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***What to expect after open heart valve surgery?
Changes in health-related quality of life***

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Abstract

Purpose: To i) describe changes in health-related quality of life (HRQoL) preoperatively, at discharge, and four weeks after discharge following open heart surgery; ii) compare the performance of the EuroQol Questionnaire (EQ-5D 5L) and the Kansas City Cardiomyopathy Questionnaire (KCCQ) against an anchor-based approach and to iii) investigate the association between HRQoL and 180-day readmission.

Methods: A prospective, consecutive cohort (single-center study) of 291 patients completed the EQ-5D 5L and KCCQ pre-operatively, at discharge and four weeks post-discharge. Changes in HRQoL over time were evaluated, and the performance of the instruments was investigated. The association between HRQoL and readmission were investigated with Cox Proportional Hazard models.

Results: Scores of the EQ-5D Index and VAS decreased significantly from the preoperative assessment to discharge and improved from discharge to four weeks after. The KCCQ-scores significantly improved from baseline to four weeks after. Minimal clinically important improvements from before surgery to four weeks after were seen amongst 24% (EQ-5D Index), 45% (EQ-5D VAS) and 57% (KCCQ). More than one-third experienced worse HRQoL one month after discharge. Area under the curve (AUC) (performance of the instruments) demonstrated; EQ-5D Index AUC 0.622 (95% CI 0.540-0.704), VAS AUC 0.674 (95% CI 0.598-0.750) and KCCQ AUC 0.722 (95% CI 0.65-0.792). None of the HRQoL measurements were associated with 180-day readmission.

Conclusions: This study revealed that HRQoL measured with the EQ-5D is significantly worse at discharge compared to before surgery, but scores increases within the first month measured with the

EQ-5D and the KCCQ. The EQ-5D and KCCQ have a moderate correlation with an anchor-based approach but were not associated with readmission.

Accepted manuscript

Introduction

The focus on improving patient quality of life and reducing symptoms after open heart valve surgery has gained prominence in the past decade. Due to advancements in surgical techniques, survival is no longer the only goal [1]. Although mortality rates are declining, patients continue to experience high readmission rates, increased symptom burden and changed bodily awareness in the early period after discharge. These are all factors that may adversely impact quality of life [2-4]. Patient-reported outcomes, including measurements of health-related quality of life (HRQoL), symptom burden, physical and mental health, have increasingly been reported in studies and trials among patients undergoing open heart valve surgery [5-8]. In general, previous studies have demonstrated that patients undergoing open heart valve surgery report significantly impaired physical and mental health status before surgery, while improvements are not seen until three to six months post-operatively [9,10,6].

A paucity of instruments have been validated to measure HRQoL in patients with heart valve disease and patients undergoing open heart valve surgery. These instruments include the generic EuroQol Questionnaire (EQ-5D) [11] and the disease-specific measures: HeartQoL [12], Kansas City Cardiomyopathy Questionnaire (KCCQ) [13], and Minnesota Living with Heart Failure Questionnaire (MLHFQ) [11]. However, none of these measures were explicitly developed for this population and not designed to capture changes from before and after open heart valve surgery. Previously, differences in performance of generic vs disease-specific instruments have been investigated comparing EQ-5D vs MLHFQ [11], but the performance of the KCCQ in patients undergoing open heart valve surgery is unknown.

In other cardiac populations, poor self-reported health is known to be associated with worse long-term outcomes (e.g., mortality, morbidity, and readmission) [14,15]. However, among patients undergoing a heart valve procedure, the results are conflicting [5,16,17]. Inconsistency in reporting,

different use of instruments, and low response rates make it difficult to determine the association between patient-reported outcomes and adverse events, such as readmission after heart valve surgery [5,18].

Accordingly, more information on the specific instruments, their performance, and associations with adverse outcomes are needed.

The overall aim of the current study was to strengthen the evidence of patient-reported outcomes in patients undergoing open heart valve surgery and thus, contribute to a shift in clinical care that incorporates the perspective of the patient. The specific objectives were to conduct a comprehensive study of i) changes in HRQoL pre-operatively, at discharge, and four weeks after discharge following open heart surgery; ii) comparison of the performance of KCCQ and EQ-5D against an anchor-based approach; and iii) the association between HRQoL and readmission within 180 days after discharge.

Methods

Study design and scope

The current study is an exploratory outcome analysis of the *Individualized Follow-up after Valve Surgery* (INVOLVE) study [3]. The INVOLVE study was a prospective cohort single-center study investigating the effect of a multidisciplinary intervention consisting of early, individualized and intensified follow-up with a historical control group [3]. The primary analyses of the INVOLVE study demonstrated an effect of the intervention on a composite endpoint of the first event of unplanned readmissions or all-cause mortality within 180-days after discharge [3]. In the current study, data on HRQoL among the prospective intervention group alone are reported.

Participants, setting and recruitment

Data were collected at Odense University Hospital, Denmark, between November 1, 2016, and November 15, 2017. Patients undergoing open heart valve surgery (Nordic/NOMESCO surgical codes; Aorta (KFCA, KFMA, KFMC, KFMD), Mitral (KFKB, KFKC, KFMD, KDKW) and Tricuspid (KFGC, KFGE) were eligible for inclusion and were invited to complete a paper-based questionnaire pre-operatively (baseline, T0), at discharge (T1) and 4 weeks after discharge (T2). No patients were treated or referred to other institutions for management of pulmonary valve diseases during the period.

Of the initial population of 308 patients, 17 were excluded due to language barriers, cognitive impairments and emergent status at the time of surgery (Figure 1). Furthermore, patients discharged without contact with the intervention staff did not receive the T1 questionnaire.

Data collection

Patient characteristics

Demographic and clinical data were obtained from the electronic patient records, and the Western Denmark Heart Registry [19]. Data were entered into an electronic database (Research electronic data Capture, RedCap) hosted by Open Patient data Explorative Network (OPEN), Odense University Hospital [20].

Readmission

A readmission was defined as a) an admission occurring more than 24 hours after the index discharge, b) an overnight stay, c) a readmission occurring within the first 180-days after discharge (after surgery), and d) an unplanned readmission due to a presumed cardiac cause, or presumed related to the surgery [3].

Patient-reported outcomes

We used the EQ-5D 5L and the KCCQ (12-item version) to assess HRQoL. The **EQ-5D** is a generic questionnaire consisting of two parts: The Index score and the Visual Analogue Scale, (VAS). The Index score covers five domains of health (mobility, self-care, activity, pain/discomfort and anxiety), where the patients are asked to rate the severity of each domain in five levels. A score of 1 is considered to be full health and a score of 0 as being dead. The VAS is a graded, vertical thermometer type of measure anchored at 0 (worst QoL) and 100 (best QoL) [21,22]. The EQ-5D has shown high validity; it has previously been tested in a small sample of patients undergoing heart valve surgery [11]. Minimal clinically important differences (the smallest amount of benefit a patient can recognize [11,23]) of the EQ-5D has been reported to be 0.10 (Index score) and 8.61 (VAS) in a population of patients receiving rehabilitation after stroke [23] and to be 0.125 (Index score) in a small study of patients undergoing heart valve surgery [11].

The 12-item abbreviated version of the **KCCQ**[24] is a disease-specific health status questionnaire, derived from the 23-item KCCQ originally developed for patients with heart failure [24]. Currently, no disease-specific instruments have been developed for patients undergoing heart valve surgery, but the KCCQ has previously been validated in patients with severe aortic stenosis [13]. The KCCQ assesses four domains (physical limitation, symptom frequency, quality of life, and social limitation) that are combined into an overall summary score. The subscales and OS range from 0 to 100, with higher scores indicating better health status and low symptom burden [24]. A minimal clinically important difference of 3 to 5 points for the KCCQ-12 OS has previously been proposed [24]. Improvements have been described as small (5 points), moderate (10-20 points) and large (>20 points) [25,26].

We included a single question to capture the patient perspective of the overall outcome of the surgery four weeks after discharge (the anchor-based approach). Patients were asked; “*Do you feel*

better than before surgery?” Possible answers were: “*yes, feeling better*”, “*no, feeling worse*” or “*no change*”. The simple anchor-based approach was used to compare the performance of the validated instruments EQ-5D and KCCQ.

Patients completed the baseline questionnaire pre-operatively (T0, EQ-5D and KCCQ) in hospital prior to surgery and the second questionnaire (T1, EQ-5D) at the time of discharge from the surgical ward. KCCQ was not part of the T1, as the timing of discharge did not enable the requirement for measuring a two-week recall. The third and final questionnaire (T2, EQ-5D and KCCQ) was completed at the time of the four weeks consultation or within two days at home. No reminders were sent out.

Statistical analyses

Baseline characteristics and scores and numeric values of the EQ-5D and KCCQ are presented as numbers and proportions, mean and standard deviation (SD) and median and 25th to 75th percentiles (interquartile range, IQR), as appropriate.

Due to the skewed distribution of both the EQ-5D and KCCQ scores, non-parametric tests were applied to analyze these data. Differences in median scores of the instruments EQ-5D pre-operatively, at discharge and four weeks after discharge among the total group were tested with the Friedman test (paired), differences in scores of the KCCQ pre-operatively and four weeks after discharge were tested with the Wilcoxon signed-rank test (paired). Paired *t*-tests were used to analyze changes in mean scores in HRQoL at different time points. Categorical variables were compared using the χ^2 test. Minimal clinically important differences were reported for all measures. Mean change on the instruments from before surgery to four weeks after discharge was divided into the anchor-based groups based on the three potential responses and visualized with box plots and

95% confidence intervals. Receiver operating characteristic (ROC) curves, the area under the curve (AUC), its associated 95% confidence intervals and the association with the anchor-based approach of feeling better than before surgery were generated for each instrument. The ROC curve plots the sensitivity of the instrument.

Cox proportional hazards models were used to assess the association between HRQoL and hospital readmission. The worst quartile (0.691 preoperatively and 0.640 at discharge) of the EQ-5D Index score was included instead of the continuous score due to a non-linear increase in hazard rate with increasing scores. Each score of the instruments was investigated as a crude variable and adjusted for sex, age, type of valve procedure, concomitant coronary artery bypass grafting (CABG), reduced lung function, prior percutaneous coronary intervention and estimated glomerular filtration rate. Results are presented as hazard ratios (HR) with 95% confidence intervals (CI).

Missing data (on the clinical variables) were considered to be missing completely at random, and thus, the analyses only included complete observations.

A two-sided value of $p < 0.05$ was considered significant. All statistical analyses were performed with the use of SPSS software, Version 24 (IBM Corp, Armonk, NY).

Ethical considerations

The investigation conformed with the principles outlined in the Declaration of Helsinki,[27] was approved by the Danish Data Protection Agency (18/19152), Danish Patient Safety Authority, and registered at ClinicalTrials.gov (NCT03053778). All patients received both written and oral information about the study and provided written informed consent.

Results

Patient characteristics and health-related quality of life

In total, 291 patients were eligible for inclusion in the study. Of the included patients, 241 (83%) and 245 (84%) completed the EQ-5D and the KCCQ, respectively, pre-operatively and four weeks post-discharge. In addition, 223 patients (77%) completed the EQ-5D at all three time-points (Figure 1). Demographic and clinical characteristics are summarized in Table 1. Of all patients, 70% were men, the median age was 70 years, and 25% were living alone. Most patients were diagnosed with aortic stenosis (62%), followed by aortic regurgitation (19%) and mitral stenosis or regurgitation (19%) (Table 1). During the index admission, n=8 patients died (not eligible for inclusion). After discharge, 23% were readmitted. No patients died after discharge and during the four weeks follow-up, but two patients were lost to follow-up due to other reasons.

There was a significant reduction in the EQ-5D Index and VAS scores between pre-operative assessment and discharge (EQ-5D Index Δ -0.06 (IQR -0.14-0.02, $p<0.001$) and VAS score Δ -4 (IQR -20-10, $p\leq 0.05$)) and a significant increase between discharge and four weeks post-discharge (EQ-5D Index score Δ 0.06 (IQR -0.02-0.13, $p<0.001$) and VAS score Δ 11 (IQR 0-25, $p<0.001$)) (Table 2 and Figure 2). There was a significant improvement from pre-operatively to four weeks post-discharge for the EQ-5D VAS (Δ 7 (IQR -5;20, $p<0.001$)), but not for the EQ-5D Index Score Δ 0.00 (IQR -0.07-0.10, $p=NS$) (Figure 2).

Patients reported significantly improved scores on the sub-scales of the KCCQ from baseline to four weeks, except for the “social limitation” sub-scale (Table 2). Similarly, from baseline to four weeks after discharge, the KCCQ OS-scores were significantly improved (Δ 11 (IQR -4-23, $p<0.001$)) (Figure 2). Figure 3 illustrates the temporal changes in categorical thresholds within each sub-scale of the EQ-5D Index and the KCCQ.

Minimal clinically important differences

On the EQ-5D, minimal clinically important improvements from pre-operatively to four weeks were seen among 24% (Index) and 45% (VAS) of the responders, whereas 42% (Index) and 30% (VAS) reported worse outcomes. Patients who did not have a minimal clinically important improvement were more likely to be ≥ 80 of age (EQ-5D, both scales), diagnosed with ischemic heart disease and have a history of previous percutaneous coronary intervention (PCI) (EQ-5D Index Score). On the KCCQ, a minimal clinically important difference (improvement) was seen in 57% and observed as moderate (10-20 points) and large (>20 points) improvements in 19% and 30%, respectively. Among responders, 32% experienced worse outcomes on the KCCQ after four weeks. Patients who did not experience a minimal clinically important improvement on the KCCQ were more likely to have ischemic heart disease and a history of a previous PCI. Overall, patients who reported scores in the worse quartile of each measurement pre-operatively did not report a minimal clinically important difference (data not shown). The concordance between the measurements and the ability to capture minimal clinically important differences were not similar, indicating that the same patient did not necessarily have a minimal clinically important difference on the KCCQ and the EQ-5D.

The performance of EQ-5D and KCCQ on the anchor-based outcome

In total, 285 patients answered the question; “*Do you feel better than before?*” at the four-week post-discharge out-patient consultation. Of those, $n=171$ (60%) answered “*yes, feeling better*”, $n=73$ (26%) answered “*no, feeling worse*”, and $n=41$ (14%) answered “*no change*”. Differences in scores on the EQ-5D Index, EQ-5D VAS and the KCCQ on the three different answers of the anchor-based approach are presented in Figure 4.

ROC curves for the predictive effect of the EQ-5D and the KCCQ on the anchor-based outcome are presented in Figure 5. For the EQ-5D Index score, AUC was 0.622 (95% CI 0.540;704), and for the

EQ-5D VAS, AUC was 0.674 (95% CI 0.598;0.750). For the KCCQ, the AUC was 0.722 (95% CI 0.651;0.792) (Figure 5). Further diagnostic accuracy measures are presented in the supplementary table, S1.

Health-related quality of life and the risk of readmission

HRQoL scores preoperatively and at discharge were not associated with 180-day readmission in either crude or adjusted Cox proportional hazard regression models (Table 3).

Discussion

Discussion

In this prospective study, we investigated HRQoL preoperatively, at discharge and after four weeks of discharge after open heart valve surgery. Furthermore, we compared the performance of the two instruments EQ-5D and KCCQ, and investigated the association between HRQoL and 180-day readmission. We found that patients report worse HRQoL at discharge compared with the pre-operative scores, but for many patients the score improves at follow-up. Patients undergoing open heart valve surgery experienced clinical and statistical improvements in HRQoL measured with the EQ-5D VAS and the KCCQ, and nearly half of the patients experienced a moderate or large improvement within the first month after discharge. However, we also found a great variation within the individual scores and found that despite overall improvements, up to 42% of the patients report worse scores after four weeks. This indicates that patients do not derive the full effect of the surgery four weeks after discharge. The results of the current study were not unexpected, as previous studies also suggest similar findings; lower HRQoL immediately after surgery, at discharge and within the first week after discharge, but increasing scores within the first month [28,29]. Combined, the studies demonstrate how the early post-operatively period is a seemingly vulnerable period for the patient. This emphasizes the importance of clinicians informing patients

on what to expect of the pathway after surgery – especially those with mild symptoms. However, the present study also highlights the difficulty in turning data on HRQoL on a group level into an individual level as they reflect a summary of scores with a commonly wide distribution within individual scores [30]. Information on group level can be used to set a threshold of changes over time by investigating the minimal clinically important difference [30]. In the current study, the findings add to the current literature, by the presentation of the proportion of patients experiencing minimal clinically important differences. This information could potentially be incorporated into discharge planning to ensure that patients have realistic expectations when returning home. Similarly, our findings indicate that we still need more information to point out the best time-point to measure HRQoL if chosen as an outcome in future clinical trials, as current studies include measures at different timepoints [7,5].

When comparing HRQoL among patients undergoing open heart valve surgery with patients undergoing transcatheter aortic valve replacement (TAVR), patients undergoing TAVR have significantly better HRQoL in the early period after the procedure [31]. This might be explained by the minimally invasive approach (compared to sternotomy), early mobilization, a shorter length of stay, fewer restrictions and less pain [31]. Thus, the lower HRQoL immediately after open heart valve surgery seems to be affected by surgical trauma, the subsequent restrictions and the increased risk of complications and readmissions [3,17].

In the present study we compared EQ-5D and KCCQ with the simple anchor-based question. This demonstrated how the KCCQ had a slightly better performance based on the ROC curves and the AUC, compared with the EQ-5D. However, it could still be discussed whether any of the instruments fully capture how the patient perceives their health status compared with the simple approach. The results indicate that the current instruments might not be appropriate measurements of HRQoL after open heart valve surgery. The KCCQ has previously been validated among patients

with aortic stenosis undergoing TAVR and was found to be a reliable, responsive and valid measure of HRQoL after TAVR [13]. But as previously discussed, changes in HRQoL seem to be different among patients undergoing TAVR compared to patients undergoing open heart valve surgery, suggesting that it is important in future research to further validate the KCCQ specifically for patients undergoing open heart valve surgery.

Finally, we did not find HRQoL to be associated with readmission in our population, which is in line with a previous study from our group [5]. Although several studies have highlighted how low HRQoL is associated with worse long-term outcomes (e.g. mortality, morbidity) in other cardiac populations [14,32], this is not demonstrated in patients undergoing open heart valve surgery. A possible explanation for the differences might also be related to the surgical procedure with specific complications, physical symptoms, changed bodily awareness and the sound of a “*clicking valve*” in patients with mechanical prostheses. This is all issues that likely influence HRQoL, as many of these complications arise after discharge [4,8,33]. Thus, the association with readmission can be difficult to demonstrate, and the use of patient-reported outcomes at discharge might not be an appropriate predictor of future readmission in a surgical population. Also, among patients undergoing PCI, findings from a recent qualitative study indicate that undergoing a procedure influences how patients perceive the seriousness of the condition compared to receiving medical treatment [34]. These findings combined suggest that undergoing a major procedure or surgery impact HRQoL.

Limitations

Our findings should be interpreted in the context of potential limitations. First of all, despite a high response rate, there is still a risk of potential non-response bias. When investigating baseline differences between responders and non-responders, non-responders had a higher EuroScore II and

were generally in a higher NYHA class. Thus, HRQoL might be lower among non-responders. Moreover, missing data within the included instruments might also be a limitation when investigating HRQoL. Missing data within the different sum-scores of the instruments were present for 5-7% and lower for the clinical variables (2-3 %).

Another potential limitation of the chosen instruments is whether the responsiveness was sufficient to detect changes among patients undergoing open heart valve surgery. None of the above instruments were developed specifically for patients undergoing open heart valve surgery. Thus, it is unclear whether they capture all aspects that can affect overall health status, mental status and HRQoL after open heart valve surgery. Similarly, considerations of potential “floor and ceiling effects” should also be considered when investigating the use of patient-reported outcomes [35]. Floor and ceiling effects indicate how patients cannot be worse than the worst category or better than the best category. Ceiling effects exist on both instruments, which indicate that the instruments might not be appropriate and might not have the ability to capture possible changes in outcomes among patients undergoing open heart valve surgery if present. For instance, other areas currently not measured could involve symptoms of pleural- and pericardial effusions, symptoms of rhythm disorders, warning signs of wound infections and concerns on the noise of the valve (e.g., a mechanical “*clicking sound*”). This and the areas of awareness after surgery, as mentioned above, should be taken into consideration when investigating and using patient-reported outcomes following open heart valve surgery. Similarly, as the effect of the surgery is not fully present among all patients at four weeks after discharge, future studies should include a longer follow-up.

Finally, the lack of observed associations between HRQoL and readmissions could be related to the small sample size, inducing a lack of statistical power.

Conclusion

Undergoing open heart valve surgery influences HRQoL measured with the EQ-5D and KCCQ in especially the early period after discharge. More than one-third of the patients experience worse HRQoL one month after discharge compared with pre-operative scores. The EQ-5D and KCCQ have a moderate correlation with how patients perceive their health status four weeks after discharge but were not associated with readmission.

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Figure legends

Figure 1. Flowchart of included patients

*Responders of T0 and T2

**Responders at all time points, T0, T1 and T2

Figure 2. Changes in scores from baseline to discharge and four weeks after discharge on the EQ-5D and KCCQ

Differences in mean scores at different time points tested with a paired t-test, for difference in median scores, see table 2.

Figure 3. Temporal changes in categorical thresholds within each sub-scale of the EQ-5D Index and the KCCQ

Figure 4. Differences in patient-reported outcomes scores on the anchor-based approach

Illustrated is differences in scores on the EQ-5D Index, EQ-5D VAS and the KCCQ among patients with the answers “Yes, feeling better”, “No, feeling worse” or “No change” to the anchor-based question regarding change in condition from before surgery.

Figure 5. The predictive effect of EQ-5D and KCCQ on the anchor-based question of “Do you feel better than before surgery?”

Receiver operation characteristic (ROC) curves for the predictive effect of the SF-12 and the EQ-5D on readmission.

AUC: Area Under Curve, MCS: Mental Component Summary, PCS: Physical Component Summary, VAS: Visual Analogue Scale

Table 1. Demographic and clinical characteristics

	All (n=291)
Characteristics	
Sex (male, n (%))	204 (70)
Age (median (IQR))	70 (64-75)
Living alone (n (%))	72 (25)
Pre-operative characteristics and comorbidity	
Chronic obstructive pulmonary disease (n (%))	40 (14)
EuroScore II (logistic) (median (IQR))	1.97 (1.11-3.37)
Estimated glomerular filtration rate ml/min. ^a (median (IQR))	75 (60-99)
Prior percutaneous coronary intervention (n (%))	23 (8)
Hypertension (n (%))	149 (48)
Family history of ischemic heart disease (n (%))	65 (21)
Prior cardiac surgery (n (%))	15 (5)
Permanent pacemaker prior to surgery (n (%))	9 (3)
Atrial fibrillation (n (%))	60 (21)
Diabetes ^b (n (%))	37 (13)
Ejection fraction $\leq 50\%$ (n (%))	83 (29)
NYHA class ≥ 3 (n (%))	92 (32)
Body Mass Index (median, (IQR))	26 (24-29)
Current or former smoker (n (%))	172 (59)
Alcohol intake above national recommendations (n (%))	35 (12)
Primary diagnosis, valve disorder, n (%)^c	
Aortic stenosis	181 (62)
Aortic regurgitation	55 (19)
Mitral stenosis or regurgitation	54 (19)
Patient management during hospitalization	

Type of valve procedure, (n (%))	
Aortic valve, biological	194 (67)
Aortic valve, mechanical	39 (13)
Aortic valve, repair	8 (3)
Mitral valve, replacement ^d	26 (9)
Mitral valve, repair	23 (8)
Concomitant CABG (n (%))	65 (22)
Re-operation (n (%))	25 (9)
New onset atrial fibrillation, postoperatively (n (%))	130 (45)
Length of stay (median (IQR))	9 (7-12)

^a Estimated glomerular filtration rate estimated by the Cockcroft-Gault Equation.

^b Patients with diabetes; insulin, per oral and non-pharmacological treatment.

^c One patient had tricuspid valve disease and are not shown in the table, but included in the analyses

^d Both biological and mechanical mitral valve replacement

NYHA (New York Heart Association), CABG (coronary artery bypass grafting)

Table 2. Patient-reported outcomes following heart valve surgery

<i>Instrument</i>	<i>Pre-operative</i>	<i>Discharge*</i>	<i>4 weeks after discharge</i>	<i>P†</i>
<i>Median (IQR)</i>				
<i>EQ-5D</i>				
Index score	0.79 (0.69-0.86)	0.74 (0.64-0.80)	0.79 (0.73-0.86)	<0.001
VAS score	70 (50-80)	65 (50-80)	75 (65-85)	<0.001
<i>KCCQ</i>				
<i>Physical limitation</i>	66.7 (50.0-83.3)	N/A	83.3 (64.6-91.7)	0.001
<i>Symptom frequency</i>	70.8 (58.3-85.4)	N/A	79.2 (66.7-91.7)	<0.001
<i>Quality of life</i>	37.5 (25.9-62.5)	N/A	75.0 (50.0-83.3)	<0.001
<i>Social limitation</i>	66.7 (41.7-83.3)	N/A	75.0 (50.0-83.3)	0.151
<i>Summary score</i>	61.5 (47.9-76.0)	N/A	75.0 (59.4-87.5)	<0.001

*Due to two-weeks recall of the KCCQ, only EQ-5D was completed at discharge

†Differences in median scores of three EQ-5D time point were tested with the Friedman test (paired). Differences in scores of the KCCQ were tested with the Wilcoxon signed-rank test (paired).

Table 3. Association between HRQoL and 180-days readmission

	Unadjusted HR (CI)	Adjusted HR (CI)*
<i>Pre-operative</i>		
EQ-5D		
Index score, worst quartile	1.05 (0.59;1.87)	1.04 (0.54;1.79)
VAS	1.00 (0.99;1.02)	1.01 (0.99;1.02)
KCCQ		
Summary score	1.01 (0.99;1.02)	1.01 (0.99;1.02)
<i>Discharge</i>		
EQ-5D		
Index score, worst quartile	0.85 (0.46;1.58)	0.79 (0.42;1.50)
VAS	1.00 (0.98;1.01)	1.00 (0.99;1.01)

The table shows the association between the scores of EQ-5D and KCCQ and risk of readmission.

All sub-scales of the KCCQ were tested, showing the same results

*Adjusted for sex, age, type of valve procedure, concomitant CABG, reduced lung function, prior PCI and GFR.

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Figure 1

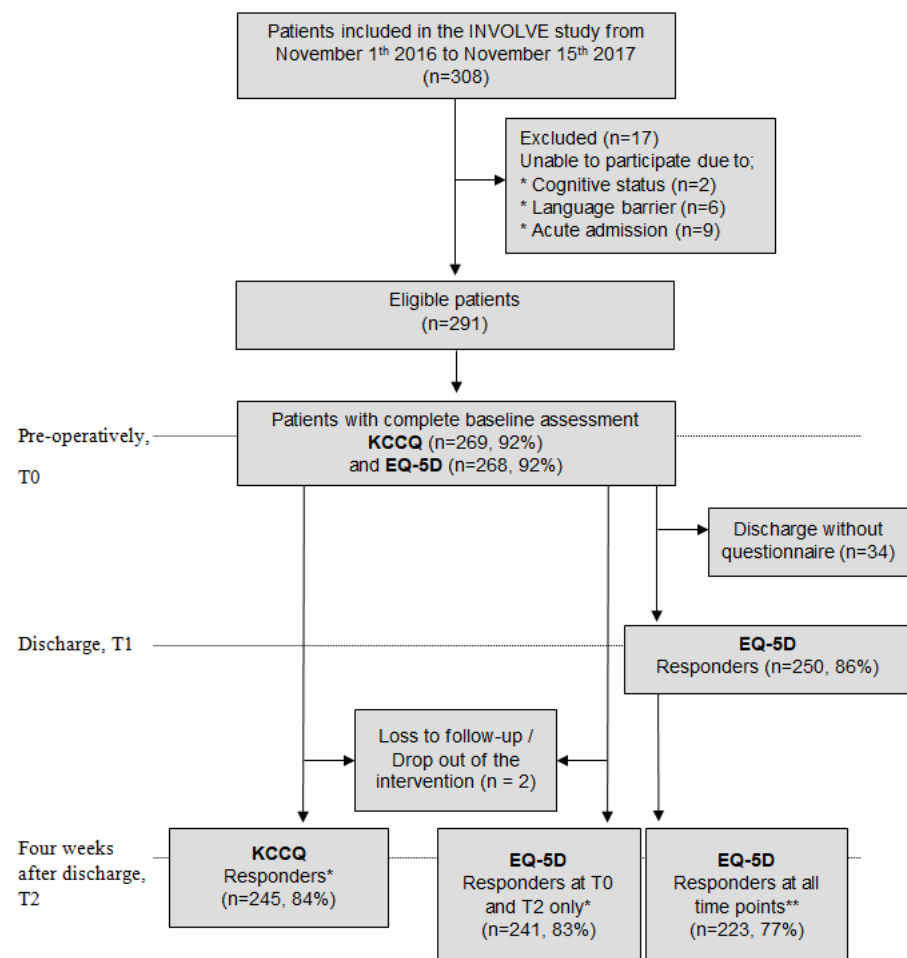


Figure 2

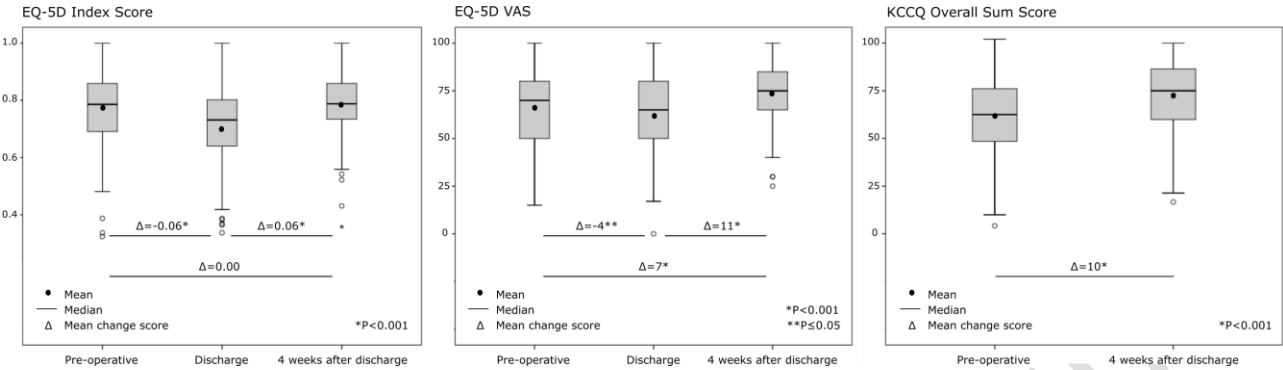


Figure 3

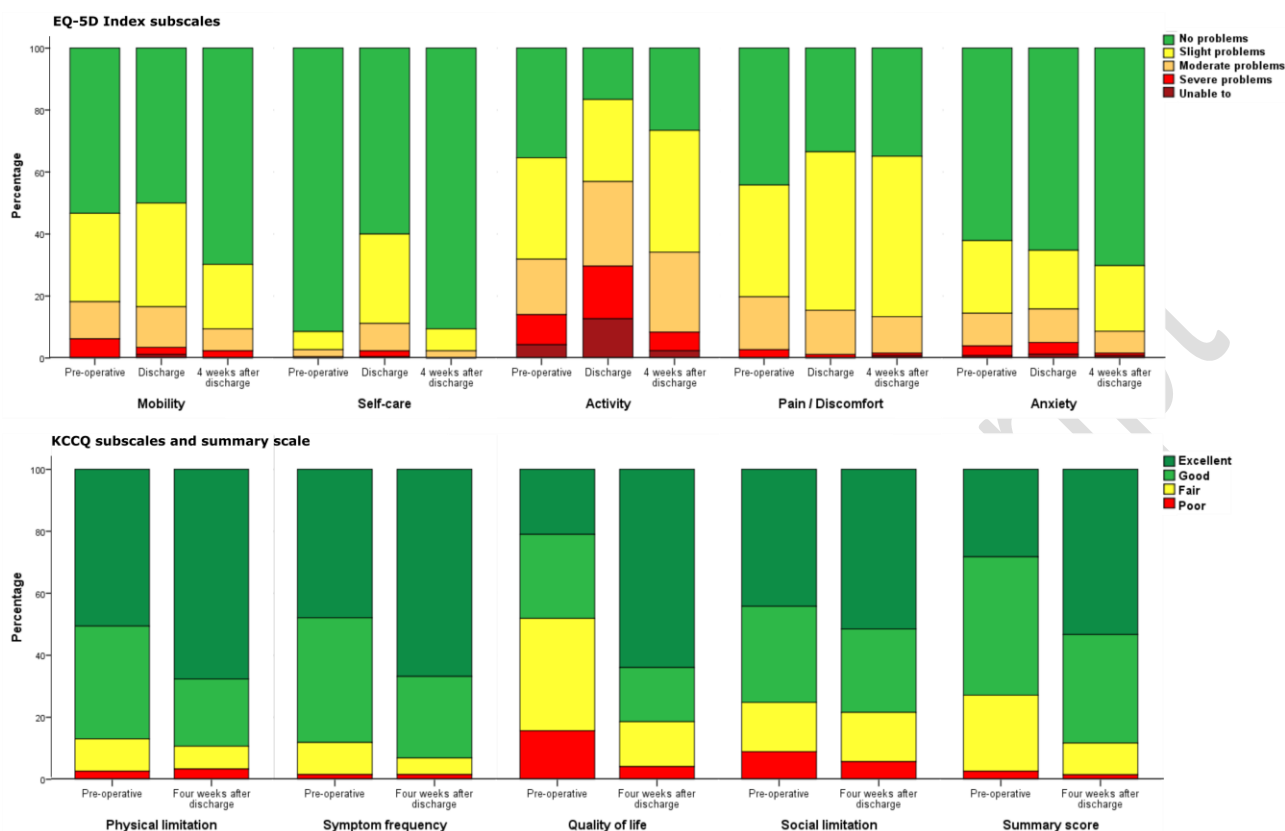


Figure 4

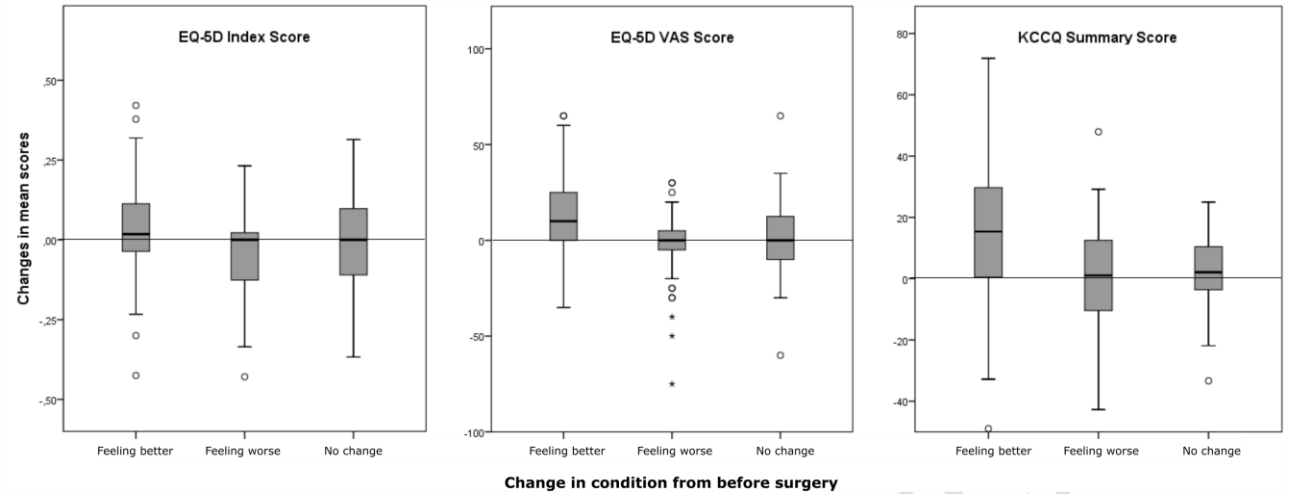
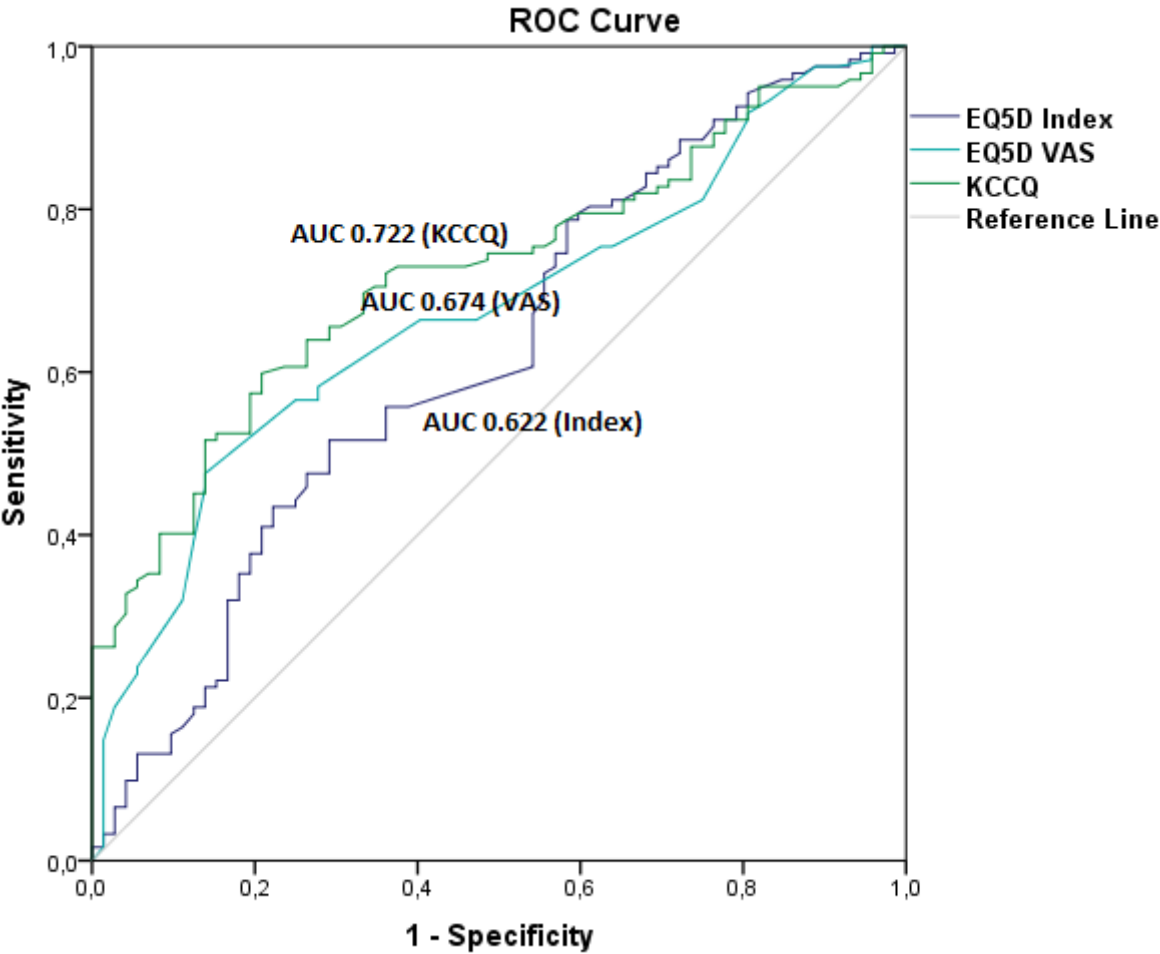


Figure 5



Supplementary table S1

	Formula	EQ-5D Index	EQ-5D VAS	KCCQ
		n	n	n
N		163	170	202
True positive, TP	-	73	93	111
False positive, FP	-	18	23	29
False negative, FN	-	49	33	35
True negative, TN	-	23	21	27
		Estimates	Estimates	Estimates
Sensitivity, Se	$TP / (TP+FN)$	0.60	0.74	0.76
Specificity, Sp	$TN / (TN+FP)$	0.56	0.48	0.48
Positive predictive value, PPV	$TP / (TP+FP)$	0.80	0.80	0.79
Negative predictive value, NPV	$TN / (TN+FN)$	0.32	0.39	0.44
Positive likelihood ratio, PLR	$Se / (1-Sp)$	1.36	1.41	1.47
Negative likelihood ratio, NLR	$(1-Se) / Sp$	0.72	0.55	0.50
Diagnostic Odds Ratio, DOR	PLR / NLR	1.90	2.57	2.95
Accuracy index, AI	$(TP+TN) / (TP+TN+FP+FN)$	0.59	0.67	0.68
Youdens index, YI	$Se + Sp - 1$	0.16	0.22	0.24

Patients with missing scores or patients experiencing similar outcomes as before surgery were not included in the calculation of the diagnostic accuracy measures