Frailty is a predictor of short- and mid-term mortality after elective cardiac surgery independently of age†


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Abstract

OBJECTIVES: Assessment of perioperative risk of elderly patients in cardiac surgery is difficult, and most of the common risk scores show over- or underestimation. Two frailty scores, the comprehensive assessment of frailty (CAF) score and the Frailty predicts death One yeaR after CArdiac Surgery Test (FORECAST), were developed as additional tools to estimate the preoperative mortality risk, taking into consideration the frailty status of elderly patients.

METHODS: Four hundred and fifty patients who were referred for elective cardiac surgery were included. All the patients were assessed with the CAF test and the FORECAST. Thirty-day and 1-year mortality were evaluated by telephone interview. Univariate and bivariate logistic regression were performed to test the predictive power of the tests on mortality. Correlation of the scores with age was calculated with Spearman ranks. Three commensurate groups were built for each of the frailty scores and the outcome was compared between the groups. All analyses were performed for Society of Thoracic Surgeons (STS) and European System for Cardiac Operative Risk Evaluation (EuroSCORE) accordingly.

RESULTS: A total of 227 male and 223 female patients were included. Thirty-day mortality was 6.1%, and 1-year mortality was 13.3%. Logistic regression showed that both scores are able to predict 30-day as well as 1-year mortality. Bivariate logistic regression showed that both frailty scores give relevant additional information to the STS and EuroSCORE for the prediction of 1-year mortality. The frailty scores were only weakly correlated with age in contrast to STS and EuroSCORE and therefore can be used as indicator of the biological age of patients besides the numerical age. Survival up to 1 year was relevantly reduced in the group of patients with the higher frailty scores.

CONCLUSIONS: CAF and FORECAST are additional tools to evaluate elderly patients adequately before elective cardiac surgery, and showed an association with short- and mid-term mortality independently of age.

Keywords: Elderly • Frail • Cardiac surgical procedures • Risk assessment

INTRODUCTION

The number of elderly patients referred for elective cardiac surgery is growing constantly [1]. These patients are considered to be at increased risk for perioperative mortality and morbidity, although several studies have shown good outcomes for this patient population [2–5]. Besides a higher number of comorbidities, the phenotype of frailty is largely represented in elderly patients with cardiovascular disease [6]. Frailty is defined as impaired or reduced resistance to external stressors and described mainly in the geriatric literature [7, 8]. Recently, it also came into the focus of studies in cardiac surgery and cardiology.

Logistic European System for Cardiac Operative Risk Evaluation (EuroSCORE) I, EuroSCORE II [9] and Society of Thoracic Surgeons (STS) score, the commonly used risk estimation systems in cardiac surgery, do not evaluate the ‘biological age’ and frailty status of patients. Different trials to develop tests to include the phenotype of frailty into risk estimations before cardiac surgery have been undertaken [10, 11]. Frailty is also frequently discussed in the context of transcatheter aortic valve implantation (TAVI) [12]. Owing to the growing importance of frailty in patients treated for cardiovascular diseases, we developed a simple battery test to assess the level of frailty and studied its relevance for short-time outcome after elective cardiac surgery. We found a correlation

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with 30-day mortality and a predictive ability of the test [13]. Here, we present the results of the 1-year follow-up of the whole patient cohort of our initial study.

**METHODS**

Two tests were applied in all the patients after admission: the Comprehensive Assessment of Frailty (CAF) test and the FORECAST (Frailty predicts death One year after Elective Cardiac Surgery Test). The tests are described in detail elsewhere [13, 14]. Maximum CAF score is 35 points, and the maximum FORECAST score is 14 points.

From September 2008 to March 2010, all the patients, 74 years of age or older, undergoing elective cardiac surgery in the Heart Center of the University of Leipzig were included in the study. All tests were carried out in a standardized environment as described before [13, 14]. In total, the assessment of the test battery took 10–20 min for each patient. In addition to the CAF, the STS score and the logistic EuroSCORE were calculated. Patients were followed up by telephone interview or by contacting their referring physician to assess 30-day and 1-year mortality. Primary end points were all-cause mortality at 30 days and 1 year after the surgical procedure or the TAVI procedure.

The Mann–Whitney test and univariate logistic regression were used to show the ability of the scoring systems to predict 30-day and 1-year mortality. Bivariate logistic regression was used to test the predictive power of the scoring systems independently of each other and of age. Calibration of the models was assessed using the Hosmer–Lemeshow test. Odds ratios (ORs) are reported with 95% confidence intervals (CIs). The patients were divided into three CAF groups, ‘not frail’, ‘moderately frail’ and ‘severely frail’, according to the initial classification as described in Ref. [13].

The patients were also divided into three groups according to their FORECAST score, EuroSCORE or STS score with a similar proportion of patients in each group. Survival during the first year was analysed using Kaplan–Meier analysis and compared between the three CAF groups using the log-rank test.

Bivariate logistic regression with interactions was additionally performed to analyse interaction between frailty scores and different procedure types (isolated aortic valve replacement (AVR), coronary artery bypass grafting (CABG), transcatheter AVR and combined or other procedures).

Spearman rank correlation was used to investigate the correlation of frailty scores, EuroSCORE and STS score with age. Correlation coefficients are reported with 95% CIs based on 10,000 bootstrap repetitions. Continuous variables are described as mean ± standard deviation.

A P-value of <0.05 was considered significant. Data analysis was performed using IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY, USA: IBM Corp).

**RESULTS**

Four hundred and fifty consecutive patients were included in the study. The mean age of the patients was 79 ± 4 years. Fifty percent were female. Twenty-three percent of patients underwent CABG, 23% had isolated mitral valve repair or replacement, 15% had a TAVI procedure (mainly transapical) and 40% had a combined or another isolated valve procedure. Baseline characteristics are summarized in Table 1.

The 30-day follow-up was completed for 423 patients and the all-cause 30-day mortality was 6.1%. The 1-year follow-up was completed for 407 patients and the mortality rate was 13.3%. The rest of the patients were lost for follow-up (9.6%). The actual status could not be assessed anymore because the patients could not be reached by phone neither by the study team nor by their family physicians.

Thirty-day mortality was 2.4% in the ‘not frail’ CAF group (mean CAF: 7 ± 2.3 points), 9.6% in the ‘moderately frail’ CAF group (mean CAF: 15 ± 3.6 points) and 11.1% in the ‘severely frail’ CAF group (mean CAF: 29.3 ± 1.9 points). One-year mortality was 7.7% in the ‘not frail’ CAF group, 16.6% in the ‘moderately frail’ CAF group and 36% in the ‘severely frail’ CAF group. Overall survival during the first year is shown in Fig. 1, and that for the three CAF groups is shown in Fig. 2 (P < 0.001).

Table 1: Baseline characteristics and operative data of the whole sample

<table>
<thead>
<tr>
<th>N</th>
<th>Age (years)</th>
<th>BMI (kg/m²)</th>
<th>Logistic EuroSCORE I (%)</th>
<th>STS score (%)</th>
<th>CAF (points)</th>
<th>FORECAST (points)</th>
<th>CABG, n (%)</th>
<th>Isolated AVR, n (%)</th>
<th>Combined and/or other, n (%)</th>
<th>TAVI, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>79 ± 4</td>
<td>27.3 ± 4</td>
<td>11.2 ± 8.6</td>
<td>4.1 ± 2.9</td>
<td>11.9 ± 6.7</td>
<td>5.9 ± 2.9</td>
<td>103 (23)</td>
<td>99 (22)</td>
<td>180 (40)</td>
<td>68 (15)</td>
</tr>
</tbody>
</table>

BMI: body mass index; CAF: comprehensive assessment of frailty score; FORECAST: Frailty predicts death One year after Elective Cardiac Surgery Test; CABG: coronary artery bypass grafting; AVR: aortic valve replacement; TAVI: transcatheter aortic valve implantation.

![Figure 1: Cumulative survival for all patients up to 1 year.](https://academic.oup.com/icvts/article-abstract/18/5/580/670900/18)
Division of patients into three groups according to the FORECAST, EuroSCORE and STS score, respectively, led to the results summarized in Table 2.

The Mann–Whitney test showed that all scores have the ability to predict 30-day and 1-year mortality ($P \leq 0.001$).

Logistic regression showed predictive power of all scoring systems on mortality. OR for 30-day mortality was 1.1 (95% CI: 1.06–1.2) for CAF, 1.3 (95% CI: 1.2–1.5) for FORECAST, 1.1 (95% CI: 1.03–1.1) for EuroSCORE and 1.3 (95% CI: 1.1–1.5) for STS score, all with a $P$-value of <0.001. For 1-year mortality, OR was 1.1 (95% CI: 1.06–1.1) for CAF, 1.3 (95% CI: 1.2–1.4) for FORECAST, 1.04 (95% CI: 1.02–1.08) for EuroSCORE and 1.2 (95% CI: 1.1–1.4) for STS score, all with a $P$-value of <0.001. Goodness-of-fit for the logistic regression models was shown: The Hosmer and Lemeshow test yielded $P$-values of >0.1 for all the models.

Bivariate logistic regression was performed only for 1-year mortality because there were not enough events until 30 days to perform a useful analysis. The results are summarized in Table 3. CAF had significant additional information if EuroSCORE is known [OR: 1.09 (95% CI: 1.04–1.14); $P < 0.001$]. The same is true for FORECAST and EuroSCORE [OR: 1.27 (95% CI: 1.14–1.42); ($P < 0.001$)]. Analysis of CAF and STS score and FORECAST and STS score showed that the scores have predictive power independently of each other. Comparison of STS score and EuroSCORE showed that EuroSCORE gives no additional information compared with STS score, in regard of 1-year mortality. The Hosmer and Lemeshow test yielded $P$-values of ≥0.1 for all the models.

Logistic regression showed significant interaction of AVR with CAF ($P = 0.005$) and FORECAST ($P = 0.029$), but for none of the other procedures. Hence, univariate analysis was performed separately for procedures including AVR and without AVR. The group with AVR showed a significantly higher OR [1.27 (95% CI: 1.13–1.42) vs 1.06 (95% CI: 1.02–1.11)].

Spearman ranks correlation showed moderate correlation of age and STS score ($\rho = 0.54$, 95% CI: 0.46–0.61) as well as of age and EuroSCORE ($\rho = 0.44$, 95% CI: 0.35–0.51). In contrast, there was only weak correlation between age and each of the frailty scores.

**Figure 2:** Kaplan–Meier survival plot for the three frailty groups defined by the CAF score.

**Table 2:** Division in three groups according to the risk assessment

<table>
<thead>
<tr>
<th>Group [range (points)]</th>
<th>Not frail (CAF 1–10)</th>
<th>Moderately frail (CAF 11–25)</th>
<th>Severely frail (CAF 26–35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>230 (51)</td>
<td>189 (42)</td>
<td>31 (7)</td>
</tr>
<tr>
<td>CAF (points)</td>
<td>7.0 ± 2.3</td>
<td>15 ± 3.6</td>
<td>29.3 ± 1.9</td>
</tr>
<tr>
<td>Logistic EuroSCORE (%)</td>
<td>9.3 ± 7.2</td>
<td>12.5 ± 8.9</td>
<td>17.7 ± 11.5</td>
</tr>
<tr>
<td>STS score (%)</td>
<td>3.2 ± 2.5</td>
<td>4.7 ± 3</td>
<td>6.7 ± 3.4</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>2.7</td>
<td>9.6</td>
<td>16.6</td>
</tr>
<tr>
<td>1-year mortality (%)</td>
<td>7.7</td>
<td>16.6</td>
<td>36.0</td>
</tr>
<tr>
<td>FORECAST Group I (0–4)</td>
<td>169 (38)</td>
<td>151 (34)</td>
<td>130 (29)</td>
</tr>
<tr>
<td>Logistic EuroSCORE (%)</td>
<td>9.1 ± 6.3</td>
<td>9.4 ± 6.9</td>
<td>14.7 ± 11.5</td>
</tr>
<tr>
<td>STS score (%)</td>
<td>3.2 ± 2</td>
<td>3.9 ± 3.1</td>
<td>5.4 ± 3.2</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>2.5</td>
<td>6.8</td>
<td>13.7</td>
</tr>
<tr>
<td>1-year mortality (%)</td>
<td>5.1</td>
<td>17.2</td>
<td>20.5</td>
</tr>
<tr>
<td>EuroSCORE Group I (2.4–6.6)</td>
<td>150 (33)</td>
<td>151 (34)</td>
<td>147 (33)</td>
</tr>
<tr>
<td>Logistic EuroSCORE (%)</td>
<td>4.8 ± 1.2</td>
<td>8.7 ± 1.3</td>
<td>20.4 ± 9.6</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>0.7</td>
<td>6.2</td>
<td>15.0</td>
</tr>
<tr>
<td>1-year mortality (%)</td>
<td>6.6</td>
<td>11.4</td>
<td>21.9</td>
</tr>
<tr>
<td>STS score Group I (0.7–2.5)</td>
<td>129 (34)</td>
<td>130 (34)</td>
<td>123 (32)</td>
</tr>
<tr>
<td>Logistic EuroSCORE (%)</td>
<td>1.7 ± 0.5</td>
<td>3.3 ± 0.5</td>
<td>7.3 ± 3.1</td>
</tr>
<tr>
<td>30-day mortality (%)</td>
<td>0.8</td>
<td>0.0</td>
<td>16.1</td>
</tr>
<tr>
<td>1-year mortality (%)</td>
<td>5.8</td>
<td>4.3</td>
<td>23.9</td>
</tr>
</tbody>
</table>

CAF: comprehensive assessment of frailty score; n: number of patients; FORECAST: Frailty predicts death One yeA R after Elective Cardiac Surgery Test.
scores (CAF: $\rho = 0.22$, 95% CI: 0.13–0.31; FORECAST: $\rho = 0.13$, 95% CI: 0.04–0.22).

Bivariate logistic regression showed that CAF score and FORECAST are associated with 1-year mortality independently of age. OR for CAF was 1.09 (95% CI: 1.05–1.13; $P < 0.001$) and 1.26 (95% CI: 1.14–1.40; $P < 0.001$) for FORECAST. The results are given in Table 3. The Hosmer and Lemeshow test yielded $P$-values of $>0.1$ for both the models.

### DISCUSSION

The frailty tests, which we have introduced, are the first that are specifically designed for an elderly elective cardiac surgical patient population and tested in a large number of patients. Other studies have used different frailty assessments before elective cardiac surgery or TAVI.

The first study that found an association of frailty and outcome of cardiac surgery was published in 2010. Lee et al. [11] used a decrease in activities of daily living, dependence in ambulation and occurrence of dementia as definition of frailty for patients that were referred for cardiac surgery. In a retrospective analysis of prospectively collected data for an internal registry, they identified 157 patients who were classified as frail. This patient cohort was younger than our study cohort (median age 71 (61–78) years). The frail patients were more likely to be female, had higher rates of comorbidities and underwent more complex procedures. The follow-up was conducted via an official vital statistics administrative database. The authors found frailty to be associated with an increase in in-hospital mortality, predictive of discharge to prolonged institutional care and associated with reduced mid-term survival.

Afilalo et al. [15] described gait speed as an incremental predictor of mortality and major morbidity for elderly patients undergoing cardiac surgery. In their prospective multicentre cohort study on 131 patients with a mean age of 76 years, they assessed 5 m gait speed and discriminated between slow walkers ($\geq 6$ s) and normal walkers ($<6$ s). They found slow gait speed to be an independent risk factor for mortality and major morbidity. Additionally, they performed a logistic regression model including STS score and gait speed and found that the model improved after addition of gait speed. For our frailty score, slow gait speed was defined according to the Fried criteria [7]. Slow gait speed led to the addition of one frailty point to the overall score. But gait speed as isolated factor was not found to be an independent risk factor for increased mortality at 30-day and 1-year follow-up in our study. In 2012, Afilalo et al. [10] published their results of a multimodality assessment of elective patients referred for coronary artery bypass surgery and/or valve surgery. They used four different frailty scores, three disability scales and five cardiac surgery risk scores. For frailty measurement, gait speed was again the most predicting parameter. The best predictive value for all cardiac surgery risk scores was found for STS score. This is in accordance with our results. STS score showed superior predictive abilities compared with the EuroSCORE. The frailty scores (CAF and FORECAST) had predictive power independently of STS score.

Frailty also comes into focus with the event of TAVI procedures. We therefore also included TAVI patients in our cohort. In this study, the number of events in TAVI patients was not large enough to perform a useful analysis of this subgroup. But we found in general that frailty plays a larger role in AVR than in CABG procedures. We think that our frailty assessment will also be applicable for TAVI patients. Especially because other studies found an association of frailty and outcome after TAVI: Stortecky et al. [16] introduced a frailty index that includes Mini Mental State Exam (MMSE), Mini Nutritional Assessment, Timed Get Up and Go test, Basic Activities of Daily Living and Instrumental Activities of Daily Living that was used for the assessment of 100 patients, 70 years or older, referred for TAVI. This frailty index was found to be strongly associated with mortality up to 1 year. Almost the same study population was used by Schoenenberger et al. [17] to find an association of frailty, assessed as described by Strotecky et al. [16], and functional decline 6 months after a TAVI procedure. The frailty index, but none of the conventionally risk assessments, was an independent predictor for this outcome. Green et al. found an association of frailty, defined as reduced gait speed, grip strength, serum albumin and activities of daily living and an increase of 1-year mortality in a study with 160 TAVI patients. Except from MMSE, all items are similarly included in our frailty index as described by Strotecky et al. [16]. The items used by Green et al. are all included in our comprehensive frailty assessment. This leads us to the assumption, that CAF and FORECAST are applicable for TAVI patients. We have not included assessment of quality of life and functional decline in our study. But in an ongoing study for validation of our frailty scores, these endpoints are of major interest.

All the studies described above and this study found an association of frailty either with conventional cardiac surgery or with TAVI procedures. What is still missing is a score to discriminate between patients eligible for one of the modalities according to their frailty index, which would potentially be a strong tool to improve patient selection. Compared with the commonly used risk prediction systems, EuroSCORE and STS score, our frailty test assesses mainly the factors that are dependent on the biological age of the patient. The EuroSCORE has been revalidated recently [9]. EuroSCORE II now includes the factor ‘poor mobility’, defined as severe impairment of mobility secondary to musculoskeletal or

| Table 3: Bivariate logistic regressions for 1-year mortality |
|----------------|----------------|----------------|
|               | OR      | 95% CI   | $P$-value |
| CAF           | 1.089   | 1.045–1.135 | <0.001   |
| EuroSCORE     | 1.029   | 1.000–1.060 | 0.053    |
| FORECAST      | 1.271   | 1.141–1.415 | <0.001   |
| EuroSCORE     | 1.029   | 0.999–1.059 | 0.056    |
| CAF           | 1.087   | 1.037–1.139 | 0.001    |
| STS score     | 1.167   | 1.045–1.304 | 0.006    |
| FORECAST      | 1.264   | 1.116–1.431 | <0.001   |
| STS score     | 1.174   | 1.052–1.309 | 0.004    |
| EuroSCORE     | 1.002   | 0.962–1.042 | 0.94     |
| STS score     | 1.231   | 1.092–1.387 | 0.001    |
| CAF           | 1.091   | 1.049–1.135 | <0.001   |
| Age           | 1.045   | 0.975–1.121 | 0.21     |
| FORECAST      | 1.265   | 1.143–1.401 | <0.001   |
| Age           | 1.056   | 0.985–1.131 | 0.12     |

CAF: comprehensive assessment of frailty score; FORECAST: Frailty predicts death One year after Elective Cardiac Surgery Test; OR: odds ratio; CI: confidence interval.
neurological dysfunction. This factor was identified as independent risk factor for mortality in univariate logistic regression. The new EuroSCORE was validated in different patient populations and showed better predictive abilities than EuroSCORE I in isolated CABG patients [18] and good accuracy for a mixed patient population compared with EuroSCORE I that significantly overestimated perioperative risk [19]. Poor mobility is defined as secondary to neurological or musculoskeletal dysfunction, thus it is not a measurement of frailty by definition. But the implementation of this item and the better discrimination of the new EuroSCORE shows the growing importance of the assessment of factors other than comorbidities for perioperative risk assessment.

In the STS score, no such assessment is provided. STS score is constantly calibrated to assess perioperative mortality and morbidity. It can be applied only in patients undergoing isolated CABG, isolated AVR, isolated mitral valve replacement or repair, or a combination of CABG and one of the valve procedures. Nevertheless, it shows good predictive abilities in several studies [20–22] and also a very good performance in our study.

Despite these good results in favour of STS and EuroSCORE, there are also studies that showed contradictory results with over- or underestimation of the scoring systems, especially for high-risk patients [21] and inaccuracy in the prediction of mortality in TAVI patients [23].

A limitation of this study is that it has been performed in a single-centre set-up and that it cannot be excluded that the performance of the tests would be different in other centres.

In conclusion, the assessment of the frailty status seems to be important in predicting mortality and morbidity in elderly patients undergoing elective cardiac surgery or TAVI procedures. The commonly used risk assessment tools, the STS score and the EuroSCORE I and EuroSCORE II show good predictive ability for short-term mortality, but are not validated for some procedures, including TAVI procedures. The newly introduced frailty assessment tools, CAF and FORECAST, provide a tool to include frailty in the assessment of patients before cardiac interventions. A study to validate the scores and to discriminate their predictive power for conventional procedures and transcatherter procedures is necessary and ongoing. The presence of frailty is a major factor that increases perioperative risk and should be taken into account when assessing patients, especially in a high-risk situation.

Conflict of interest: none declared.

REFERENCES


APPENDIX. CONFERENCE DISCUSSION

Dr S. Nashef (Cambridge, U.K.): You have carried out not one, but two frailty tests on 450 patients, which I think is no mean feat. I think you have proven conclusively that frailty is important. You have also shown that it can be measured, and you have shown that it has an impact on both early mortality and late mortality.
As you know, we have considered very seriously the inclusion of the frailty test or some sort of measure of frailty for the development of EuroSCORE II, but we decided not to for the simple reason that the overwhelming majority of centres and surgeons do not do it. The data are not available.

I have two questions for you. The first one is: How are you going to persuade this cardiac surgical community to begin to measure frailty regularly and reliably? And secondly, which of the two scores do you think we should use?

**Dr Sündermann:** It is a big honour to have the godfather of European risk-scoring systems here to discuss the paper. In regard to the first question, one thing that we saw is that the comprehensive assessments or the whole score are much too long to be included in the daily routine. So I thought the first step was to simplify the test. How to implement it in every sense in daily routine is a good question. It is difficult to perform, but I think the first step is to make it really simple and to find those factors that can be simply assessed and simply implemented in the daily risk assessment of patients.

Regarding the second question, at the moment, we validate both scores. The first step was to develop the test, and the next step is to validate it; afterwards we can see which one performs better. We also now include the quality of life of patients in the follow-up study, and I think this will also be a very important factor in deciding which test should be used.

First, the simpler ones. At the moment, I’d say the FORECAST is simpler, so it can be used more easily. And the second thing will be to see which one performs better in regard to quality of life because I think this is, for many patients, much more important than mortality. If you talk to a 90-year-old patient and tell him he is maybe going to die after the operation, he says, ‘I don’t care because I won’t feel it, but I want to know if I will have a good quality of life afterwards.’

**Dr D. Pagano (Birmingham, UK):** Just a comment. The question I asked before about these patients you have on the prediction of risk scoring systems, yes, numbers are a problem. But there is also something called ‘overdispersion’ which is unmeasured variables. And it is exactly because you’ve got these kinds of variables that may improve risk prediction in the elderly patient.

**Dr S. Head (Rotterdam, Netherlands):** You just mentioned that simplifying the scores may be able to help in reducing the time required to do these frailty assessments. Do you already see that some of the variables in the scores are more predictive than others? So, for example, is gait speed important or grip strength or cognitive functioning? I wonder whether people in the room already want to use some frailty assessments. Which one would you recommend?

**Dr Sündermann:** Gait speed has been shown to have an impact on outcome. This is definitely an important thing and has also been shown in our data to be one of the most important tests with the highest predictive ability.

**Dr T. Schwann (Toledo, OH, USA):** In terms of simplicity, I think that there is an emerging modality that is not currently being used; I am referring to increasingly easily obtainable preoperative level of activity from pedometers and accelerometers. This may be an interesting, simple approach that would address the frailty issue from not quite as rigorous a perspective, but certainly there is some emerging data suggesting that preoperative activity correlates with long-term outcome and may be a very simple technique.

Secondly, do you have any data or would you know of any data whereby if you identify frailty, there is something that we can do to change that frailty score for individuals such that we impact the long-term outcomes?

**Dr Sündermann:** This is an interesting question. Of course, it does help if you know whether a patient is frail or not. I think this would play an important role, especially when deciding between management options: for example, in the choice between TAVI and conventional therapy.

This was where it all started when TAVI emerged, that it was found not very useful to just use the EuroSCORE. If it was a 15% EuroSCORE, the patient had to undergo a TAVI. So we thought we had to investigate other factors that are important for assessment of the patient. So this may be a point where it can help.

**Dr J. Gummert (Bad Oeynhausen, Germany):** Very short question: Frailty may change from day to day, especially in elderly patients. We all have had this experience. Do you have any data in terms of if you assess frailty on a day-to-day basis, are there any differences? Have you done this?

**Dr Sündermann:** We didn’t assess frailty over days; we just assessed it before the operation. It would be very interesting to assess it after the operation as well, of course. This would be quite interesting.