

Management of Cardiovascular Disease in the Renal Transplant Recipient

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Cardiovascular disease is the major cause of death among renal transplant recipients (RTRs). Between 17% and 50% of deaths on transplantation are caused by cardiovascular disease [1,2], and the incidence of cardiovascular disease among RTRs seems to be increased threefold to fourfold over that observed in age-matched control populations [1].

The optimum management of cardiovascular disease in transplant patients is not as clear as it should be. The large corpus of cardiovascular trials virtually excludes patients with advanced renal disease. Concern has been expressed that the risk factors associated with cardiovascular disease in RTRs may differ from those in the traditional Framingham model, and that the traditional cardiac pharmacopeia may have an unfavorable therapeutic index. For example, until very recently, nephrologists have been tentative in using angiotensin-converting enzyme (ACE) inhibitors and statins in transplant patients.

Although the concerns regarding the generalizability of data derived from non-RTR populations are legitimately raised, on balance the literature suggests that the following assumptions hold:

1. The major risk factors for cardiovascular disease in RTRs are similar to those in the general population.
2. The risk-modification strategies proven in the general population are likely to be effective in RTRs.

3. The rates of adverse effects are manageable, and the therapeutic index of most interventions is favorable.

This article reviews the causes of and major risk factors for cardiovascular disease in RTRs, followed by an appraisal of the evidence for specific risk-factor interventions for cardiovascular disease in RTRs.

Etiology of cardiac disease in renal transplant recipients

The term cardiac disease is frequently taken to mean ischemic heart disease (IHD). This implied identity is unfortunate, because cardiac disease in RTRs frequently results not from coronary disease but from disordered ventricular geometry and function, a condition that can be called cardiomyopathy of overload (Fig. 1). Cardiomyopathy may present as asymptomatic left ventricular hypertrophy (LVH) or manifest clinically as congestive heart failure (CHF). This distinction is perhaps moot in the general population, in which most left ventricular disorders are closely associated with underlying coronary artery disease, the two disorders developing *pari passu*. In RTRs, however, as in dialysis and chronic renal insufficiency, left ventricular disorders are commonly caused by ventricular remodeling in response to hemodynamic stresses from anemia and hypertension in the absence of clinically overt IHD [3–8]. Although IHD and cardiomyopathy have several risk factors in common, they are distinct entities and diverge with respect to the importance of hemodynamic factors, particularly the role of chronic anemia, which is predictive of CHF but not of IHD [8].

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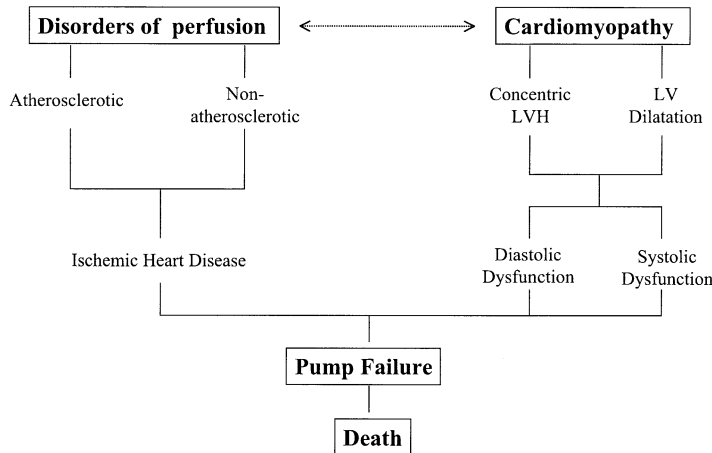


Fig. 1. Causes of cardiac death. LV, left ventricular; LVH, left ventricular hypertrophy.

Burden of disease

Left ventricular abnormalities

Several studies confirm the high prevalence of left ventricular abnormalities in RTRs and in aggregate suggest that elevated left ventricular mass is present in 40% to 60% of RTRs. Parfrey et al [9] examined an inception cohort of 102 renal transplant patients and found that only 17% had normal ventricles, whereas concentric LVH was found in 41%, eccentric LVH in 32%, and systolic dysfunction in 12% [9]. Regression of LVH does occur after transplantation but is incomplete: approximately 39% of patients still have an elevated left ventricular mass index (>132 g/m² in men, >102 g/m² in women) at 4 years, indicating that renal transplantation only partially reverses the stimulus to hypertrophy [10].

Clinical disease: congestive heart failure versus ischemic heart disease

Prevalence

Approximately 15% of transplanted patients have a history of IHD before transplantation. In a cohort of 1021 RTRs in Manitoba and Newfoundland, 10% had a documented history of IHD, and 11% had a documented history of CHF. IHD and CHF were almost mutually exclusive: only 2% of recipients had clinical evidence of both disorders, supporting the notion that these syndromes show less overlap in renal failure than in the general population.

Incidence

Among patients free of cardiac disease in the first year after transplantation, the subsequent

incidence of a major ischemic event (de novo IHD) is 1.2% to 1.5% per year [1,9,11], similar to the incidence observed in the Framingham Study [12] (Table 1). At 1.2% per year, the incidence of de novo CHF is two to three times higher in RTRs than in the general population, suggesting that renal transplantation may represent a state of accelerated heart failure [13,14]. As in other populations, the development of IHD or CHF predicts poor patient outcome. Compared with patients who remain free of cardiac events, RTRs who develop de novo CHF or IHD have a 1.5-fold to twofold higher risk of death, independently of age, gender, and diabetes (relative risk [RR], for CHF 1.8, 95% confidence interval [CI], 1.2–2.6; RR, for IHD 1.5; CI, 1.05–2.1) [7].

Risk factors for cardiomyopathy

Left ventricular hypertrophy

Long-term cohort studies of cardiac hypertrophy in RTRs are rare. Most studies have shown that LVH regresses but does not normalize following transplantation [10,11,15–22]. In a 4-year follow-up study, the major predictors of nonregression of LVH were age, duration of hypertension, and severity of hypertension as measured by the number of antihypertensive medications used [11]. The impact of EKG LVH was examined in a large retrospective cohort of RTRs in Manitoba [9]. Fourteen percent of patients had LVH by Cornell EKG criteria in the first year after transplantation. LVH was a risk factor for death (RR, 1.9; CI, 1.22–3.22) and CHF (RR, 2.27; CI, 1.08–4.81) independent of other major prognostic variables. Persistent or de novo LVH 5 years after

Table 1
Studies of risk factors for vascular disease

Study	N	Inception cohort?	Free of cardiac disease?	Posttransplantation risk factors	Endpoints	Incidence Events/100 patient-years
Aker	427	N	No	No	CV events	4.9
Ducloux	207	Y	No	Yes	CV events	8.8
Kasiske	706	Y	No	Yes	IHD	1.53
					CVA	1.00
					PVD	1.00
Kasiske	1124	Y	Yes	Yes	IHD	Not given
Lindholm	1347	Y	No	Yes	CV death	Not given
Rigatto	638	Y	Yes	Yes	IHD	1.23
					CVA	1.26
					Death	2.5

Abbreviations: CV, cardiovascular; CVA, cerebrovascular accident; IHD, ischemic heart disease; PVD, peripheral vascular disease.

transplantation also predicted CHF (RR, 2.71; CI, 1.17–6.3) and subsequent death (RR, 2.15; CI, 1.14–4.01). Anemia and diastolic blood pressure were the only independent risk factors for increasing Cornell voltage (a marker of left ventricular mass) between the first and fifth years.

Congestive heart failure

Rigatto et al [8] examined the development of CHF in a cohort of 638 RTRs in Canada. Only de novo events in patients free of cardiac disease at 1 year after transplantation were examined to minimize confounding by pretransplant disease and risk factors. The independent risk factors identified are summarized in Table 2.

As expected, age and diabetes were identified as major risk factors for CHF. These variables have long been shown to predict CHF in the general population.

Table 2
Risk factors for de novo congestive heart failure in 638 adult renal transplant recipients

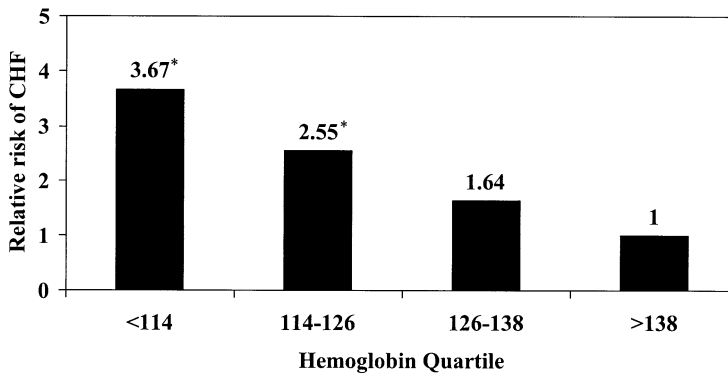
Variable	Relative risk (95% confidence interval); <i>P</i> value*
Age (decade)	1.43 (1.16, 1.77); 0.001
Diabetes	2.30 (1.43, 3.69); 0.001
Hemoglobin (per 10-g/L decrease)	1.24 (1.10, 1.39); 0.001
Systolic blood pressure (per 10 mm Hg)	1.29 (1.10, 1.50); 0.001
Serum albumin (per 10-g/L decrease)	2.10 (1.08, 4.07); 0.03
Cadaveric donor	3.18 (1.24, 8.18); 0.02

* Results of a multivariate Cox regression model.

The major modifiable risk factors identified were anemia and hypertension. The relationship between hemoglobin and risk of CHF was smoothly progressive for any hemoglobin level below normal. Risk was highest for patients in the lower hemoglobin quartiles (hemoglobin < 126), suggesting that even modest reductions in hemoglobin may be associated with cardiac morbidity (Fig. 2). Similar trends were observed for blood pressure. No threshold of risk was identified for either variable.

Several direct and indirect observations support a causal association between these hemodynamic factors and CHF. Both anemia and hypertension were documented to occur well before the development of CHF [8]. The monotonic increasing risk of CHF observed with worsening hypertension and anemia is consistent with causality. Moreover, studies in renal transplantation and in related populations (with chronic renal insufficiency or undergoing dialysis) have consistently shown an association between hypertension/anemia, and left ventricular growth [11,23]. Finally, a direct link has been documented between EKG LVH, hemodynamic factors, and CHF in RTR [9]. It is therefore likely that anemia and hypertension promote ventricular growth and remodeling, leading to CHF.

De novo IHD preceded or occurred simultaneously with CHF in only one-third of the cases in this cohort. Although IHD was a significant risk factor for CHF, it was not implicated in the majority of cases. Anemia and hypertension remained highly significant risk factors even after adjustment for IHD, suggesting that most CHF develops independently of coronary artery disease,



* $p < 0.03$ with respect to reference quartile

Fig. 2. Adjusted RR of de novo congestive heart failure according to hemoglobin quartile in 638 renal transplant recipients. *, $P < .03$ with respect to reference quartile.

because of hemodynamic stress from anemia and hypertension.

Cadaveric donation is probably a marker for unmeasured patient-selection biases, because cadaveric donation is preferred for marginal recipients. Hypoalbuminemia has been associated with CHF and progressive left ventricular cavity enlargement in dialysis patients [24]. It may be a marker of malnutrition or chronic inflammation, either of which could promote cardiomyocyte attrition, cardiomyopathy, and CHF [25].

Ischemic heart disease

Several large cohort studies have examined risk factors for IHD in RTR (see Tables 1 and 3) [1,2,8,26–28]. The occurrence of IHD was measured differently in each study (eg, all-cause mortality, cardiovascular mortality, myocardial infarction, coronary revascularization), so a formal meta-analysis is impossible. Despite this heterogeneity, several important patterns emerge. Most studies have corroborated the importance of age, gender, and diabetes in the development of IHD. The modifiable risk factors smoking and hyperlipidemia have been identified repeatedly.

Blood pressure has not been implicated in many studies. Two considerations deserve mention in this regard. First, hypertension is predictive of graft failure, which is a censoring end point in almost all studies [29]. If the impact on the graft occurs more rapidly than the impact on the heart, a true relationship between blood pressure and IHD events will be obscured by the phenomenon of competing outcomes (ie, patients are censored before they experience a cardiac event). Second, and perhaps more importantly,

most cohorts examined recurrent and de novo disease together. This aggregation may obscure the relationship with blood pressure as measured after transplantation, because recurrent events are probably related to risk factors existing before transplantation. The methodology used by Rigatto et al [8] minimized the latter source of confounding by studying de novo disease occurring after 1 year in patients free of cardiac disease in the first year after transplantation. Consequently, the expected relationship between blood pressure and IHD was seen in that study. A more recent study by Kasiske et al [30] has confirmed an independent association between systolic blood pressure and graft failure.

In contrast to its close association with cardiomyopathy, anemia has not been associated with IHD in renal transplant cohorts. This lack of association may result from opposing physiologic effects. On the one hand, anemia may promote cardiac ischemia by decreased oxygen delivery to myocardium and increased cardiac work; on the other, it may lower blood viscosity, enhancing flow and perfusion pressure distal to a coronary stenosis, thus compensating for a decrease in oxygen-carrying capacity. Moreover, most major ischemic events (eg, unstable angina, myocardial infarction) occur because of thrombosis over nonstenotic, unstable, lipid-rich atherosclerotic plaques. Anemia might weakly inhibit plaque thrombosis by lowering blood viscosity and increasing flow. It is likely that anemia has a neutral, or at most a weak protective effect on the incidence of major IHD events.

Acute rejection has been identified frequently as an independent risk factor for IHD. It is not

merely a marker for hypertension, donor status, steroid use, cadaveric donation, renal function, or delayed graft function, because it seems to be independent of these variables [8,12]. Repeated episodes of acute rejection may cause a state of chronic inflammation. Atherosclerosis is widely considered an inflammatory disorder, and markers of inflammation such as C-reactive protein have been independently associated with IHD in the general population [31]. Hypoalbuminemia is a crude marker of chronic inflammation and has been associated with IHD in several renal transplantation cohorts as well. In RTR, acute rejection and hypoalbuminemia may therefore reflect a state of chronic inflammation, which in turn may promote atherosclerosis.

Much debate has taken place regarding the relative cardiac toxicity of immunosuppressive agents. Different agents clearly have different cardiovascular risk profiles (eg, tacrolimus is associated with posttransplant diabetes mellitus [PTDM], and sirolimus is associated with hyperlipidemia). The impact of these differences on the patient is unclear, however. For example, one observational study showed that although tacrolimus is associated with higher risk of PTDM, and PTDM is associated with lower graft and patient survival, tacrolimus use nevertheless was associated with better patient outcomes overall [32]. Such results suggest that the impact of antirejection drugs on cardiovascular disease and survival is probably very complex, mediated by both direct vascular effects and by indirect effects on multiple risk factors. Effects on known cardiovascular risk factors cannot easily or simply predict the overall impact of these drugs on patient survival. In the absence of randomized clinical trial data showing a clear superiority of one regimen over another, the author and colleagues prefer to base

antirejection therapy primarily on the patient's risk of allograft rejection and to manage cardiovascular risk with other medications as necessary.

The role of homocysteine elevations in the genesis of IHD in RTRs is unclear. Limited observational data in RTRs suggest an association. To date, the evidence linking homocysteine with cardiac disease in the general population is purely observational [33–35]. The causal inference is thus less robust than for risk factors such as blood pressure and hyperlipidemia, for which extensive clinical trial evidence exists. A randomized clinical trial of homocysteine lowering in RTRs is currently under way and may settle the issue.

Treatment

With rare exceptions, few clinical trials in RTRs exist to help guide therapeutic decisions for prevention and treatment of cardiovascular disease. In the absence of direct evidence, recommendations must be based on observational data and on extrapolation of data from other populations. The recommendations made in the following section conform to these necessities

Risk-factor modification

Lifestyle modifications

As with nontransplant patients, all RTRs should be advised to stop smoking and to exercise, achieve ideal body weight, and eat a balanced diet.

Cholesterol reduction with statins

In several studies (Table 3), high cholesterol has been shown to be a risk factor for

Table 3
Studies of risk factors for vascular disease

Study	Endpoints	Risk factors							
		Age	Male Gender	DM	BP	Lipids	Rejection	Other	
Aker	CV events	Y		Y		Y			Smoking, BMI urate
Ducloux	CV events	Y	Y						HCY, GFR
Kasiske	IHD	Y	Y	Y		Y	Y		Splenectomy
Kasiske	IHD	Y		Y		Y	Y		Albumin, proteinuria
Lindholm	CV death	Y	Y	Y			Y		Delayed function, transfusion
Rigatto	IHD	Y	Y	Y	Y		Y		

Abbreviations: BMI, body mass index; CV, cardiovascular; DM, diabetes mellitus; GFR, glomerular filtration rate; HCY, homocysteine; IHD, ischemic heart disease; Y, yes.

cardiovascular disease in RTRs. Specific lipid targets for RTRs have not been developed, so treatment targets for the highest-risk groups of the general population are recommended by the American National Kidney Foundation [36]. A recent randomized, controlled trial of fluvastatin in RTRs with low-density lipoprotein (LDL) levels between 4 and 9 mmol/L demonstrated a statistically significant reduction in the secondary end point of nonfatal myocardial infarction and cardiovascular death [37]. Subgroup analyses using this end point showed similar efficacy in younger and older RTRs, men and women, diabetics and nondiabetics, and persons with low and high LDL levels at entry [38]. Because the primary composite outcome, death or myocardial infarction or coronary revascularization, did not achieve statistical significance, the results are not definitive. Taken in context, however, the results are strikingly consistent with the larger body of statin trials in the general population and strongly support the aggressive and liberal use of statins in RTRs.

The risk of adverse events with fluvastatin, particularly musculoskeletal complaints, was not higher than with placebo. Unlike fluvastatin, however, most other statins are metabolized through the same microsomal cytochrome as the calcineurin inhibitors tacrolimus and cyclosporine. Concomitant use of statins and calcineurin inhibitors may lead to higher levels and higher toxicities of both drugs. In practice, toxicities can be avoided by starting at half of the usual statin dose, titrating carefully, and monitoring calcineurin inhibitor levels and markers of myositis at each dose change. Combinations of statins, calcineurin inhibitors, and fibrates are not recommended.

Blood pressure targets

Hypertension is a risk factor for CHF, IHD, and graft failure in RTRs, but randomized, controlled trials of blood pressure lowering in RTRs are rare, and none have examined clinical end points (death, cardiovascular events, graft failure). Thus, recommendations must be extrapolated from the general population and nontransplant chronic kidney disease. Hypertension is a long-established risk factor for death, IHD, CHF, and LVH and for the progression of renal disease in the general population and in patients with chronic kidney disease [39–46]. Clinical trials in type 1 diabetes have established the benefit on proteinuria

and glomerular filtration rate of reducing blood pressure below 140/90. The relationship between achieved blood pressure and outcome in these studies suggests continued accrual of benefit at blood pressures lower than 140/90. The Modification of Diet in Renal Disease study, conducted in nondiabetic patients with renal failure, demonstrated that the impact on renal failure progression of an age-specific, lower-than-usual blood pressure target (< 125/75 mm Hg in patients < 65 years; < 130/85 in patients > 65 years) was dependent on the degree of proteinuria. Patients with protein excretion exceeding 1 g/d benefited more than those with protein excretion of less than 1 g/d [47,48]. The Hypertension Optimal Treatment study demonstrated a survival benefit for a lower-than-usual diastolic blood pressure (< 80 mm Hg) in diabetics [49]. There was no evidence of increased mortality in patients with very low achieved blood pressures, supporting the safety of lower-than-usual blood pressure targets. Based on these data, the clinical practice guidelines promulgated in the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure recommend a blood pressure target of less than 130/80 mm Hg in patients with chronic kidney disease or diabetes [50]. Given the similarities between RTRs and patients with chronic kidney disease, a target of 130/80 mm Hg or lower seems appropriate for all RTRs.

Renin-angiotensin antagonists

Again, direct evidence of benefit in RTR is lacking for renin-angiotensin antagonists (RAAs). Numerous large, randomized controlled trials, however, have shown that ACE inhibitors are superior to non-RAAs in reducing progression of renal disease, ischemic and CHF event rates, and mortality [51–59]. Angiotensin-receptor blockers (ARBs) also reduce renal and cardiovascular events in type 2 diabetics, in patients with CHF with and without low ejection fraction, and after myocardial infarction [60–67]. The reduction in event rates seems to be similar to those achieved with ACE inhibitors in most settings. Direct comparisons with ACE inhibitors suggest ARBs are not superior [68,69], but one trial established that valsartan is at least 87% as effective as captopril after myocardial infarction [66]. The combination of ACE inhibitors and ARBs seems to reduce further the risk of cardiac and renal events in nondiabetic renal disease and heart failure [70,71]. The benefit of ACE inhibitors on

cardiovascular disease seems to extend to patients with mild-to-moderate renal failure [72].

There is no compelling biologic reason to believe RAAs would not be of benefit in RTRs. There are no important interactions between RAAs and immunosuppressive medications. RTRs are at higher risk of acute renal failure and hyperkalemia, but these risks are also elevated in chronic renal insufficiency and severe heart failure, where the overall benefit of these agents has been clearly demonstrated. ACE inhibitors may be associated with worse anemia, possibly because of reduced erythropoietin production, although the impact of this effect is not clear [73,74]. It would seem reasonable to recommend RAAs to any transplant patient with diabetes, chronic allograft nephropathy, or cardiovascular disease. Whether treatment of all transplant recipients with RAAs would prolong graft and patient survival, reduce cardiovascular events, and reduce PTDM is a compelling question that should be addressed in a randomized, controlled trial.

Antiplatelet therapy

It is well established that antiplatelet therapy is effective for secondary prophylaxis of cardiovascular events in patients with known atherosclerotic disease (ischemic stroke, peripheral vascular disease, ischemic heart disease, after myocardial infarction) and for primary prophylaxis in diabetes [37,75,76]. A large observational study of outcomes following myocardial infarction in patients with chronic kidney disease showed that acetylsalicylic acid (ASA) use is associated with improved survival after myocardial infarction across a broad spectrum of renal function, as would be expected in this high-risk population [77]. Compared with high-dose ASA (>650 mg/d), low-dose ASA is less likely to cause renal dysfunction or gastric ulceration and probably has similar clinical efficacy [78]. Overall, the use of ASA for prophylaxis of cardiovascular events seems appropriate in RTRs with known atherosclerotic disease or diabetes.

Should all RTRs receive ASA for primary prophylaxis? This is a much harder question to answer, and, as usual, direct trial evidence is lacking. A large meta-analysis of ASA use for primary prevention in the general population showed a 28% reduction in the odds ratio for myocardial infarction but a very much smaller impact (odds ratio, 0.93; CI, 0.84–1.02) on overall mortality, largely because of fatal gastrointestinal

bleeding and hemorrhagic strokes attributed to ASA [79]. It was estimated that ASA treatment would result in clinical benefit for patient groups having an annual risk for cardiovascular disease greater than 1%, assuming a similar bleed rate across risk groups. The fact that the overall benefit of antiplatelet agents in primary prophylaxis is highly dependent on the bleeding rate is of concern to nephrologists, because the risk of bleeding in renal populations is much higher. The rate of gastrointestinal bleeds in RTRs, for example, may be as much as 10 times higher than in the general population [80]. Thus, the risk/benefit ratio of primary prophylaxis with antiplatelet therapy in RTRs is unclear, and recommendations cannot be made.

Beta blockers

Several large randomized, controlled trials have shown improved short- and long-term survival with beta blockade in patients with myocardial infarction [81–84]. A large meta-analysis of several randomized, controlled trials estimated the odds ratio for death following myocardial infarction in patients given beta blockers versus placebo to be 0.81 (CI, 0.75–0.87) [85]. More recently, several trials have demonstrated improved survival and less frequent hospitalization for CHF with beta blockade in patients with moderate and severe CHF or left ventricular dysfunction [86–90]. The beneficial effect is seen in both ischemic and nonischemic heart disease and over a wide spectrum of disease severity (ie, New York Heart Association class 2–4). The benefit is additive to that of ACE inhibitors and other standard therapies for CHF but can be seen in patients not receiving ACE inhibitors as well [72].

The benefit of beta blockers has not been directly demonstrated in patients with kidney transplants. Biologically, there is no compelling reason to believe RTRs will respond differently from the general population. A recent cohort study of nontransplant patients with chronic kidney disease presenting with acute myocardial infarction showed beta-blocker use was associated with improved survival [52]. Another cohort study has indicated beta-blocker use is independently associated with improved survival on dialysis [91]. It is highly probable that beta blockers will confer benefit in transplant recipients with myocardial infarction or CHF.

Anemia management

There has been little investigation of the role of anemia management in the prevention of cardiomyopathy and CHF in RTRs. Rigatto et al data suggest that a hemoglobin level below 120 g/L may be a causal risk factor for CHF in RTRs. Clinical trials in dialysis patients, however, have not shown survival benefit with higher hemoglobin targets [92]. Achievement of higher hemoglobin targets did not lead to regression of LVH in CKD [93]. It seems reasonable to treat anemia in the setting of a failing allograft in the same way it is treated in native kidney failure (target hemoglobin, 110–120 g/L). Whether higher targets are desirable is at present unknown.

Nontraditional risk factors

Several novel and nontraditional risk factors for cardiac disease in patients with renal disease, such as homocysteine, lipoprotein (a), C-reactive protein, hyperparathyroidism, and oxidative stress, are the subject of much active research. The strength of the epidemiologic evidence available so far is weaker for these factors than for those discussed previously, and recommendations cannot be made.

Revascularization

Coronary artery disease before transplantation is associated with adverse events after transplantation [94]. One small trial in patients with

diabetes showed benefit from identifying and revascularizing significant coronary artery disease before transplantation [95]. This trial is limited by its small numbers and by the poor quality, by modern standards, of the perioperative medical management in the control arm. Nevertheless, this study has had great impact on practice, and most transplantation centers investigate all but the lowest-risk patients and aggressively revascularize any significant coronary lesions (Fig. 3) [96]. A more detailed review of cardiac risk assessment before renal transplantation is beyond the scope of this article.

The issue of when and how to revascularize after transplantation is less clear, and the evidence base is sparse. Patients with kidney disease in general are at a higher risk of cardiovascular events. In the author and colleagues' experience, however, they tend to be less aggressively investigated and revascularized, in part because of a widely held belief that revascularization is either impossible (because of diffuse coronary involvement) or futile (because of high rates of restenosis and bypass graft occlusion). The data in renal transplant patients do not support the futility of revascularization, however. Herzog et al [97] showed that an aggressive revascularization modality (coronary artery bypass grafting [CABG] with and without inferior mammary grafting [IMG]) was associated with lower risk of cardiac death or myocardial infarction than less aggressive modalities (percutaneous transluminal coronary angioplasty [PTCA]/stent) after adjustment

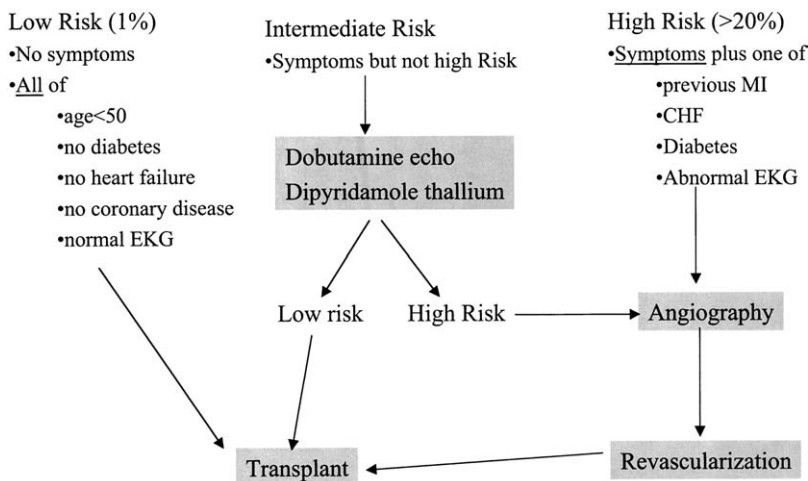


Fig. 3. Pretransplantation assessment of cardiac disease. CHF, congestive heard failure; EKG, electrocardiogram; MI, myocardial infarction.

for comorbid conditions. The data suggest that techniques known to be associated with better patency (CABG with IMG > CABG without IMG > stent > PTCA) are associated with improved outcome. Because these data are observational, selection bias cannot be completely excluded as an explanation for the results. Moreover, the study did not compare revascularization with medical management alone. Despite these major limitations, the author believes that coronary revascularization, including CABG, should be considered for the same indications in RTRs as in nonrenal patients. A randomized, controlled trial of medical management versus coronary revascularization in RTRs would be necessary to prove benefit, but an adequately powered study is probably unfeasible.

Summary

RTRs are at high risk for ischemic heart disease and heart failure. Although some differences pertain, most of the major risk factors are similar to those in the general population. It is highly probable that interventions of proven benefit in the general population will also be of benefit in RTRs. A combination of lifestyle modifications (smoking cessation, maintenance of ideal body weight, healthy diet), aggressive blood pressure control (<130/80 mm Hg), use of ACE inhibitors or ARBs, lipid lowering with statins, antiplatelet therapy for diabetics and those with established coronary disease, and beta blockers for CHF or after myocardial infarction is likely to have a major benefit on patient survival and cardiac morbidity among transplant recipients. Coronary revascularization should be considered for the same indications as in the general population.

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