mental health, although depression scores were not significantly different. Possible mechanisms for this finding include better small molecule clearance, better volume management, reduced inflammation, and more convenient timing of dialysis [82].

Another issue to consider is the impact on caregivers. This is particularly relevant for peritoneal dialysis patients due to the significant home-care that is required.

In one observational study of 201 elderly patients, the caregivers for 84 hemodialysis patients were compared to 40 peritoneal dialysis patients, who were both compared to a control group of caregivers of 77 non-elderly hemodialysis patients. Caregivers of peritoneal dialysis patients scored significantly lower on the mental component of the SF-36 than caregivers of hemodialysis patients. The authors hypothesized that this may be related to the challenges of repetitive dialysis exchanges and other medical responsibilities; these can be onerous and lead to feelings of anxiety, stress, resentment, and guilt [83].

While there have been multiple studies investigating the difference in HRQoL between PD and HD, the HRQoL related to hemodialysis access (i.e., AVF vs. AVG vs. TDC) has not been studied as extensively. The existing measures, including the CHOICE Health Experience Questionnaire (CHEQ) and Kidney Disease Quality of Life (KDQOL), have only a handful of broad questions exploring dialysis access type [84, 85]. More recently, the short-form vascular access questionnaire (SF-VAQ) was developed. This is a validated questionnaire evaluating patient satisfaction in a Canadian setting associated with HD access type. HD through an AVF was associated with the highest overall satisfaction, followed by TDC, with AVG having the lowest scores. Interestingly, the study determined that while AVF scored well in terms of outcomes like concerns around hospitalization and bathing, TDC was preferred when it came to physical complaints like pain, bleeding, swelling, and bruising [86].

Recently, quality of life considerations have been explicitly referenced in contemporary guidelines for the management of patients with ESRD [87]. However, there may still be tension between what might be recommended in guidelines and what an individual patient may find preferable, especially in the elderly [88].

Guidelines for ESRD patients often present a uniform approach to management, prioritizing interventions to reduce mortality and manage disease complications. The overall goal is to provide a simplified pathway to guide management rather than address complex issues that may develop for individual patients. Many ESRD patients have multiple comorbid conditions, which can generate conflicting treatment recommendations [89]. In older patients, an individualized approach that considers competing sources of morbidity and mortality can inform clinical decisions. Clinicians, in conjunction with patients and caregivers, can prioritize patient-centered outcomes, even if these outcomes may not be easily explained by a well-described disease process [90].

Key Points

- With regard to management of vascular surgery issues in the elderly patient with renal failure, most recommendations are similar to those for younger patients. However, current guidelines often present a uniform approach to management, whereas older patients with ESRD may benefit from a more individualized approach due to heavy burden of comorbidities and shortened life expectancy.
- Both hemodialysis (HD) and peritoneal dialysis (PD) are reasonable renal replacement therapies in elderly patients with likely similar long-term outcomes, though PD requires significantly more patient resources and can be difficult for elderly patients and their caregivers to implement.

- In patients receiving HD, both arteriovenous fistulas (AVF) and arteriovenous grafts (AVG) are clearly superior to tunneled dialysis catheters as access modalities. AVF are likely superior to AVG, when they mature, but lengthy AVF maturation time can lead to prolonged TDC dependence. In elderly patients, the long-term benefits of AVF need to be balanced against the effects of prolonged TDC dependence on patients with already shortened life expectancy.
- Repair of asymptomatic, intact abdominal aortic aneurysms in elderly patients with renal failure is associated with poor perioperative and long-term outcomes. Delaying surgical intervention, especially in patients with difficult anatomy requiring open repair, may be reasonable in many cases.
- Medical management is the first choice in asymptomatic elderly patients with carotid artery occlusive disease and dialysis dependence. In well-selected patients with good life expectancy and severe extracranial carotid stenosis, carotid endarterectomy (CEA) is reasonable. The role of carotid artery stenting (CAS) in asymptomatic renal failure patients is unclear, and patients with clinical characteristics that make CEA difficult, and hence favor CAS, are likely best served with medical management alone.

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