JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
VOL. 75, NO. 17, 2020

PUBLISHED BY ELSEVIER

ORIGINAL INVESTIGATIONS

# Health Status Changes and Outcomes in Patients With Heart Failure and Mitral Regurgitation

## COAPT Trial

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## ABSTRACT

**BACKGROUND** In the COAPT (Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients With Functional Mitral Regurgitation) trial, transcatheter mitral valve repair (TMVr) with the MitraClip rapidly improved health status and reduced the long-term risks for death and heart failure (HF) hospitalization in patients with HF and severe secondary mitral regurgitation who remained symptomatic despite maximally tolerated guideline-directed medical therapy (GDMT).

**OBJECTIVES** The aim of this study was to examine if early health status changes were associated with long-term clinical outcomes in the COAPT population.

**METHODS** The association between change in health status (Kansas City Cardiomyopathy Questionnaire overall summary score [KCCQ-OS]) from baseline to 1 month and the composite rate of death or HF hospitalization between 1 month and 2 years in the COAPT trial were evaluated, and whether treatment (TMVr or GDMT alone) modified this association was tested.

**RESULTS** Among 551 patients with HF and severe secondary mitral regurgitation who were alive at 1 month, those randomized to TMVr were more likely than those randomized to GDMT alone to achieve a ≥10-point improvement in KCCQ-OS from baseline to 1 month (TMVr, 58%; GDMT alone, 26%). Early improvement in KCCQ-OS was inversely associated with the risk for death or HF hospitalization between 1 month and 2 years ($p < 0.001$). When analyzed as a continuous variable, a 10-point increase in KCCQ-OS was associated with a 14% lower risk for death or HF hospitalization (hazard ratio: 0.86; 95% confidence interval: 0.81 to 0.92; $p < 0.001$), with no significant interaction with treatment group ($p_{interaction} = 0.17$). After adjusting for demographic and clinical factors, the association between change in KCCQ-OS and outcomes was strengthened (hazard ratio: 0.79; 95% confidence interval: 0.73 to 0.86; $p < 0.001$).

**CONCLUSIONS** In patients with HF and severe secondary mitral regurgitation, a short-term change in disease-specific health status was strongly associated with the subsequent long-term risk for death or HF hospitalization. These findings reinforce the prognostic utility of serial KCCQ-OS assessments to identify patients at risk for poor long-term clinical outcomes in this population. (Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients With Functional Mitral Regurgitation [The COAPT Trial]; NCT01626079)
(J Am Coll Cardiol 2020;75:2099–106) © 2020 by the American College of Cardiology Foundation.

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ISSN 0735-1097/$36.00
https://doi.org/10.1016/j.jacc.2020.03.002

**ABBREVIATIONS AND ACRONYMS**

**CI** = confidence interval

**GDMT** = guideline-directed medical therapy

**HF** = heart failure

**HR** = hazard ratio

**KCCQ** = Kansas City Cardiomyopathy Questionnaire

**KCCQ-OS** = Kansas City Cardiomyopathy Questionnaire overall summary score

**SMR** = secondary mitral regurgitation

**TMVr** = transcatheter mitral valve repair

In selected patients with heart failure (HF) and secondary mitral regurgitation (SMR), edge-to-edge transcatheter mitral valve repair (TMVr) provides substantial early and long-term benefits. The majority of patients experience rapid alleviation of symptoms, improvement in functional capacity, and improvement in quality of life, typically within days after TMVr (1,2), likely due at least in part to acute reduction in left atrial pressure and relief of pulmonary congestion. Over a somewhat longer time horizon, TMVr also reduces the risk for HF hospitalization (effect evident by ~3 months) and the risk for death (benefit evident by 1 to 2 years) (3), most likely as a result of ventricular remodeling (or prevention of further adverse ventricular remodeling) or other more gradual structural changes. Although improvement in health status, reduction in the risk for hospitalization, and improvement in survival are important patient-centered outcomes, it is also possible that these outcomes may be inter-related. For example, previous studies in patients with chronic HF have demonstrated that both current health status and changes in health status over time are associated with risk for subsequent mortality and HF hospitalization (4,5). Moreover, in patients with severe aortic stenosis undergoing transcatheter aortic valve replacement, poor baseline health status is a strong predictor of both 1-month (6) and 1-year mortality (7).

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In light of these findings, we hypothesized that in patients with HF and severe SMR, early changes in health status might be associated with the subsequent risk for adverse outcomes, including HF hospitalization or death. To evaluate this hypothesis, we examined the association between short-term changes in health status and the subsequent risk for HF hospitalization or death in patients enrolled in the COAPT (Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients with Functional Mitral Regurgitation) trial. Furthermore, we sought to examine whether there was a differential association between change in early health status and subsequent outcomes on the basis of treatment assignment (TMVr vs. standard care). If change in health status at 1 month was found to be an independent long-term prognostic factor, this knowledge would provide important information at the time of early follow-up. Identifying patients at high risk for poor outcomes at this time point could permit further efforts to improve long-term outcomes, such as referral for advanced HF therapies.

## METHODS

**STUDY DESIGN.** The design (8) and primary results (3) of the COAPT trial (NCT01626079), including the primary health status results (1), have been published previously. Briefly, COAPT was a multicenter, randomized, open-label trial of TMVr with the MitraClip device (Abbott, Santa Clara, California) in patients with HF with left ventricular ejection fractions between 20% and 50% and grade 3 to 4+ SMR who remained symptomatic despite maximally tolerated

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Manuscript received February 7, 2020; revised manuscript received February 28, 2020, accepted March 1, 2020.

guideline-directed medical therapy (GDMT). Patients were randomized 1:1 to TMVr plus GDMT or GDMT alone and followed through 2 years for clinical events and health status. The study was approved by the Institutional Review Board at each participating site, and all patients provided written informed consent.

**HEALTH STATUS.** HF-specific health status was evaluated at baseline and at 1, 6, 12, and 24 months from baseline using the Kansas City Cardiomyopathy Questionnaire (KCCQ) (9). The KCCQ consists of 23 questions that assess 5 domains of health status: physical limitation, symptoms, quality of life, social limitation, and self-efficacy; the first 4 domains are combined into an overall summary score (KCCQ-OS). Scores for the KCCQ-OS range from 0 to 100, with higher scores indicating better health status. Changes in KCCQ-OS of 5, 10, and 20 points correspond to small, moderate, and large clinical changes, respectively (10).

**STATISTICAL ANALYSIS.** The primary analysis examined the association between change in KCCQ-OS from baseline to 1 month and the subsequent risk for the composite of death or HF hospitalization between 1 month and 2 years. Because the analysis examined short-term changes in health status, only patients who survived 1 month and had a baseline and 1-month KCCQ were included. Patients were divided into cohorts on the basis of change in KCCQ-OS as follows: worse ($\Delta \leq -5$ points), no change ($\Delta > -5$ and $< 5$ points), small improvement ($\Delta \geq 5$ and $< 10$ points), moderate improvement ($\Delta \geq 10$ and $< 20$ points), and large improvement ($\Delta \geq 20$ points). To evaluate the association between change in KCCQ-OS and time to death or HF hospitalization, we constructed Kaplan-Meier curves (starting at 1 month) and compared groups using the log-rank test. We also calculated the sensitivity, specificity, positive predictive value, and negative predictive value for the association between a KCCQ-OS change of <10 points at 1-month and 2-year outcomes.

We then examined the association between change in KCCQ-OS (as a continuous variable) and time to death or HF hospitalization using Cox proportional hazards regression, first adjusted only for treatment assignment and then additionally adjusted for the following baseline measures: age, sex, ischemic cardiomyopathy, Society of Thoracic Surgeons predicted risk for mortality with mitral valve replacement, history of atrial fibrillation, left ventricular ejection fraction, chronic lung disease, prior stroke or transient ischemic attack, prior coronary artery bypass graft surgery, peripheral vascular disease, diabetes, creatinine clearance, left ventricular end-diastolic volume, pulmonary artery systolic pressure, moderate or greater tricuspid regurgitation, baseline brain natriuretic peptide level, and baseline KCCQ-OS. We tested whether the association between early (baseline to 1 month) change in KCCQ-OS and outcomes was nonlinear using penalized splines with 2 degrees of freedom (11) and also tested for an interaction between treatment assignment and change in KCCQ-OS. In secondary analyses we examined these relationships for the individual endpoints of death and HF hospitalization. For HF hospitalization, this association was analyzed with Fine and Gray subdistribution hazard models considering death as a competing risk. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, North Carolina) and R (R Foundation for Statistical Computing, Vienna, Austria), and statistical significance was defined as a 2-sided p value <0.05.

**TABLE 1 Patient Characteristics**

| | TMVr (n = 279) | GDMT (n = 272) | p Value |
|---|---|---|---|
| Age, yrs | 71.5 ± 11.9 | 72.3 ± 10.6 | 0.46 |
| Female | 33.7 (94/279) | 37.9 (103/272) | 0.31 |
| White | 74.2 (207/279) | 72.8 (198/272) | 0.71 |
| Body mass index, kg/m$^2$ | 27.2 ± 5.8 | 27.2 ± 6.0 | 0.99 |
| Ischemic cardiomyopathy | 60.9 (170/279) | 59.9 (163/272) | 0.81 |
| Coronary artery disease | 72.0 (201/279) | 72.1 (196/272) | 1.00 |
| Prior myocardial infarction | 50.9 (142/279) | 50.4 (137/272) | 0.90 |
| Prior CABG surgery | 39.4 (110/279) | 39.7 (108/272) | 0.95 |
| Peripheral vascular disease | 16.5 (46/279) | 18.0 (49/272) | 0.64 |
| Prior stroke | 11.5 (32/279) | 11.4 (31/272) | 0.98 |
| Atrial fibrillation | 55.2 (154/279) | 51.1 (139/272) | 0.34 |
| Diabetes mellitus | 34.8 (97/279) | 39.3 (107/272) | 0.27 |
| Creatinine clearance, ml/min | 52.3 ± 28.3 | 48.4 ± 25.4 | 0.09 |
| Chronic lung disease | 22.2 (62/279) | 22.1 (60/272) | 0.96 |
| Home oxygen | 3.6 (10/279) | 2.9 (8/272) | 0.67 |
| Prior pacemaker | 7.5 (21/279) | 9.6 (26/272) | 0.39 |
| STS replacement score, % | 7.4 ± 4.9 | 8.1 ± 5.9 | 0.10 |
| Ejection fraction, % | 31.3 ± 9.1 | 31.1 ± 9.6 | 0.77 |
| Left ventricular end-diastolic volume, ml | 195.4 ± 70.6 | 194.4 ± 72.3 | 0.87 |
| Pulmonary artery systolic pressure, mm Hg | 43.7 ± 13.6 | 44.4 ± 14.0 | 0.57 |
| Tricuspid regurgitation, moderate or greater | 13.0 (36/276) | 15.0 (39/260) | |
| Baseline KCCQ-OS | 54.0 ± 22.6 | 52.5 ± 23.1 | 0.44 |
| 30-day KCCQ-OS | 70.9 ± 21.1 | 54.6 ± 24.7 | <0.001 |

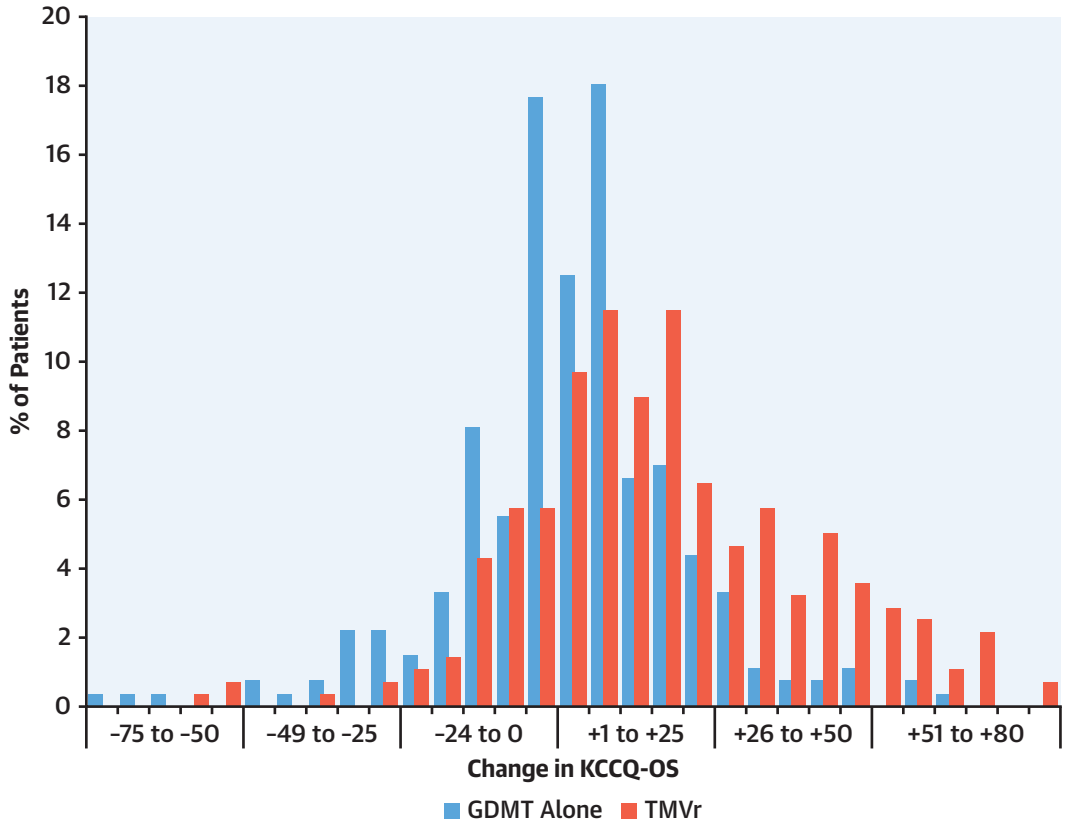
Values are mean ± SD or % (n/N).

CABG = coronary artery bypass grafting; GDMT = guideline-directed medical therapy; KCCQ-OS = Kansas City Cardiomyopathy Questionnaire overall summary score; STS = Society of Thoracic Surgeons; TMVr = transcatheter mitral valve repair.

## RESULTS

**PATIENT POPULATION.** Among 614 patients with HF and grade 3 to 4+ SMR enrolled in COAPT at 78 centers in the United States and Canada, 10 patients died

**FIGURE 1** Distribution of Change in KCCQ-OS at 1 Month Stratified by Treatment Group

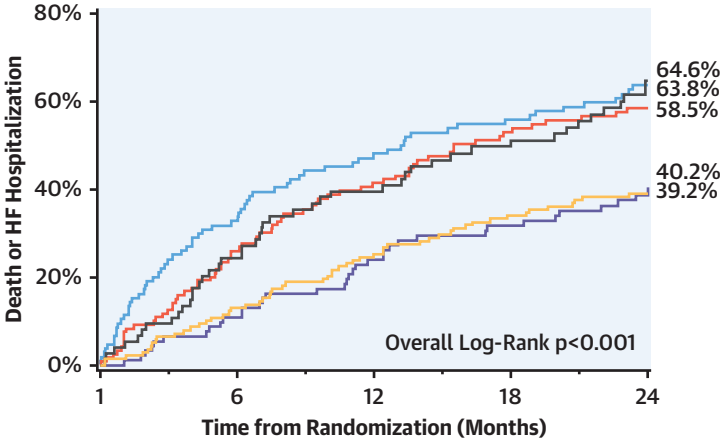



**Red bars** indicate patients randomized to transcatheter mitral valve repair (TMVr); **blue bars** indicate patients randomized to guideline-directed medical therapy (GDMT) alone. Worse, Δ ≤−5 points; no change, Δ >−5 and <5 points; small improvement, Δ ≥5 and <10 points; moderate improvement, Δ ≥10 and <20 points; large improvement, Δ ≥20 points. KCCQ-OS = Kansas City Cardiomyopathy Questionnaire overall summary score.

within 1 month, 5 patients withdrew from the study, and 48 patients did not provide health status data either at baseline or at 1-month follow-up. As such, our analytic cohort included 551 patients who survived 1 month and completed the KCCQ at baseline and 1 month (median follow-up 24.7 months; interquartile range: 14.4 to 36.5 months), of whom 50.6% were randomized to TMVr. The mean age was 71.9 ± 11.3 years, 35.8% were women, and the mean left ventricular ejection fraction was 31 ± 9%. Baseline characteristics were well matched between the TMVr and GDMT-only groups (Table 1).

**UNADJUSTED ASSOCIATION OF KCCQ-OS WITH OUTCOMES.** In the overall population, mean KCCQ-OS was 53.2 ± 22.8 at baseline and improved to 62.8 ± 24.3 at 1 month, with higher mean KCCQ-OS in the TMVr group (TMVr vs. GDMT alone, 70.9 ± 21.1 vs. 54.6 ± 24.7; $p < 0.001$). Although there was a broad distribution of changes in early KCCQ-OS in both groups, patients randomized to TMVr generally reported greater improvement in health status compared with those randomized to GDMT alone (Figure 1). At 1 month, 111 patients had worse health status (41 TMVr, 70 GDMT alone), 125 were unchanged (43 TMVr, 82 GDMT alone), 81 had small improvements (32 TMVr, 49 GDMT alone), 94 had moderate improvements (57 TMVr, 37 GDMT alone), and 140 had large improvements (106 TMVr, 34 GDMT alone). At least moderate improvement in health status at 1 month was reported by 58.4% of patients randomized to TMVr versus 26.1% of those

**CENTRAL ILLUSTRATION** **Kaplan-Meier Cumulative Event Curves for Death or Heart Failure Hospitalization**




*Number at risk:*

| | | | | | |
|---|---|---|---|---|---|
| Worse | 111 | 70 | 54 | 45 | 33 |
| No Change | 125 | 88 | 67 | 52 | 44 |
| Small | 81 | 56 | 42 | 34 | 23 |
| Moderate | 94 | 82 | 68 | 60 | 48 |
| Large | 140 | 120 | 104 | 91 | 78 |

Worse (KCCQ change ≤5)
No Change (>-5 and <5)
Small Improvement (≥5 and <10)
Moderate Improvement (≥10 and <20)
Large Improvement (≥20)

**Arnold, S.V. et al. J Am Coll Cardiol. 2020;75(17):2099–106.**

Groups were defined on the basis of change in Kansas City Cardiomyopathy Questionnaire overall summary score (KCCQ) from baseline to 1 month using established thresholds for clinically important changes (10). HF = heart failure.

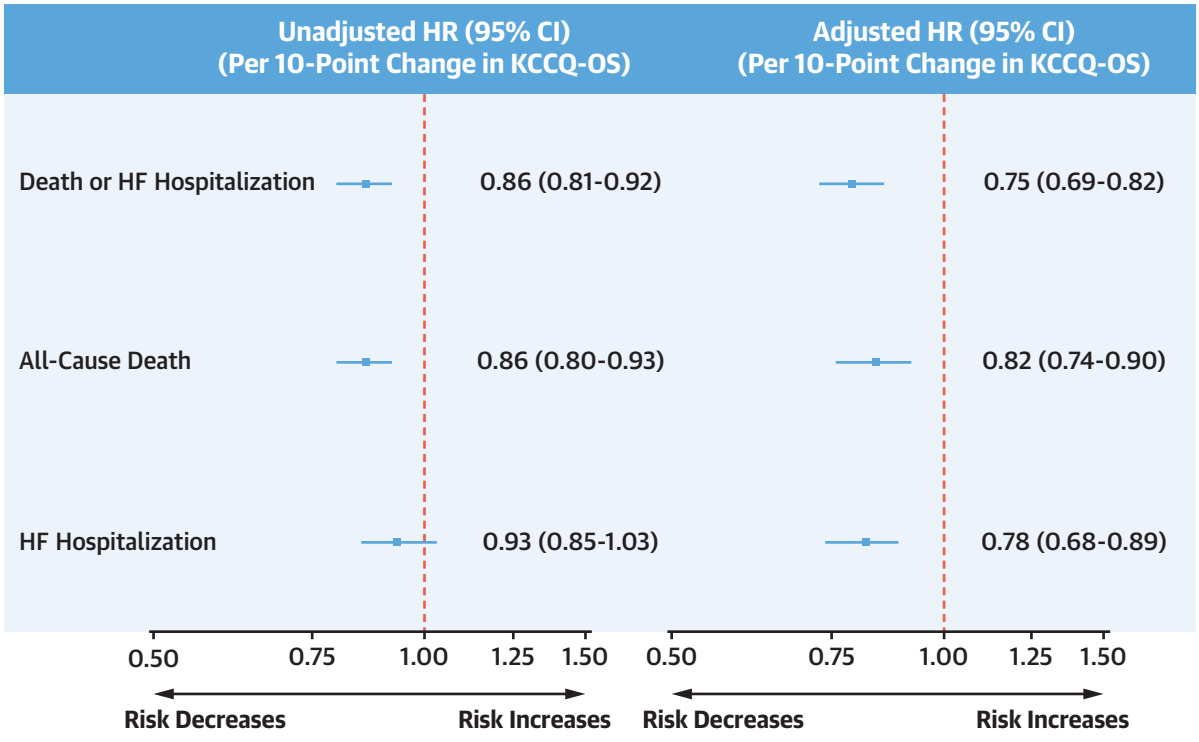
randomized to GDMT alone. Patients with moderate and large improvements in health status at 1 month had significantly lower rates of composite death or HF hospitalization between 1 month and 2 years (40.2% and 39.2%, respectively) compared with those with small improvements (64.6%), no change (58.5%), and worse health status (63.8%) (log-rank $p < 0.001$) (**Central Illustration**). A change in KCCQ-OS of <10 points had a positive predictive valve of 63% for death or HF hospitalization at 2 years and a negative predictive value of 60% (Supplemental Table 1). Similar results were observed for death and HF hospitalization outcomes alone (Supplemental Figure 1).

**ADJUSTED ASSOCIATION OF KCCQ-OS WITH OUTCOMES.** In the proportional hazards model that also included treatment assignment, every 10-point increase in KCCQ-OS from baseline to 1 month was associated with a 14% lower hazard of death or HF hospitalization during follow-up (hazard ratio [HR]: 0.86; 95% confidence interval [CI]: 0.81 to 0.92; $p < 0.001$). The association between change in KCCQ-OS and outcomes was statistically linear (cubic spline $p = 0.85$) (Supplemental Figure 2) and did not differ by treatment assignment ($p_{interaction} = 0.17$). After adjusting for multiple demographic and clinical factors, the association between the change in KCCQ-OS and subsequent outcomes was strengthened (adjusted HR: 0.75; 95% CI: 0.69 to 0.82; $p < 0.001$) (**Figure 2**, Supplemental Table 2). Consistent results were observed for death and HF hospitalization outcomes alone (**Figure 2**, Supplemental Table 2).

## DISCUSSION

In the COAPT trial of patients with HF and severe SMR, we found that short-term change in disease-specific health status was strongly and inversely associated with the subsequent long-term risk for death or HF hospitalization (**Central Illustration**). This association was independent of patient factors as well as treatment assignment, although patients

**FIGURE 2** Association of Change in KCCQ-OS at 1 Month With 2-Year Outcomes




The unadjusted model is adjusted only for treatment assignment, while the adjusted model includes patient demographic and clinical factors (see Methods section for details). Cox proportional hazards regression was used for the combined outcome of death or heart failure hospitalization and for all-cause death. Fine and Gray subdistribution hazard models were used for heart failure hospitalization (with death as a competing risk). Change in Kansas City Cardiomyopathy Questionnaire overall summary score (KCCQ-OS) is scale per 10 points. **Blue dots/lines** represent the hazard ratios/confidence intervals. **Dashed red line** indicates a hazard ratio of 1, where points to the left of the line indicate lower risk and points to the right indicate higher risk.
CI = confidence interval; HF = heart failure; HR = hazard ratio.

randomized to TMVr were far more likely to demonstrate at least moderate improvement in health status at 1 month. For a procedure that may result in early health status benefits as well as later improvements in clinical outcomes, it is useful to know that those patients with early improvement in health status are also more likely to derive long-term clinical benefits. Conversely, by identifying TMVr nonresponders at an early time point, 1-month change in the KCCQ-OS can identify a subset of patients who are at relatively high risk for poor long-term clinical outcomes. This knowledge could not only inform discussions about prognosis with the patient and their family but could also trigger consideration of other advanced HF therapies, such as left ventricular assist device placement or cardiac transplantation.

**PRIOR STUDIES.** Several previous studies in patients with chronic HF have shown that short-term changes in disease-specific health status are associated with long-term outcomes. In patients with HF after myocardial infarction, change in KCCQ-OS from 1 to 3 months after the index hospitalization was inversely associated with all-cause mortality (HR per 5-point decrease: 1.11; 95% CI: 1.04 to 1.19) as well as the combined outcome of cardiovascular mortality or hospitalization (HR per 5-point decrease: 1.12; 95% CI: 1.07 to 1.18) over a mean follow-up duration of 14 months (4). In a combined analysis of the TOPCAT (Aldosterone Antagonist Therapy for Adults With Heart Failure and Preserved Systolic Function) and HF-ACTION (Exercise Training Program to Improve Clinical Outcomes in Individuals With Congestive Heart Failure) trials, an increase (improvement) in KCCQ-OS between 2 follow-up visits (from 4 to 12 months for TOPCAT and from 3 to 6 months for HF-ACTION) was associated with a lower risk for subsequent cardiovascular death or HF hospitalization over follow-up of about 3 years, regardless of whether the patient had HF with preserved or reduced ejection

fraction (5). Finally, in a substudy of the HF-ACTION trial, increases in KCCQ-OS up to 8 points at 3 months after initiation of an exercise program were associated with reduced risk for all-cause mortality or hospitalization over follow-up of about 3 years, but larger improvements in health status were not associated with additional risk reduction (12). Our study adds substantially to the prior research by quantifying the association of KCCQ-OS with outcomes after TMVr and by identifying an early time period at which assessment using the KCCQ can be particularly actionable.

**CLINICAL IMPLICATIONS.** The fact that an early change in the KCCQ-OS was strongly associated with subsequent clinical outcomes suggests that the KCCQ-OS may be considered not only an important patient-centered outcome for patients with HF and severe SMR but also a valuable signal for guiding therapy. In particular, given the lack of validated predictors of benefit from TMVr, the use of a readily obtainable and inexpensive marker of early response to therapy to guide additional therapeutic optimization could be a particularly powerful strategy to improve outcomes. For example, these data (and the overall results of COAPT) suggest that for patients with HF and severe SMR, the first step should be medical optimization. If the clinical response (as measured using the KCCQ) is not sufficient (or durable) and the patient has appropriate anatomy, the next step should be TMVr. If this does not result in significant improvement in the KCCQ, consideration may then be given to advanced HF therapies or, if the patient is not a candidate for these approaches, palliative care. However, despite the intuitive appeal of this proposed care pathway, further study is necessary to validate this approach.

**STUDY LIMITATIONS.** First, although the association between change in KCCQ-OS and outcomes was statistically linear and the distribution of change in KCCQ-OS was fairly broad, only 20% of patients had a clinically meaningful decline in KCCQ-OS, which limited our power to examine this association over the full range of response.

Second, COAPT included patients with HF and severe SMR, so it is unknown whether these findings generalize to patients with primary (i.e., degenerative) mitral regurgitation or those with HF and lesser degrees of MR.

Finally, we did not consider other potential markers of improvement (e.g., reduction in mitral regurgitation, left ventricular remodeling, left atrial pressure) because these analyses were beyond the scope of our study. Future studies should examine how these mechanistic data can be used to supplement the predictive insights from the KCCQ.

## CONCLUSIONS

In a large multicenter cohort of patients with symptomatic HF and severe SMR, we found that short-term changes in disease-specific health status were strongly and inversely associated with the subsequent risk for death or HF hospitalization. Although patients treated with TMVr were far more likely to experience moderate or large improvements in short-term health status, the association of these benefits with long-term outcomes did not differ by treatment assignment. These data suggest that serial assessments of health status in patients with HF and severe SMR, particularly around times of medical intensification or interventional therapy, may be beneficial to identify patients with a potentially improved prognosis or, conversely, those who remain at high risk for poor outcomes. Future studies are warranted to validate this concept and to determine how to best use these short-term health status data to inform subsequent treatment decisions so as to optimize patient outcomes.

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## PERSPECTIVES

**COMPETENCY IN PATIENT CARE AND PROCEDURAL SKILLS:** In patients with HF and severe SMR, short-term changes in symptoms, functional status, and quality of life are associated with longer-term risks of death or HF hospitalization. Patients undergoing TMVr more often experience improvement in short-term health status, and this is associated with lower risks of adverse outcomes during long-term follow-up.

**TRANSLATIONAL OUTLOOK:** Future studies should focus on short-term interventions for HF that can optimize outcomes after TMVr.

## REFERENCES

**1.** Arnold SV, Chinnakondepalli KM, Spertus JA, et al. Health status after transcatheter mitral-valve repair in heart failure and secondary mitral regurgitation: COAPT trial. J Am Coll Cardiol 2019;73:2123–32.

**2.** Arnold SV, Li Z, Vemulapalli S, et al. Association of transcatheter mitral valve repair with quality of life outcomes at 30 days and 1 year: analysis of the transcatheter valve therapy registry. JAMA Cardiol 2018;3:1151–9.

**3.** Stone GW, Lindenfeld J, Abraham WT, et al. Transcatheter mitral-valve repair in patients with heart failure. N Engl J Med 2018;379:2307–18.

**4.** Kosiborod M, Soto GE, Jones PG, et al. Identifying heart failure patients at high risk for near-term cardiovascular events with serial health status assessments. Circulation 2007;115:1975–81.

**5.** Pokharel Y, Khariton Y, Tang Y, et al. Association of serial Kansas City Cardiomyopathy Questionnaire assessments with death and hospitalization in patients with heart failure with preserved and reduced ejection fraction: a secondary analysis of 2 randomized clinical trials. JAMA Cardiol 2017;2:1315–21.

**6.** Arnold SV, O'Brien SM, Vemulapalli S, et al. Inclusion of functional status measures in the risk adjustment of 30-day mortality after transcatheter aortic valve replacement: a report from the Society of Thoracic Surgeons/American College of Cardiology TVT Registry. J Am Coll Cardiol Intv 2018;11:581–9.

**7.** Arnold SV, Spertus JA, Vemulapalli S, et al. Association of patient-reported health status with long-term mortality after transcatheter aortic valve replacement: report from the STS/ACC TVT Registry. Circ Cardiovasc Interv 2015;8:e002875.

**8.** Mack MJ, Abraham WT, Lindenfeld J, et al. Cardiovascular outcomes assessment of the MitraClip in patients with heart failure and secondary mitral regurgitation: design and rationale of the COAPT trial. Am Heart J 2018;205:1–11.

**9.** Green CP, Porter CB, Bresnahan DR, Spertus JA. Development and evaluation of the Kansas City Cardiomyopathy Questionnaire: a new health status measure for heart failure. J Am Coll Cardiol 2000;35:1245–55.

**10.** Spertus J, Peterson E, Conard MW, et al. Monitoring clinical changes in patients with heart failure: a comparison of methods. Am Heart J 2005;150:707–15.

**11.** Eilers PHC, Marx BD. Flexible smoothing with B-splines and penalties. Statist Sci 1996;11:89–121.

**12.** Luo N, O'Connor CM, Cooper LB, et al. Relationship between changing patient-reported outcomes and subsequent clinical events in patients with chronic heart failure: insights from HF-ACTION. Eur J Heart Fail 2019;21:63–70.

**KEY WORDS** health status, heart failure, mitral regurgitation, mitral valve, mitral valve repair, randomized clinical trial

**APPENDIX** For supplemental tables and figures, please see the online version of this paper.