Institutional report - Cardiac general

One-year follow-up of patients undergoing elective cardiac surgery assessed with the Comprehensive Assessment of Frailty test and its simplified form

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Abstract

Assessment of perioperative risk of elderly patients in cardiac surgery is demanding. Most of the commonly used cardiac surgery risk scores over- or underestimate individual risk. Therefore, we recently developed a ‘frailty score’, the comprehensive assessment of frailty (CAF) score that showed a good prediction of 30-day mortality. The aim of the study was to evaluate the ability of the new score predicting one-year outcome. CAF was preoperatively applied to 400 patients ≥74 years that were admitted to cardiac surgery between September 2008 and January 2010. For 213 of these patients one-year follow-up was assessed by telephone interview until April 2010. One hundred and ten male and 103 female patients were included. Twenty-five percent underwent isolated coronary revascularization, 35% isolated valve procedures and 26% underwent combined procedures. One-year mortality was 12.2%. Patients who died within one year had a median frailty score of 16 [5;33] compared to 11 [3;33] to the one-year survivors (P = 0.001). A new, easily applicable score (‘Frailty predicts death One year after Elective Cardiac Surgery Test’) was built out of the basic score and showed a promising ability to predict one-year mortality. CAF is a new additional tool to assess prognosis of elderly patients before cardiac surgical interventions. The ‘CAF’ score facilitates prediction of mid-term outcome of high-risk elderly patients.

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1. Introduction

Risk scores are important tools in cardiac surgery to estimate perioperative morbidity and mortality. However, the major disadvantage of the widely used STS-score (Society of Thoracic Surgeons Score) and EuroSCORE (European System for Cardiac Operative Risk Evaluation score) is their focus on medical diagnoses and organ co-morbidities for scoring operative risk. The true biological status of the patient is not well reflected in these scoring systems. A growing number of elderly people is admitted for elective cardiac surgery [1]. These patients usually have several co-morbidities that lead to a higher operative risk and higher mortality [2, 3]. Frailty is a strong predictor for perioperative mortality [4]. We modified the ‘comprehensive assessment of frailty’ (CAF) score with the aim to integrate several items reflecting the biological status of the patient with respect to the elective cardiac surgery patient population. This score showed a good correlation to 30-day mortality [5]. The aim of the current analysis was to assess the ability of this new score to predict one-year mortality. To facilitate the assessment of frailty we present here a shortened version of the test which is called ‘Frailty predicts death One year after Elective Cardiac Surgery Test’ (FORECAST).

2. Patients and methods

2.1. The comprehensive assessment of frailty (CAF)

The ‘CAF’ score was preoperatively assessed in elderly (≥74 years) elective cardiac surgery patients. The score had been previously described in detail [5]. In summary, the score is composed of different items to quantify the physical performance and coordinative abilities of the patient in addition to scores that are already used to define frailty in geriatric medicine, such as the Fried criteria [6]. A number of laboratory results as creatinine and the FEV₁ are added.

Single point values given for every test item are summarized to form a single score. The detailed test design including its individual items and scoring templates can be
2.2. Frailty predicts death One year after Elective Cardiac Surgery Test (FORECAST)

We also tested a simplified version of the CAF that was composed of those five test items which have shown the highest impact on the predictive power of the CAF:

Chair rise: Patient is asked to get up and down from a chair three times and time is measured.

Weak: Patient is asked if he felt weak in the last two weeks.

Stair: Patient is asked to climb as many stairs as he is able to.

CFS: Clinical frailty scale is a clinical frailty scale from the Canadian Study of Health and Aging: two physicians (one a cardiac surgeon, the other an experienced clinician) different to the person observing the CAF testing itself were asked to estimated frailty of the patient [7].

Creatinine: Serum creatinine level.

We tested a simplified version of the CAF that was arbitrary divided into three groups labeled ‘not frail’ (1–10 points), ‘moderately frail’ (11–25 points) and ‘severely frail’ (26–35 points). In addition to the CAF, the STS-score and the logistic EuroSCORE were calculated [8].

2.3. Patients

From September 2008 to January 2010, 400 consecutive patients (206 female and 194 male) ≥74 years of age undergoing elective and urgent cardiac surgery in the Heartcenter of the University of Leipzig were included in the initial study. All tests were carried out in a standardized environment. In total, the assessment of the test battery took 10–20 min for each patient. Results of the CAF-scores were arbitrary divided into three groups labeled ‘not frail’ (1–10 points), ‘moderately frail’ (11–25 points) and ‘severely frail’ (26–35 points). In addition to the CAF, the STS-score and the logistic EuroSCORE were calculated [8]. Patients were followed by telephone interview or by contacting their referring physician to assess one-year mortality. One-year follow-up could be completed for 213 of these patients (103 female and 110 male) who had reached their one-year follow-up at April 2010.

2.4. Statistical analysis

The primary endpoint was the one-year all-cause mortality. Secondary endpoints were overall major adverse cardiac and cerebrovascular events as well as total duration of intensive care unit (ICU) stay, length of mechanical ventilation and postoperative resuscitation. Sample size calculations showed that the number of patients included to the study was sufficient if a margin of error of 7% for the confidence interval of incidence of one-year mortality was accepted.

Differences in continuous variables between non- and moderate frailty groups to severely frail were analyzed with a Mann–Whitney test. Differences in binary data were analyzed with Fisher’s exact test. Mann–Whitney test was used to compare CAF-score and one-year mortality as well as to compare EuroSCORE and STS-score to one-year mortality.

### Table 1. Baseline characteristics and outcome

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>BMI (kg/m²)</th>
<th>BNP (pg/ml)</th>
<th>Logistic EuroSCORE</th>
<th>STS-score</th>
<th>Thirty-day mortality (%)</th>
<th>One-year mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80.1 ± 4</td>
<td>75.1 ± 13</td>
<td>166 ± 9</td>
<td>27.4 ± 4</td>
<td>933 [31;11,442]</td>
<td>11 [5;33]</td>
<td>3.3 [0.1;13.6]</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

3. Results

Two hundred and thirteen of 400 patients reaching their one-year endpoint until April 2010 were followed up. For baseline characteristics see Table 1. The only study exclusion criterion was an age ≤74 years. Mean age was 80.1 ± 4 years. Out of the study population, 25% underwent isolated coronary revascularization, 35% isolated conventional valve procedures and 26% underwent combined procedures. Transcatheter transfemoral or transapical aortic valve implantation was performed in 14%. Median logistic EuroSCORE for all patients was 9 [2.5;61.9]. Median STS-score was 3.3 [0.1;13.6]. Thirty-day and one-year mortality was 8.0% and 12.2%, respectively. Median CAF-score was calculated with a value of 11 [3;33]. Patients that died within one year had a significantly higher CAF-score of 16 [5;33] compared to 11 [3;31] to the survivors (P < 0.001) (Fig. 1).

Patients that died within one year also had a significantly higher EuroSCORE (12 [3;54] vs. 9 [3;62]; P = 0.006) and STS-score (5 [0.1;10] vs. 3 [0.8;14]; P = 0.02) but the difference was highly significant only for the CAF-score.

According to the CAF-score grading in three categories described earlier 99 patients were assessed as ‘not frail’, 95 as ‘moderately frail’ and 19 patients as ‘severely frail’.

One-year mortality within each CAF subgroup shows a significantly higher mortality rate among patients in the CAF-category ‘severely frail’ compared to patients of the
There were no differences in the occurrence of postoperative myocardial infarction and postoperative stroke, but patients had to be resuscitated more often when in a higher frailty group and had a longer stay at the ICU (Table 2).

Univariate logistic regression showed that one-year mortality was related to the CAF-score (OR 1.11, 95% CI 1.05–1.17, \( P < 0.001 \)) and demonstrated good calibration (Hosmer–Lemeshow: 9 classes; \( \chi^2 = 4.2; P = 0.76 \)).

The effect remained significant when adjusted to EuroSCORE (Table 3) in the multivariate analysis.

The CAF-score showed a good predictive ability concerning one-year mortality. The area under the curve was 0.7 with a 95% CI of 0.6–0.8. This compares well to the AUC for the EuroSCORE of only 0.67 with a 95% CI of 0.6–0.8 (Fig. 2) that showed no significant relation to one-year mortality (\( P = 0.14 \)).

CAF was positively correlated with the length of ventilator assistance (\( P = 0.007 \)) as well as the EuroSCORE (\( P = 0.001 \)). No correlation of the CAF-score to other secondary endpoints could be detected.

As a next step we examined which items contributed most to the predictive ability of the CAF-score. Age as single factor was not a significant predictor of one-year mortality. The largest AUC was found for the test item ‘Chair rise’ (AUC 0.73) followed by the items ‘Weak’ (AUC 0.69), ‘Stair’ (AUC 0.69), ‘Creatinine’ (AUC 0.67) and ‘CFS’ (AUC 0.66) (see Fig. 3).

A modified CAF-score was built by summarizing only these test items for each patient. The AUC of the newly plotted ROC curve also had significant relation to one-year mortality and had the highest AUC (0.76) of all scoring systems.

Table 2. Baseline characteristics and outcome in the three frailty groups

<table>
<thead>
<tr>
<th>CAF group</th>
<th>Not frail</th>
<th>Moderately frail</th>
<th>Severely frail</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n )</td>
<td>99*</td>
<td>95</td>
<td>19</td>
</tr>
<tr>
<td>Age (years)</td>
<td>79.2 ± 3*</td>
<td>80.8 ± 4</td>
<td>81.8 ± 5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>76.2 ± 1.4</td>
<td>75.4 ± 1.4</td>
<td>75.1 ± 15</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168 ± 9*</td>
<td>166 ± 9</td>
<td>162 ± 8</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.3 ± 4</td>
<td>27.4 ± 4</td>
<td>29.1 ± 7</td>
</tr>
<tr>
<td>BNP (pg/ml)</td>
<td>68 [31;1144]</td>
<td>1371 [72;9139]</td>
<td>1202 [214;7364]</td>
</tr>
<tr>
<td>CAF</td>
<td>7.3 ± 2***</td>
<td>14.9 ± 4***</td>
<td>29.2 ± 2</td>
</tr>
<tr>
<td>Logistic EuroSCORE</td>
<td>7.5 [2.546.7]***</td>
<td>9.5 [2;7.62]</td>
<td>12.3 [5.13.4]*</td>
</tr>
<tr>
<td>STS-score</td>
<td>2.4 [0.110.6]***</td>
<td>3.7 [1.313.6]*</td>
<td>5 [3.13.4]</td>
</tr>
<tr>
<td>Postoperative MI (%)</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Postoperative stroke (%)</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>PO Resuscitation (%)</td>
<td>2*</td>
<td>1*</td>
<td>16</td>
</tr>
<tr>
<td>ICU stay (h)</td>
<td>12 [0;727]</td>
<td>19 [0;2168]</td>
<td>27 [0;623]</td>
</tr>
<tr>
<td>In-hospital mortality (%)</td>
<td>4</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Thirty-day mortality (%)</td>
<td>4**</td>
<td>8*</td>
<td>26</td>
</tr>
<tr>
<td>One-year mortality (%)</td>
<td>7**</td>
<td>12**</td>
<td>42</td>
</tr>
</tbody>
</table>

\( *P < 0.05; **P < 0.01; ***P < 0.001 \) compared to the group ‘severely frail’. BMI, body mass index; BNP, brain natriuretic peptide; MI, myocardial infarction; PO, postoperative; ICU, intensive care unit; CAF, comprehensive assessment of frailty; STS, Society of Thoracic Surgeons; EuroSCORE, European System for Cardiac Operative Risk Evaluation.
for one-year mortality (Fig. 4). For 30-day mortality the AUCs for this simplified CAF-score, STS-score and EuroSCORE are similar.

4. Discussion

Because of age prioritization the EuroSCORE seems to over- or underestimate mortality [9, 10]. Some authors describe a strong overestimation of the perioperative risk even in high-risk patients by the EuroSCORE [11]. By contrast, the STS-score seems to slightly underestimate perioperative risk [8]. To improve perioperative risk assessment, it is important to integrate factors that describe the biological status of the patient better than age alone. Patients show different vulnerability to external factors, a condition referred to as the geriatric syndrome of frailty [12, 13]. Several factors contribute to the frailty of a patient and there is a variety of scores measuring this state [6, 7, 14].

By design, the STS and EuroSCORE are scores to address perioperative risk and are not useful to predict long-term outcomes. This information is however equally important when therapeutical decisions are made and may also impact the decision-making process for the patient.

The main goal of the present study was to demonstrate that also biological factors should be used to predict early and mid-term outcome. For this we used a scoring system (‘CAF’) that has shown a good correlation and accuracy to quantify 30-day mortality in elderly people undergoing elective cardiac surgery [5]. The score is a combination of clinical features, laboratory values and the measurement of frailty. The aim of this study was to test the predictive power of the CAF-score with regards to one-year mortality.

The key finding of this study was that the CAF-score can estimate one-year mortality risk after elective cardiac surgery in the elderly. Logistic regression and the AUC of the ROC curve showed a good correlation and a good accuracy of the model. The CAF-score performed better in this regard as the STS and EuroSCORE, which comes as no surprise as these scores by design are made to predict perioperative risk rather than the late risk of mortality.

A disadvantage of the CAF-score is that it is time-consuming as it takes 10–20 min to perform the test. Special equipment, for example to measure the hand grip strength is also required. It is therefore not easily integrated into daily clinical routine. Therefore, we identified those factors that showed the best discrimination concerning one-year mortality as single factors: ‘Chair rise’, ‘Weakness’, ‘Stair-rise’, ‘CFS’ and ‘Creatinine’. These factors were used to build a modified CAF-score (FORECAST), which showed a promising ability to predict one-year mortality and a good accuracy of the model. The time to assess frailty with this limited number of items is reduced to 3–5 min which allows an easy assessment of frailty during the routine clinical examination. A clear limitation is, that the population that was used to validate this test was the same population that was used to develop the test and from a single institution only. The modified test will therefore be evaluated prospectively in a new and larger patient population in a multicenter setting.

In summary, the CAF-score and the newly developed ‘FORECAST’ may serve to better predict short- and mid-term outcome of elderly patients undergoing elective cardiac surgery.

References


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Conferece discussion

Dr. C. Muneretto (Brescia, Italy): Your study includes a fine statistical analysis of sensitivity and specificity of the score system you developed, as well as a comparison with the EuroSCORE and STS score in terms of capability to predict the outcome at one year.

Nowadays assessment of preoperative risk profile in elderly high-risk patients is mandatory, since this population now represents an important percentage of overall surgical activity. The comprehensive assessment you suggested for the frailty evaluation may also be important in assessing mid-term prognosis and survival, especially in patients who are candidates for novel and very expensive therapies, for example, TAVI, thus avoiding the waste of money that we face today in patients with a very poor expected midterm outcome. Do you believe that the comparability in predicting mid-term outcome of your score could be the same in octogenarians who underwent OPCAB or mitral and tricuspid surgery?

And the third question is related to the fact that you compare sensitivity and specificity of your systems in comparison with EuroSCORE and STS score for prediction of morbidity and mortality at mid-term, especially at one year. Obviously EuroSCORE and STS have not been designed for that. Do you think that, in the future, your CAF system should be integrated with STS or EuroSCORE evaluation for Italian high-risk populations or should the conventional score systems simply be replaced?

Dr. Sündermann: Regarding the first question, why only 212 patients were included in the study, it’s because only 212 of the patients had reached the one-year follow-up endpoint when the manuscript was written.

The second question, regarding the different operations to which the scores should be applied, we didn’t differentiate between patients who underwent OPCAB surgery or mitral valve repair or TAVI, but just included all patients, not caring about which operation they underwent. So it would be a good idea to differentiate between these groups.

And to the third question, of course EuroSCORE and STS score haven’t been validated for one-year mortality, so it was not the idea to compare these scores for one-year mortality, it was just to have scores to compare with. And of course, it should not be used instead of EuroSCORE and STS score. It was just the idea to build a score that could be used for this patient population and also for a longer follow-up, but not to be used instead of the EuroSCORE and STS score.

Dr. Muneretto: You enrolled over 400 patients and you said that only 213 survived at one year, so you had 47% mortality at one year in the entire population?

Dr. T. Treasure (London, UK): No, what he said was that he submitted the abstract before the study was mature enough for all patients to have reached at least 12 months follow-up.

Dr. Sündermann: Exactly.

Dr. Treasure: I think that in due course you’ll give us the full results. My comment was just to clarify the position.

Dr. P. Sergeant (Leuven, Belgium): What have been the conclusions and the inferences in your institute when you identified these high frailty scores? Have you reached conclusions about the surgical indication when these scores are identified before surgery?

Dr. Sündermann: No, we haven’t done that. We just followed up all patients.

Dr. T. Aberg (Nuriootpa, Australia): Much of your data reflects a mixture of organ dysfunction. Have you thought about how you would be able to refine this? To put on a jacket may reflect cerebral function with its implications, but also muscular or articular function which have other implications. So how are you going to proceed?

Dr. Sündermann: All these tests should represent organ function, coordinate abilities that represent cerebral function, that’s true. As to how to proceed: the test with all test items, and also with the shortened test, a native abilities that represent cerebral function, that’s true. As to how to proceed, the test with all test items, and also with the shortened test, a big number of patients is necessary to see if it’s possible to validate this test.

Dr. I. Gilfillan (Perth, WA, Australia): Coming from Australia, my patients, this age group, are somewhat pragmatic, and they’re not particularly worried about death. What they are concerned about is losing independence and ending up in a care facility. Do you have any information on this score as a predictor of that outcome?

Dr. Sündermann: That’s a very good question. And unfortunately, we haven’t done this for this study. But for validation of the test, we also want to include factors like independence and where patients stay after hospital.