Background. Both preoperative left ventricular dysfunction and postoperative renal function deterioration are associated with increased long-term mortality after cardiac surgery. The influence of preoperative left ventricular dysfunction on postoperative renal dysfunction and long-term mortality is not defined.

Methods. We collected data from 641 consecutive patients undergoing coronary bypass surgery with cardiopulmonary bypass in 1991 at our institution. Prospective follow-up was through to July 2004.

Results. In-hospital mortality was 2.7% (17 of 641). During follow-up, 248 (40%) patients discharged alive died (5 and 10 yr survival 90% and 70%, respectively). On univariate analysis, preoperative left ventricular dysfunction (ejection fraction $<50\%$) and an increase in serum creatinine $\geq 25\%$ in the first postoperative week were associated with long-term mortality. The associated mortality risk was additive in predominantly non-overlapping patients groups: the hazard ratio (HR) for renal function deterioration only was 1.41 [95% confidence interval (CI) 0.95–2.32, $P=0.083; n=64$] and for left ventricular dysfunction only 1.71 (95% CI 1.26–2.95, $P=0.0026; n=73$). In patients in whom both were present, HR was 3.23 (95% CI 2.52–20.28, $P<0.0001; n=20$). Although postoperative renal dysfunction was associated with left ventricular dysfunction ($P=0.008$), both left ventricular dysfunction and postoperative renal function deterioration were independently associated with long-term mortality on multivariate analysis, as were age and the use of venous conduits.

Conclusions. Both postoperative renal function deterioration and preoperative left ventricular dysfunction independently identify largely non-overlapping groups of patients with increased long-term mortality after coronary bypass surgery. In the group of patients with both factors present, the mortality risks appear additive.


Keywords: complications, renal; heart, cardiopulmonary bypass; risk; surgery, cardiovascular

Accepted for publication: March 23, 2009

Coronary artery bypass graft (CABG) surgery is the most frequently performed cardiac surgical procedure in the western world. Despite many advances in surgical, anaesthetic, and postoperative intensive care procedures, CABG surgery continues to be associated with serious morbidity and mortality. Renal dysfunction is among the most serious complication after CABG, affecting up to 30% of patients (Table 1); this incidence has not changed in the last few decades. Serious renal dysfunction requiring renal replacement therapy has a high mortality rate, up to 80% (Table 1), but it is generally perceived that temporary worsening of renal function after cardiac surgery has little clinical relevance. However, several recent studies clearly demonstrated that small changes in renal function across a
broad spectrum of medical and surgical conditions (including cardiac and vascular surgery) resulted in increased in-hospital morbidity and mortality, increased use of hospital resources, and worse long-term survival. After cardiac surgery, the in-hospital mortality associated with postoperative renal dysfunction ranged from 15% to 20% compared with 1.1% in patients without renal dysfunction. In a cohort of cardiac surgical patients with a long-term follow-up time of 100 months, we demonstrated that patients with postoperative renal dysfunction (increase of serum creatinine from baseline) have higher long-term mortality rates. Interestingly, the higher mortality rates were similar for all patients with postoperative renal dysfunction, whether the creatinine levels had returned to the preoperative baseline at discharge or not.

Postoperative renal dysfunction is caused by multiple factors. One of the main risk factors in cardiac surgical patients is poor preoperative cardiac function. In patients undergoing CABG, preoperative left ventricular dysfunction is associated with higher operative and postoperative mortality rates. Nowadays, an increasing number of patients undergoing CABG surgery have impaired left ventricular function. The contribution of preoperative left ventricular dysfunction to postoperative renal dysfunction, with its associated increased long-term mortality, has not to our knowledge been studied in CABG patients.

In our previous cohort study of adult cardiac surgical patients, we found increased long-term mortality in those who had a deterioration in renal function after operation. The present study group consists of all CABG patients from the earlier study cohort. We evaluated the effect of preoperative left ventricular dysfunction on postoperative renal function and analysed the combined influence of both conditions on long-term mortality. We hypothesized that the earlier observed increased mortality rate associated with postoperative renal dysfunction remains a permanent risk factor, and therefore we extended the follow-up period from 8 to 13.5 yr.

### Methods

Institutional approval was obtained and the need for informed consent was waived. All adult patients who underwent elective or emergency isolated coronary artery bypass surgery with cardiopulmonary bypass (CPB) in 1991 entered the study. Patients on dialysis before cardiac surgery were excluded from further analysis (n=6). Included were 641 consecutive patients, and data from patient charts, intensive care unit (ICU) charts, and anaesthesia records were entered into a database. The following variables were assessed.

### Preoperative data

These were: age, gender, BMI, presence of cerebral vascular disease, peripheral vascular disease, diabetes, hypertension, hypercholesterolaemia, pulmonary disease (requiring chronic bronchodilator therapy), baseline serum creatinine (obtained the day before surgery and in emergency cases just before surgery), congestive heart failure, previous myocardial infarction, previous cardiac surgery, previous percutaneous angioplasty, number of diseased coronary arteries with stenosis >70%, left main coronary artery stenosis >50%, urgent and emergent surgical priority, and administration of radiocontrast agent within 1 week. Preoperative left ventricular function was measured by left ventriculography in the right anterior oblique position as a routine registration in conjunction with preoperative coronary angiography and evaluated by the attending cardiologist; ventricular function was categorized into three groups: normal left ventricular function (ejection fraction (EF) >50%), moderate left ventricular function (EF ≥25% and <50%), and markedly reduced left ventricular function (EF <25%). In four patients, preoperative left ventricular measurement was missing (0.6%). The Cockcroft–Gault formula was used to estimate preoperative creatinine clearance.

### Intraoperative data

Coronary artery bypass surgery was performed according to the institutional protocol. The left internal mammary artery has been the graft of choice to bypass the left anterior descending branch. The decision to use arterial or venous conduits was made by the attending surgeon. Arterial conduits include left and right internal mammary arteries and the gastroepiploic artery. Saphenous veins were used as venous conduits. The use of arterial or venous conduits was divided into categories: (i) complete arterial revascularization; (ii) arterial and venous conduits; and (iii) venous conduits. Other

### Table 1 Incidences of renal dysfunction, dialysis, and mortality after cardiac surgery

<table>
<thead>
<tr>
<th>Author(ref. no.)</th>
<th>Year</th>
<th>No. of patients</th>
<th>Renal dysfunction</th>
<th>Dialysis outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Incidence (%)</td>
<td>Mortality (%)</td>
</tr>
<tr>
<td>Abel and colleagues</td>
<td>1976</td>
<td>500</td>
<td>21.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Bhat and colleagues</td>
<td>1976</td>
<td>490</td>
<td>28.1</td>
<td>10.9</td>
</tr>
<tr>
<td>Mangano and colleagues</td>
<td>1998</td>
<td>2417</td>
<td>7.7</td>
<td>19</td>
</tr>
<tr>
<td>Ryckwaert and colleagues</td>
<td>2002</td>
<td>591</td>
<td>15.6</td>
<td>12</td>
</tr>
<tr>
<td>Provenchere and colleagues</td>
<td>2003</td>
<td>649</td>
<td>17.2</td>
<td>27.5</td>
</tr>
<tr>
<td>Thakar and colleagues</td>
<td>2005</td>
<td>31 677</td>
<td>15.7</td>
<td>5.9</td>
</tr>
<tr>
<td>Loef and colleagues</td>
<td>2005</td>
<td>698</td>
<td>17.2</td>
<td>14.5</td>
</tr>
<tr>
<td>Karkouti and colleagues</td>
<td>2009</td>
<td>3500</td>
<td>34</td>
<td>15.8</td>
</tr>
</tbody>
</table>
intraoperative data included: the use of aprotinin, duration of CPB, duration of operation, urine output during operation, and lowest haematocrit during CPB.

**Postoperative data**

The following were recorded: surgical re-exploration for bleeding or cardiac tamponade, myocardial infarction, serum creatinine at the first, second, seventh postoperative day, and at discharge from the hospital, cerebral stroke, intra-aortic balloon pump (IABP), length of stay in the ICU, dialysis, low cardiac output syndrome (cardiac index <2.2 litre min\(^{-1}\) m\(^{-2}\)), and in-hospital mortality. Postoperative renal function deterioration was defined as an increase in the serum creatinine level in the first postoperative week of at least 25% from preoperative level.

**Long-term follow-up data**

After a follow-up time of 13.5 yr, the vital status of all patients as of July 2004 was ascertained by extracting data from the patient charts of the outpatient clinic or by contacting the general practitioner of the patient. If a patient had died during follow-up, the date of death was established. No patients were lost and the outcome assessment was complete.

**Anaesthesia, CPB, and ICU management**

The patients received total i.v. anaesthesia, induced with sufentanil (0.5 µg kg\(^{-1}\)), midazolam (0.05–0.1 mg kg\(^{-1}\)), and pancuronium (0.1 mg kg\(^{-1}\)) to facilitate tracheal intubation. Anaesthesia was maintained with sufentanil (2–5 µg kg\(^{-1}\)) and a continuous infusion of midazolam (0.1 mg kg\(^{-1}\) h\(^{-1}\)). The patients lungs were ventilated with air and oxygen \((F\text{O}_2=0.4)\). Radial artery and central venous pressures were continuously monitored. Aprotinin (2,000,000 IE) was given at the start of CPB at the discretion of the surgeon. Non-pulsatile CPB was performed with a non-occlusive roller pump and membrane oxygenator (Cobe Optima; Cobe Laboratories, Lakewood, CO, USA). The extracorporeal circuit was primed with 500 ml of 6% hydroxyethyl starch and 1000 ml of lactated Ringer’s solution. An initial dose of heparin 300 IU kg\(^{-1}\) was given before cannulation of the aorta and right atrium to obtain a kaolin-activated clotting time >400 s. Additional heparin was given during CPB when the kaolin-activated clotting time was <400 s. Flow during CPB was maintained at 2.2 litre min\(^{-1}\) m\(^{-2}\) during moderate hypothermia (32°C) with α-stat pH management. Cold St Thomas’ solution was infused into the aortic root for cardioplegia during aortic cross-clamping. During CPB, the mean arterial pressure was kept between 60 and 90 mm Hg using phenylephrine or nitroglycerin as needed. After weaning of CPB, protamine was given in a dose equal to the initial dose of heparin.

In the ICU, patients were managed according to a set protocol targeted at a cardiac index ≥2.2 litre min\(^{-1}\) m\(^{-2}\) and a urine production of ≥1 ml kg\(^{-1}\) h\(^{-1}\). Indications for initiation of renal replacement therapy were: signs and symptoms of extracellular volume overload, azotaemia (serum urea >40 mmol litre\(^{-1}\)), hyperkalaemia, and metabolic acidosis that could not be managed with other therapies.

**Statistical analysis**

All statistical analyses were conducted using SPSS 11.0 for Windows. Data are given as mean (SD).

Univariate testing of variables between the group of patients who did during hospitalization and the group of patients discharged alive was performed with the t-test for continuous variables and the χ\(^2\) test for discrete variables. Baseline variables were compared among the group with and without preoperative left ventricular dysfunction. Multivariate analysis was performed to test the association of left ventricular function with different preoperative variables. Univariate testing was also performed to compare the group with and without postoperative renal function deterioration. We then used backward logistic multivariate analysis to test the independent association of postoperative renal function deterioration with different variables. Variables with P<0.1 in the univariate analysis were included in the multivariate analysis.

In those patients discharged alive, long-term outcome was studied with the Kaplan–Meier survival analysis, and the logrank test was used to compare survival between the groups; hazard ratios (HR) and 95% confidence intervals (CI) were estimated for long-term mortality. For univariate survival analysis, continuous variables were grouped according to quartiles. All variables with a P-value of <0.1 in the univariate logrank test were included in a multivariate Cox regression analysis. Backward variable selection was used until only significant covariates remained in the model. HRs and 95% CI were estimated for independent risk factors. Statistical significance was accepted at P<0.05.

**Results**

Clinical characteristics, operative, and postoperative variables of the patients discharged alive (n=624) are summarized in Table 2. The patients with markedly reduced left ventricular function (n=10) and moderate reduction in left ventricular function (n=90) were grouped together as having left ventricular dysfunction. The in-hospital mortality in the entire cohort was 2.7% (n=17). Renal replacement during hospital stay was required in three patients (0.5%) in the postoperative renal function deterioration group. Only one of these patients survived (67% mortality). In the group of patients with postoperative renal dysfunction who were
infarction (7 vs 32%) significantly more patients had a postoperative myocardial
infarction compared with 10 (32%) in the group without aprotinin (vs 32%) in the group
without aprotinin was associated with adverse renal and cardiac
effects. There was a trend towards a higher postoperative
estimated creatinine clearance, peripheral vascular disease,
and left ventricular dysfunction; and procedure related,
including postoperative IABP, re-exploration, and emergen-
cy operation (Table 4).

During long-term follow-up, 248 of the 624 patients
discharged alive died (40%). Univariate analysis of long-term
outcome in the patients discharged alive was analysed
with the logrank test (Table 5) and the Kaplan–Meier sur-

Table 2 Preoperative, intraoperative, and postoperative characteristics of 624
patients who underwent isolated CABG and were discharged alive. Data
presented as mean (sd) or number (%). Preoperative Cr, preoperative serum
creatinine; CPB, cardiopulmonary bypass; Cr, serum creatinine; CABG,
coronary artery bypass grafting; IABP, intra-aortic balloon pump

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>1.034 (1.007–1.062)</td>
<td>0.014</td>
</tr>
<tr>
<td>Preoperative left ventricular dysfunction</td>
<td>2.12 (1.22–3.67)</td>
<td>0.008</td>
</tr>
<tr>
<td>Re-exploration</td>
<td>5.42 (2.30–12.77)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>2.78 (1.47–5.22)</td>
<td>0.002</td>
</tr>
<tr>
<td>Postoperative IABP</td>
<td>4.95 (1.49–16.40)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Table 3 Variables associated with preoperative left ventricular dysfunction by
multiple logistic regression analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated creatinine clearance (ml min⁻¹)</td>
<td>0.988 (0.976–1.000)</td>
<td>0.042</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>2.39 (1.35–4.24)</td>
<td>0.003</td>
</tr>
<tr>
<td>Prior myocardial infarction</td>
<td>4.91 (2.83–8.51)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triple vessel disease</td>
<td>2.30 (1.34–3.97)</td>
<td>0.003</td>
</tr>
<tr>
<td>Preoperative Cr (μmol litre)</td>
<td>110.2 (43.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cr change (%)</td>
<td>−4.0 (16.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Renal function deterioration</td>
<td>84 (13.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Re-exploration</td>
<td>22 (3.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior CABG (%)</td>
<td>33 (5.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative IABP (%)</td>
<td>12 (1.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative low output syndrome (%)</td>
<td>18 (2.8)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 4 Predictive factors in multiple logistic regression analysis associated with postoperative renal function deterioration after CABG

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>1.034 (1.007–1.062)</td>
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<td>Emergency operation</td>
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</tr>
<tr>
<td>Postoperative IABP</td>
<td>4.95 (1.49–16.40)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Table 5 Risk factors associated with mortality during long-term follow-up in
patients (n=614) discharged alive after coronary artery bypass surgery
(logrank test)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>1.034 (1.007–1.062)</td>
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<td>2.12 (1.22–3.67)</td>
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<td>Re-exploration</td>
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<tr>
<td>Postoperative IABP</td>
<td>4.95 (1.49–16.40)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

In addition, we analysed whether the intraoperative use of aprotinin was associated with adverse renal and cardiac
effects. There was a trend towards a higher postoperative
serum creatinine with an increase of 24 (sd 87)% in the
aprotinin group compared with 10 (32)% in the group
without aprotinin (P=0.09). In the aprotinin group, signifi-
cantly more patients had a postoperative myocardial
infarction (7 vs 11 patients; P=0.022). Furthermore, we
found a higher in-hospital mortality (P=0.013), previous
cardiac operation (P<0.001), IABP (P=0.015), longer
duration of surgery (P<0.001) and perfusion time
(P=0.01) in the aprotinin group.

The patients with preoperative left ventricular dysfunc-
tion had lower estimated creatinine clearances [67.2 (18.1)
vs 74.4 (22.2) ml min⁻¹; P=0.001] and a higher preva-
lence of peripheral vascular disease, prior percutaneous
angioplasty, prior myocardial infarction, and triple vessel
disease compared with good left ventricular function.
Using multiple logistic regression, an association of pre-
operative left ventricular dysfunction with preoperative

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survival (Fig. 3). Postoperative renal function deterioration in the patients with a good ventricular function \( (n=64) \) resulted in a mortality risk with an HR of 1.41 (95% CI 0.95–2.32, \( P=0.083 \)). The group of patients \( (n=73) \) with preoperative left ventricular dysfunction and no postoperative renal function deterioration showed a significant increased mortality risk with an HR of 1.71 (95% CI 1.26–2.95; \( P=0.0026 \)). The highest mortality rate was observed in the group of patients \( (n=20) \) with a combination of preoperative left ventricular dysfunction and postoperative renal function deterioration (HR of 3.23; 95% CI 2.52–20.28, \( P<0.0001 \)). During long-term follow-up, none of the patients required dialysis for end-stage renal disease.

Univariate analysis clearly demonstrated an increased long-term mortality rate of preoperative left ventricular dysfunction and postoperative renal dysfunction. To study the influence of confounding variables, we performed multivariate analysis. Variables associated with long-term outcome with a \( P \)-value of <0.1 by univariate analysis were included in a multivariate Cox proportional hazards analysis to test the independent association with long-term outcome. In addition to the variables presented in Table 5, congestive heart failure, perfusion time, and low cardiac output syndrome were included in the multivariate analysis. Creatinine increase >25%, on which renal dysfunction was based, was adjusted for baseline creatinine clearance in multivariate analysis. After adjusting for confounding variables, preoperative left ventricular dysfunction and postoperative renal function deterioration remained a significant predictor for long-term mortality. In addition, age and the use of venous conduits were also independent risk factors for long-term mortality (Table 6).

### Discussion

This long-term follow-up study of CABG patients clearly demonstrated that even a transient increase in serum creatinine has serious prognostic implications that persisted after 13.5 yr. In addition, we found that preoperative left ventricular dysfunction and the occurrence of immediate postoperative renal function deterioration were significant predictors of long-term mortality.
Adverse effect of postoperative renal dysfunction on long-term mortality

Several studies showed the importance of postoperative worsening of renal function on long-term survival. In a recent study, patients after CABG surgery were stratified by the percentage increase in creatinine from baseline. After a follow-up of 90 days, patients with the largest creatinine increases (50–99% or >100%) had a significantly higher mortality compared with those with a smaller increase (<50%).

Owing to a limited follow-up time, the survival in the categories was mainly determined by the mortality within 30 days, which is consistent with our reported in-hospital mortality. In addition to our previous observations, the findings of the present study, with an extended follow-up period of 13.5 yr, clearly confirm that modest changes of renal function in CABG patients result in an important effect on long-term mortality.

Interestingly, Welten and colleagues described the same effect in a different group of patients after a 10 yr follow-up. Temporary worsening of renal function (>10% estimated creatinine clearance by the Cockcroft-Gault formula) during the first 3 days after elective open abdominal aortic aneurysm surgery was associated with higher long-term mortality. Remarkably, although renal function may recover completely during the first postoperative week after this type of surgery, these patients remain at high risk of long-term mortality. We observed the same phenomenon: cardiac surgical patients with postoperative renal dysfunction have the same mortality risk whether the creatinine levels had returned to the preoperative baseline at discharge or not.

Thus, these findings suggest that temporary worsening of renal function after major cardiac or vascular surgery has an extended effect on long-term mortality.

Adverse effect of left ventricular dysfunction on mortality

In this study, preoperative left ventricular dysfunction is a major risk factor for postoperative renal dysfunction and mortality. We analysed the contribution of patient and procedure-related factors. In line with earlier studies, we observed an increased prevalence of peripheral vascular disease, previous myocardial infarction, and multivessel disease, and lower levels of estimated preoperative creatinine clearance in the patients with ventricular dysfunction.

Preoperative left ventricular dysfunction may reduce the ability to cope with the stress of complicated surgery and haemodynamic derangements. Furthermore, these complications, including postoperative low cardiac output syndrome, re-exploration, and requirement for postoperative IABP, have impact on the perioperative haemodynamic stability and may have contributed to postoperative renal function deterioration as shown in this study. The in-hospital and long-term mortality rate in our patients with left ventricular dysfunction were significantly increased, confirming an earlier study by Appoo and colleagues with a follow-up of 5 yr. HRs for death in Appoo’s study were adjusted for several known independent variables except postoperative renal dysfunction. The data from our study, however, demonstrate an important contribution of postoperative renal dysfunction on long-term mortality, and in patients with preoperative left dysfunction the mortality risk almost doubled.

In the present study, we focused on the effects of preoperative left ventricular dysfunction and early postoperative renal dysfunction on long-term mortality. In addition, we identified other independent risk factors associated with adverse outcome, including age, preoperative renal function, and the use of venous conduits only.

A decreased survival rate due to cardiovascular risk factors has primarily been described in patients with end-stage kidney disease. However, there is increasing evidence that mild-to-moderate preoperative renal dysfunction is associated with adverse long-term outcome in patients with several cardiovascular disease states. Shlipak and colleagues examined more than 130 000 patients and found that established renal disease is a risk factor for death after myocardial infarction. Recently, Hillis and colleagues found that preoperative estimated glomerular filtration rate (eGFR) was an independent predictor of mortality during the follow-up after coronary artery bypass grafting. Cooper and colleagues evaluated 500 000 patients undergoing cardiac surgery and found that operative mortality increased with declining eGFR. Our data are in line with these findings.

For many years, aprotinin has been used routinely to reduce perioperative blood loss in cardiac surgery. However, recently the safety of this widely used drug was questioned because of increased risk of cardiovascular events, postoperative renal dysfunction, and long-term
mortality. In our study, aprotinin was used at the discretion of the surgeon in 18% of the patients. In these patients, we observed an increased risk of postoperative myocardial infarction and a trend towards postoperative renal dysfunction, but no association with long-term mortality was found.

This study relates to clinical practice in 1991 and changes in perioperative patient management, such as the use of statins and phosphodiesterase inhibitors, new antiplatelet drugs, off-pump coronary artery bypass surgery, stenting, total arterial revascularization, and normothermic CPB may have reduced the risk of postoperative renal dysfunction. However, data on the incidence of postoperative renal dysfunction show no improvement in the last three decades, suggesting that other factors might also be involved.

This study has some limitations. First, this study is a single-centre experience and may not be generalizable to other centres. Differences in selection and patient treatment may influence the outcome. However, risk factors for postoperative renal function deterioration are consistent with those found in the previous studies, and the in-hospital and long-term mortalities are in line with the results of the other studies. Secondly, multivariate analysis has been used to reduce confounding in determining the long-term mortality risk with several variables. However, additional confounders could have influenced our results; differences in additional medical therapy with antiplatelet drugs, management of dyslipidaemias, or the use of angiotensin-converting enzyme inhibitors could have influenced the outcome.

In conclusion, both postoperative renal function deterioration and preoperative left ventricular dysfunction independently identify largely non-overlapping groups of patients with increased long-term mortality after CABG surgery. In patients with both risk factors, the long-term mortality nearly doubled. Thus, these risk factors identify patients who may benefit from more prolonged and intensive medical follow-up, and appropriate treatment strategies.

References

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