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ORIGINAL RESEARCH

STRUCTURAL

Applying the 2025 ESC/EACTS Recommendations for the Treatment of Severe Tricuspid Regurgitation to Real-World Practice

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ABBREVIATIONS AND ACRONYMS

EACTS = European Association for Cardio-Thoracic Surgery

ESC = European Society of Cardiology

HF = heart failure

HFH = heart failure hospitalization

LV = left ventricular

LVD = left ventricular dysfunction

OMT = optimal medical therapy

RV = right ventricular

RVD = right ventricular dysfunction

TR = tricuspid regurgitation

T-TEER = tricuspid valve transcatheter edge-to-edge repair

TTVI = tricuspid valve transcatheter intervention

ABSTRACT

BACKGROUND According to the 2025 ESC/EACTS guidelines for the management of valvular heart disease, transcatheter tricuspid valve interventions (TTVI) have received a Class IIa recommendation (Level of Evidence: A) for the treatment of patients with severe symptomatic tricuspid regurgitation. However, in patients with severe left ventricular dysfunction (LVD) or right ventricular dysfunction (RVD) or precapillary pulmonary hypertension (pcPH), optimal medical therapy (OMT) is preferred because of the potential risk for futility.

OBJECTIVES The aim of this study was to evaluate clinical and symptomatic outcomes in such "OMT candidate" patients.

METHODS Using data from EuroTR (European Registry of Transcatheter Repair for Tricuspid Regurgitation), guideline-based thresholds for LVD, RVD, and pcPH were applied to patients undergoing tricuspid valve transcatheter edge-to-edge repair (T-TEER). Patients meeting ≥1 exclusion criterion ("OMT candidates") were compared with those meeting current recommendations ("TTVI appropriate") regarding NYHA functional class improvement and 2-year survival free from heart failure hospitalization (HFH).

RESULTS Among 1,626 T-TEER patients, 213 (13.1%) met ≥1 exclusion criterion (4.2% of those with LVD, 6.8% of those with RVD, and 3.6% of those with pcPH). Severe LVD, RVD, and pcPH were each associated with significantly lower 1-year HFH-free survival (LVD, 54.6% vs 72.9% [$P < 0.001$]; RVD, 59.0% vs 73.2% [$P = 0.003$]; pcPH, 56.2% vs 73.4% [$P = 0.021$]; median survival follow-up 446 days [Q1-Q3: 192-805 days]). Despite higher NYHA functional class at baseline and follow-up, the rate of ≥1-class improvement was comparable across subgroups (LVD, 51.1% vs 59.4% [$P = 0.25$]; RVD, 59.7% vs 59.0% [$P = 0.90$]; pcPH, 51.3% vs 59.4% [$P = 0.31$]). Overall, "OMT candidates" had lower HFH-free survival than "TTVI-appropriate" patients (58.7% vs 74.3%; $P < 0.001$) but showed comparable symptomatic relief (≥1 NYHA functional class in 56.2% vs 59.5%; $P = 0.68$).

CONCLUSIONS T-TEER may provide symptomatic benefit in selected high-risk patients with severe LVD, RVD, or pcPH. In the absence of randomized evidence, multidisciplinary evaluation at experienced heart valve centers remains essential to balance potential benefit against procedural futility. Further studies are warranted to refine patient selection and optimize outcomes in this challenging cohort.

Over the past decade, the transcatheter treatment of tricuspid regurgitation (TR) has advanced substantially. On the basis of 3 randomized controlled trials and several large registries,[1-7] tricuspid valve transcatheter interventions (TTVI) have received a Class IIa recommendation (Level of Evidence: A) for the treatment of patients with severe symptomatic TR in the new 2025 European Society of Cardiology (ESC)/ Europen Association for Cardio-Thoracic Surgery (EACTS) valvular guidelines, irrespective of the technique used (repair or replacement).[8] On the basis of the severity of TR, symptomatic burden, comorbidities, and echocardiographic and hemodynamic parameters, the guidelines provide dedicated treatment recommendations (surgical, transcatheter, or conservative).

Key determinants for treatment allocation include severe left ventricular (LV) or right ventricular (RV) dysfunction and severe precapillary pulmonary

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hypertension (pcPH). Given the limited evidence supporting transcatheter interventions in the presence of 1 or more of these criteria and few reports of limited effect in patients with heart failure (HF) with reduced ejection fraction,[9,10] the guidelines prefer optimal medical therapy (OMT) in this subgroup of patients to avoid possible futility.

Accordingly, in the present retrospective analysis we investigated survival and symptomatic alleviation in patients who would be classified "TTVI appropriate" or "OMT candidates" according to the new treatment algorithm.[8]

METHODS

STUDY COHORT AND VARIABLES. Using data from EuroTR (European Registry of Transcatheter Repair for Tricuspid Regurgitation; NCT06307262), we applied the aforementioned guideline criteria to patients who underwent tricuspid valve transcatheter edge-to-edge repair (T-TEER) under real-world conditions. Severe LV dysfunction (LVD) was defined as LV ejection fraction < 30%. Severe RV dysfunction (RVD) was present if 1 of the 3 following criteria was met in hierarchical order: transthoracic echocardiography-derived: 1) 3-dimensional RV ejection fraction <35%; 2) RV fractional area change ≤22%; or 3) tricuspid annular plane systolic excursion <10 mm. Severe pcPH was defined by a mean pulmonary artery pressure of >35 mm Hg in the presence of pulmonary vascular resistance >5 WU.[8] As previously described, right heart catheterization was performed prior to T-TEER after optimized medical recompensation in an euvolemic state as judged by each center.[11,12] "OMT candidates" were defined by the presence of at least 1 factor: LVD, RVD, or pcPH. Patients with missing information regarding LVD, RVD, or pcPH were excluded from this study. This study was performed in line with the principles outlined in the Declaration of Helsinki and received proper ethical oversight.

The primary endpoint was a composite of 1-year mortality, HF hospitalization (HFH), or persistent relevant exertional dyspnea as expressed by NYHA functional class ≥III at 1-year follow-up. Secondary endpoints included 1-year survival free from HFH and improvement in NYHA functional class by at least 1 grade.

STATISTICAL ANALYSIS. All data are expressed as mean ± SD. Two-year survival rates free from HFH were depicted using Kaplan-Meier charts. The statistical significance of survival differences was assessed using the log-rank test. Differences between 2 independent samples were evaluated using the Mann-Whitney *U* test or the chi-square test as appropriate. The primary endpoint was adjusted using a multivariable logistic regression model including all parameters with $P < 0.005$ in a univariable analysis. Results of the secondary endpoints were stratified by the presence of severe LVD, RVD, and pcPH. Missing data were assessed using a missing-completely-at-random test, suggesting that the assumption of missing completely at random was not met ($P < 0.05$). A 2-sided *P* value of <0.05 was considered to indicate statistical significance. All analyses were performed using R version 4.0.4 (R Foundation for Statistical Computing) and SPSS version 25 (IBM).

RESULTS

BASELINE CHARACTERISTICS AND OVERALL RESULTS. A total of 1,626 patients were included, all with available data on LV and RV function and pulmonary hemodynamic Status (median age 80 years; Q1-Q3: 76-83 years; 54.1% women). Baseline characteristics are summarized in Table 1. TR was graded as severe in 45.1%, massive in 31.8%, and torrential in 21.0% of patients.

Sixty-eight patients (4.2%) presented with severe LVD, with a median LV ejection fraction of 25% (Q1-Q3: 20%-26%). Measures of RV function suggested severe RVD in 110 patients (6.8%), with a median 3-dimensional RV ejection fraction of 29% (Q1-Q3: 27%-32%), median RV fractional area change of 21% (Q1-Q3: 18%-36%), and median tricuspid annular plane systolic excursion of 15 mm (Q1-Q3: 9-18 mm). Severe pcPH was present in 58 patients (3.6%), with median mean pulmonary artery pressure and pulmonary vascular resistance of 41 mm Hg (Q1-Q3: 38-48 mm Hg) and 7.3 WU (Q1-Q3: 5.4-7.4 WU), respectively. At least 1 criterion (LVD, RVD, or pcPH) was met in 213 of EuroTR patients (13.1%), defining the "OMT candidates" within the study cohort. Among those, only 22 patients (1.4%) presented with more than 1 criterion.

Following T-TEER, TR was significantly reduced to ≤1+ in 48.1% and ≤2+ in 81.9% of patients, with good durability at 1-year follow-up (≤1+ in 31.5% and ≤2+ in 71.8%). Table 2 outlines procedural characteristics.

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TABLE 1 Baseline Characteristics

	Entire Cohort (N = 1,626)	OMT Candidates (n = 213)	TTVI Appropriate (n = 1,413)	*P* Value	Data Available (n)
Age, y	80 (76-83)	78 (73-82)	80 (76-83)	<0.001	1,620
Female	858 (52.8)	102 (47.9)	756 (53.3)	0.126	1,626
Edema	1,047 (65.3)	151 (72.2)	896 (64.3)	0.024	1,603
Ascites	227 (15.0)	45 (22.0)	182 (13.9)	0.003	1,510
eGFR, mL/min	45 (32-61)	39 (30-56)	46 (33-62)	0.001	1,342
Loop diuretic	1,506 (93.1)	201 (94.4)	1,305 (92.9)	0.427	1,618
AF/atrial flutter	1,476 (90.8)	190 (89.2)	1,286 (91.0)	0.395	1,626
Dyslipidemia	764 (49.8)	90 (44.6)	647 (50.0)	0.112	1,535
CAD	713 (43.8)	113 (53.1)	600 (42.5)	0.004	1,626
AHT	1,318 (83.9)	169 (82.0)	1,149 (84.2)	0.437	1,571
Stroke/TIA	138 (11.5)	28 (16.0)	110 (10.8)	0.046	1,195
Diabetes mellitus	389 (24.8)	64 (31.1)	325 (23.8)	0.025	1,569
COPD	286 (17.6)	45 (21.1)	241 (17.1)	0.146	1,511
TR vena contracta, mm	10 (8-14)	11 (8-14)	10 (8-14)	0.957	1,488
TR EROA, mm^2	60 (41-88)	56 (41-76)	60 (41-80)	0.256	1,442
TR RegVol, mL	49 (37-65)	50 (37-64)	48 (37-65)	0.895	1,332
LVEF, %	55 (47-60)	45 (27-56)	55 (49-60)	<0.001	1,626
LVEDD, mm	48 (43-53)	52 (46-61)	47 (43-52)	<0.001	1,474
TAPSE, mm	17 (14-20)	15 (12-18)	17 (14-20)	<0.001	1,598
RV FAC, %	38 (31-46)	30 (20-40)	39 (32-45)	<0.001	944
3D RVEF, %	46 (40-51)	33 (29-40)	47 (42-52)	<0.001	352
RA area, mm^2	34 (28-42)	34 (28-42)	34 (28-42)	0.646	1,320
Echocardiographic sPAP, mm Hg	41 (32-51)	43 (34-55)	41 (31-51)	0.044	1,626
sPAP, mm Hg	43 (35-54)	50 (38-63)	42 (35-52)	<0.001	1,529
dPAP, mm Hg	18 (13-24)	23 (18-29)	17 (13-22)	<0.001	1,469
mPAP, mm Hg	28 (22-35)	35 (26-40)	27 (22-34)	<0.001	1,626
PVR, WU	2.4 (1.7-3.6)	3.8 (2.0-6.0)	2.3 (1.6-3.3)	<0.001	781
M-TEER	126 (7.7)	27 (12.7)	99 (7.0)	0.004	1,626
MR severity				0.112	1,602
0+	117 (7.3)	14 (6.7)	103 (7.4)		
1+	1,013 (63.2)	126 (60.3)	887 (63.7)		
2+	350 (21.8)	42 (20.1)	308 (22.1)		
3+	95 (5.9)	19 (9.1)	76 (5.5)		
4+	27 (1.7)	8 (3.8)	19 (1.4)		
TR severity				0.496	1,622
2+	35 (2.2)	11 (5.2)	24 (1.7)		
3+	731 (75.1)	91 (42.7)	640 (45.4)		
4+	516 (31.8)	68 (31.9)	448 (31.8)		
5+	340 (21.0)	43 (20.2)	297 (21.1)		
NYHA functional class				0.002	1,038
I	9 (0.9)	2 (1.4)	7 (0.8)		
II	139 (13.4)	12 (8.2)	127 (14.2)		
III	733 (70.6)	98 (67.1)	635 (71.2)		
IV	157 (15.1)	34 (23.3)	123 (13.8)		

Values are median (Q1-Q3) or n (%).

3D = 3-dimensional; AF = atrial fibrillation; AHT = arterial hypertension; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; dPAP = diastolic pulmonary artery pressure; eGFR = estimated glomerular filtration rate; EROA = effective regurgitant orifice area; FAC = fractional area change; LVEF = left ventricular ejection fraction; LVEDD = left ventricular end-diastolic volume; mPAP = mean pulmonary artery pressure; MR = mitral regurgitation; M-TEER = mitral transcatheter edge-to-edge repair; OMT = optimal medical therapy; PVR = pulmonary vascular resistance; RA = right atrial; RegVol = regurgitant volume; RV = right ventricular; RVEF = right ventricular ejection fraction; sPAP = systolic pulmonary artery pressure; TAPSE = tricuspid annular plane systolic excursion; TIA = transient ischemic attack; TR = tricuspid regurgitation; TTVI =transcatheter tricuspid valve intervention.

COMPOSITE ENDPOINT OF 1-YEAR MORTALITY, HFH, AND PERSISTENT DYSPNEA. Overall, the primary composite endpoint of 1-year mortality, HFH, or persistent dyspnea, defined as NYHA functional class ≥III, occurred in 708 patients (43.5%). The incidence of the primary endpoint was significantly higher among patients with LVD (60.3% vs 42.8%; $P = 0.004$), RVD (53.6% vs 42.8%; $P = 0.027$), and pcPH (63.8% vs 42.8%; $P = 0.002$) as well as those fulfilling at least 1 of the aforementioned criteria (57.3% vs 41.5% for "OMT candidates" vs "TTVI appropriate"; $P < 0.001$). A multivariable model confirmed "OMT candidates" to be associated with a significantly higher likelihood of meeting the primary endpoint (OR: 1.75; 95% CI: 1.11-2.78; $P = 0.015$) (Table 3).

IMPACT OF RVD, LVD, AND pcPH ON SECONDARY ENDPOINTS. The presence of severe LVD, RVD, and pcPH was associated with significantly lower 1-year HFH-free survival (LVD, 54.6% vs 72.9% [$P < 0.001$]; RVD, 59.0% vs 73.2% [$P = 0.003$]; pcPH, 56.2% vs 73.4% [$P = 0.021$]; at least 1 of the previous criteria, 58.7% vs 74.3% [$P < 0.001$]; for "OMT candidates" vs "TTVI-appropriate", respectively) (Figures 1A to 1D, Central Illustration). With regard to 1-year survival, pcPH was associated with significantly decreased 1-year survival (67.7% vs 82.8% [$P = 0.003$]) and LVD as well as RVD with numerically lower survival (LVD, 76.3% vs 82.4% [$P = 0.175$]; RVD, 80.1% vs 82.3% [$P = 0.531$]). Correspondingly, 1-year survival was significantly lower in "OMT candidates" compared with "TTVI-appropriate" patients (77.7% vs 83.0%; $P = 0.001$). Of note, 30-day survival was comparable across subgroups (LVD, 96.8% vs 100% [$P = 0.199$]; RVD, 99.1% vs 100% [$P = 0.702$]; pcPH, 98.2% vs 98.7% [$P = 0.766$]).

Although LVD, RVD, and pcPH were associated with higher NYHA functional class at baseline and follow-up, the improvement of at least 1 NYHA functional class was similar, irrespective of the presence of each criterion (LVD, 51.1% vs 59.4% [$P = 0.254$]; RVD, 59.7% vs 59.0% [$P = 0.899$]; pcPH, 51.3% vs 59.4% [$P = 0.314$]; at least 1 criterion, 56.2% vs 59.5% [$P = 0.676$]; for "OMT candidates" vs "TTVI appropriate," respectively) (Figures 2A to 2D). Comparable results were observed for NYHA functional class improvement of at least 2 classes (LVD, 19.1% vs 17.4% [$P = 0.624$]; RVD, 19.5% vs 17.3% [$P = 0.752$]; pcPH, 17.9% vs 17.4% [$P = 0.932$]; at least 1 criterion, 17.1% vs 17.5% [$P = 0.914$]; for "OMT candidates" vs "TTVI appropriate," respectively). However, fewer "OMT candidates" achieved NYHA functional class ≤II at follow-up (51.1% vs 63.6%; $P = 0.008$),

TABLE 2 Procedural Characteristics

	Entire Cohort (N = 1,626)	OMT Candidates (n = 213)	TTVI Appropriate (n = 1,413)	*P* Value
Number of devices				0.436
0	8 (0.6)	3 (1.6)	5 (0.4)	
1	350 (24.8)	50 (26.2)	300 (24.5)	
2	801 (56.7)	115 (60.2)	686 (56.1)	
≥3	254 (18.0)	23 (12.0)	231 (18.9)	
Type of device				0.067
MitraClip/TriClip	822 (55.5)	107 (53.0)	715 (55.9)	
PASCAL	659 (44.5)	95 (47.0)	564 (44.1)	
Procedure time, min	107 (79-143)	104 (70-136)	107 (80-145)	0.148
TR severity discharge				0.895
1+	713 (48.1)	97 (48.3)	616 (48.0)	
2+	501 (33.8)	65 (32.3)	436 (34.0)	
3+	222 (15.0)	33 (16.4)	189 (4.7)	
4+	35 (2.4)	3 (1.5)	32 (2.5)	
5+	12 (0.8)	3 (1.5)	9 (0.7)	
TR severity follow-up				0.378
1+	371 (31.5)	44 (29.3)	327 (31.9)	
2+	473 (40.2)	60 (40.0)	413 (40.3)	
3+	269 (22.9)	35 (23.3)	234 (22.8)	
4+	49 (4.2)	9 (6.0)	40 (3.9)	
5+	14 (1.2)	2 (1.3)	12 (1.2)	

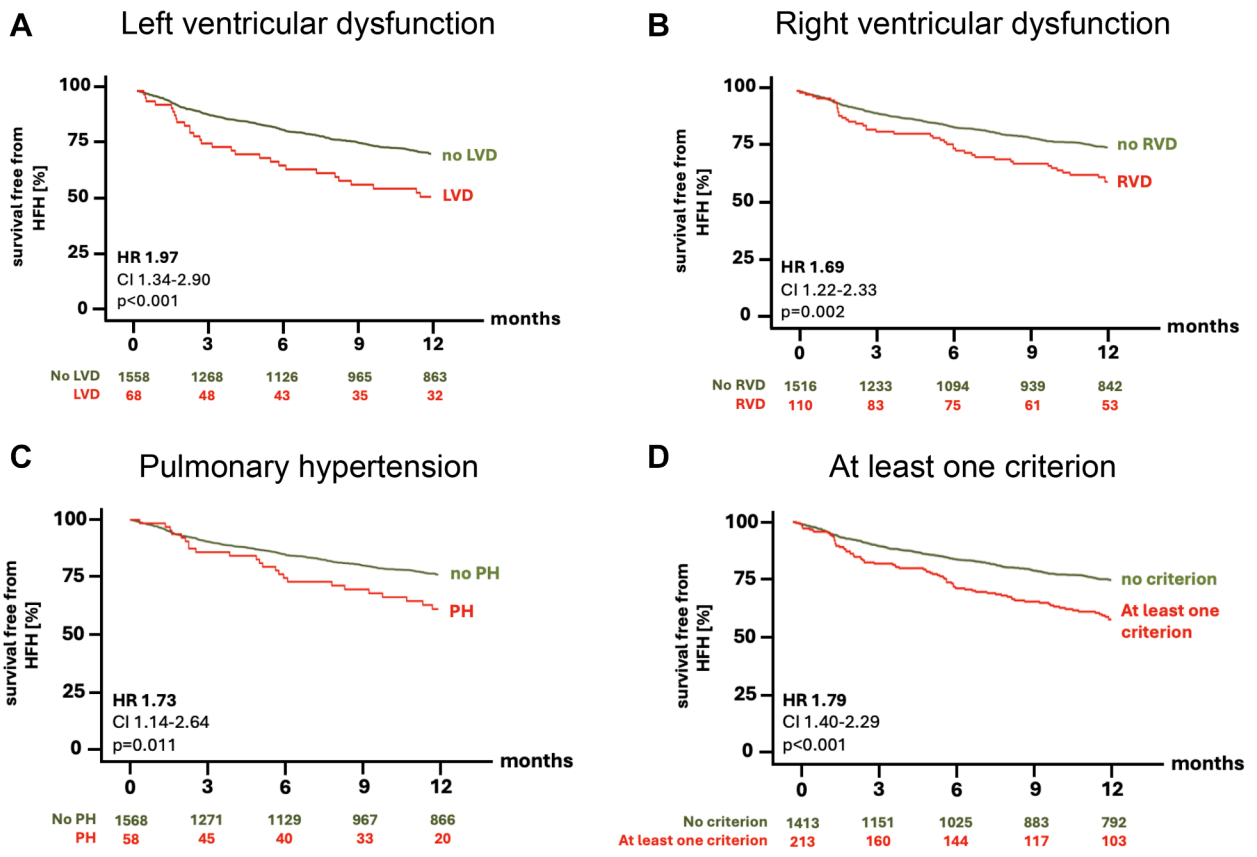
Values are n (%) or median (Q1-Q3).
Abbreviations as in Table 1.

TABLE 3 Multivariable Regression Model (1-Year Mortality, Heart Failure Hospitalization, NYHA Functional Class ≥III)

	Univariable			Multivariable		
	OR	95% CI	*P* Value	OR	95% CI	*P* Value
OMT candidate	1.742	1.265-2.399	<0.001	1.746	1.114-2.783	0.015
Torrential TR	1.059	0.833-1.347	0.640			
Age	0.989	0.976-1.002	0.086			
Male	1.374	1.128-1.672	0.002	1.251	0.954-1.639	0.105
BMI	0.994	0.987-1.001	0.104			
AHT	1.100	0.838-1.444	0.493			
Dyslipidemia	0.915	0.748-1.119	0.385			
COPD	1.546	1.196-.997	<0.001	1.806	1.268-2.728	0.001
PAD	1.088	0.771-1.534	0.631			
DM	1.200	0.953-1.510	0.121			
Previous stroke	1.071	0.751-1.528	0.703			
RV lead	1.523	1.227-1.890	<0.001	1.757	1.296-2.382	<0.001
AF	0.687	0.491-0.962	0.029	0.743	0.453-1.219	0.240
CAD	1.480	1.214-1.804	<0.001	1.167	0.887-1.536	0.271
NYHA functional class IV	1.982	1.390-2.827	<0.001	1.953	1.308-2.916	0.001
MR	1.545	1.350-1.768	<0.001	1.549	1.248-1.923	<0.001
M-TEER	2.164	1.491-3.141	<0.001	0.603	0.346-1.051	0.074
Gap size	0.996	0.952-.042	0.862			
eGFR	0.986	0.981-0.991	<0.001	0.989	0.983-0.996	<0.001

BMI = body mass index; DM = diabetes mellitus; PAD = peripheral artery disease; other abbreviations as in Table 1.

FIGURE 1 Survival Free From HFH



Survival free from heart failure hospitalization (HFH) was significantly reduced in the presence of severe left ventricular dysfunction (LVD), right ventricular dysfunction (RVD), or severe precapillary pulmonary hypertension (PH).

reflecting their more advanced baseline status (NYHA functional class IV in 23.3% vs 13.8%; $P = 0.003$). Among "OMT candidates," 30.7% of patients had residual TR ≥3+ at follow-up. In those patients, improvement in NYHA functional class was less pronounced compared with patients with durable TR reduction (improvement by at least 1 NYHA functional class in 45.2% vs 67.8%; $P = 0.014$).

DISCUSSION

As demonstrated by the present analysis, according to the 2025 ESC/EACTS valvular guideline recommendations, a small proportion of patients (13.1%, every 7th patient) who underwent T-TEER under real-world conditions would have been allocated to OMT only because of the presence of severe LVD, RVD, or pcPH. According to evidence from several randomized controlled trials, the primary benefit of TTVI beyond OMT consists of symptomatic relief and quality-of-life improvement (Kansas City Cardiomyopathy Questionnaire score, NYHA functional class), as well as a reduction in cumulative HF hospitalizations.[1,3,13,14] As mentioned earlier, randomized controlled clinical trials have all excluded such patients with severely reduced LV or RV function as well as pcPH. Thus, our knowledge on the clinical response of those patients is limited to real-world data. The prognostic impact of LVD, RVD, and pcPH has been shown in several registries.[12,15,16] However, interestingly, more than 78% of these patients survive more than 1 year after T-TEER, and more than

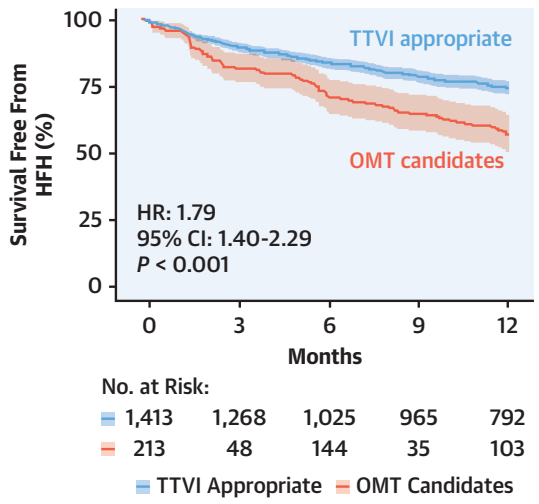
CENTRAL ILLUSTRATION Treatment of Severe TR in Real-World Practice

Applying the 2025 ESC/EACTS Recommendations for the Treatment of Severe Tricuspid Regurgitation to Real-World Practice: Insights From EuroTR, N = 1,626

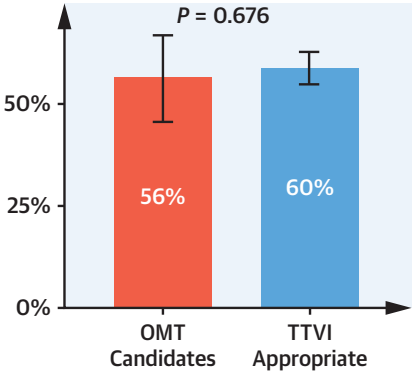
Severe LVD	Severe RVD	Severe Precapillary PH
LVEF <30%	3D RVEF <35% or RV FAC ≤22% or TAPSE <10 mm	mPAP >35 mm Hg PVR >5 WU
n = 68 (4.2%)	n = 110 (6.8%)	n = 58 (3.6%)

"OMT candidates" n = 213 (13.1%)

Survival Free From HFH



NYHA Improvement by 1 Grade

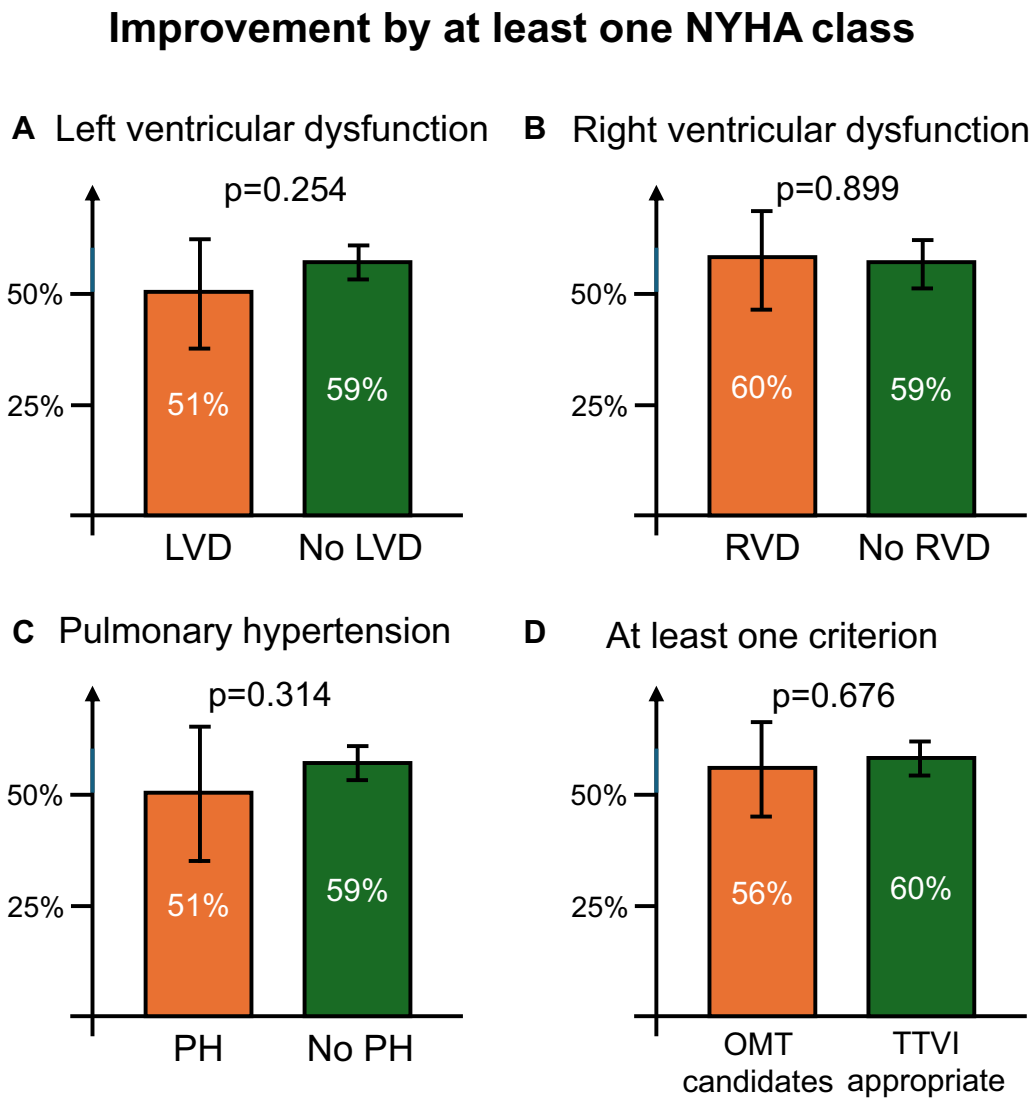


- Within the EuroTR registry, 213 patients (13.1%) would have been allocated to OMT only due to the presence of severe LVD, RVD, or precapillary PH ("OMT candidates").
- A composite endpoint of 1-year mortality, HFH or persistent dyspnea (NYHA functional class ≥III) was significantly more common in "OMT candidates" (OR: 1.75; 95% CI: 1.11-2.78; *P* = 0.015).
- Survival free from HFH was lower in "OMT candidates", reflecting their higher risk profile and more frequent comorbidities.
- Improvement by at least 1 NYHA functional class was comparable between "OMT candidates" and "TTVI appropriate" patients.
- T-TEER may provide symptomatic benefit in selected high-risk patients with severe LV/RV dysfunction or precapillary PH, which should be taken into consideration for Heart Team discussions and informed decision making with the patient.

Stolz L, et al. JACC Cardiovasc Interv. 2026;19(7):843-853.

When applying the 2025 European Society of Cardiology (ESC)/European Association for Cardio-Thoracic Surgery (EACTS) recommendations for treatment of patients with severe tricuspid regurgitation to real-world practice, "optimal medical therapy (OMT) candidates" had lower heart failure hospitalization (HFH)-free survival than "transcatheter tricuspid valve intervention (TTVI)-appropriate" patients but showed comparable symptomatic relief. 3D = 3-dimensional; EuroTR = European Registry of Transcatheter Repair for Tricuspid Regurgitation; FAC = fractional area change; LVD = left ventricular dysfunction; LVEF = left ventricular ejection fraction; mPAP = mean pulmonary artery pressure; PH = pulmonary hypertension; PVR = pulmonary vascular resistance; RV = right ventricular; RVD = right ventricular dysfunction; RVEF = right ventricular ejection fraction; T-TEER = tricuspid transcatheter edge-to-edge repair.

FIGURE 2 Improvement of NYHA Functional Class by at Least 1 Grade



Improvement of at least 1 NYHA functional class was comparable irrespective of the presence of LVD, RVD, and severe precapillary pulmonary hypertension. OMT = optimal medical therapy; TTVI = transcatheter tricuspid valve intervention; other abbreviations as in Figure 1.

55% experience symptomatic relief, even if NYHA functional class ≤II was less frequently achieved in "OMT candidates" (51.1% vs 63.6%; $P = 0.008$). The fact that "OMT candidates" with durable TR reduction at 1-year follow-up presented with a higher percentage of NYHA functional class improvement hints a potential prognostic benefit of T-TEER even in the presence of LVD, RVD, or pcPH. The rate of mortality or HFH was also significantly higher in "OMT candidates" in the context of the higher risk profile and more frequent comorbidities (Table 1). Of note, no significant differences were observed for 30-day survival rates in patients with vs those without RVD, LVD, or pcPH, indicating comparable in-

hospital and early outcome safety profiles. In the absence of an OMT-only control group in this observational study, no conclusions can be drawn concerning the actual effect of the therapy on any of the study high risk subgroups. Therefore, individual expectations need to be discussed with patients and their relatives to understand which degree of symptomatic relief represents a meaningful treatment goal. In this context, TTVI might be a reasonable treatment approach for symptomatic reduction in selected patients with severe LVD or RVD and/or pcPH, emphasizing possible nuances of patient selection for TTVI beyond the scope of current guideline recommendations. However, high rates of adverse events within the first year and residual symptoms should be taken into consideration by the heart team for final decision-making in this high-risk cohort.

As described in the new guideline document, patients should be evaluated and managed at experienced heart valve centers providing the full spectrum of currently available medical, transcatheter, and surgical procedures to enable the best possible therapeutic decision-making and outcomes.[8] Especially in patients with advanced HF, access to a specialized HF unit is essential to allow interventional valve therapy to be incorporated into a comprehensive long-term treatment strategy, including heart transplantation or LV assist device implantation. The key element in this process is shared decision-making between the patient and the heart team, especially in individuals with impaired LV or RV function or pcPH, in which the expected therapeutic benefit in the absence of randomized evidence should be carefully discussed.[8]

STUDY LIMITATIONS. This study is subject to the typical limitations of a retrospective analysis. As can be seen from the numerous quantification parameters listed in the guideline, the assessment of RV function is challenging.[8] As not all parameters were available in the study cohort, the hierarchical definition (three- vs two- vs one-dimensional) described earlier was chosen using the guideline-recommended thresholds. No comprehensive Kansas City Cardiomyopathy Questionnaire data before and after T-TEER were available within the EuroTR registry. Echocardiographic analyses were site reported and did not undergo core laboratory supervision. However, measurements were performed by experienced physicians at each center. The EuroTR registry does not include echocardiographic parameters of RV function immediately post-procedurally. However, previous literature suggests that the prevalence of acute right HF following T-TEER is very low.

CONCLUSIONS

While awaiting further outcome data or even dedicated clinical trials for such high-risk patient cohorts, heart teams must strive to master the difficult task of determining the respective probabilities of procedural futility or symptomatic benefit. The present data provide helpful information for heart teams and caregivers to support individualized decision-making in this specific patient subgroup. Finally, we hope that the present analysis will foster future research in this challenging patient cohort to better understand the pathophysiology of RV and pulmonary circulatory changes after TTVI procedures and their associated outcomes.

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PERSPECTIVES

WHAT IS KNOWN? According to the 2025 ESC/EACTS guidelines for the management of valvular heart disease, TTVIs have received a Class IIa recommendation (Level of Evidence: A) for the treatment of patients with severe symptomatic TR.

WHAT IS NEW? A small proportion of patients (13%) who underwent T-TEER under real-world conditions would have been allocated to OMT only because of the presence of severe LVD, RVD, or pcPH according to recent guideline recommendations. Although associated with lower 1-year survival rates free from HFH, patients with severe LVD, RVD, or pcPH experiences comparable symptomatic benefit, as expressed by NYHA functional class improvement of at least 1 class.

WHAT IS NEXT? Further studies are warranted to refine patient selection and optimize outcomes in the challenging setting of severe TR and right HF.

REFERENCES

1. Sorajja P, Whisenant B, Hamid N, et al. Transcatheter repair for patients with tricuspid regurgitation. *N Engl J Med*. 2023;388:1833–1842.

2. Donal E, Dreyfus J, Leurent G, et al. Transcatheter edge-to-edge repair for severe isolated tricuspid regurgitation: the Tri.Fr randomized clinical trial. *JAMA*. 2024;333(2):124–132.

3. Hahn RT, Makkar R, Thourani VH, et al. Transcatheter valve replacement in severe tricuspid regurgitation. *N Engl J Med*. 2025;392:115–126.

4. Stolz L, Kresoja KP, von Stein J, et al. Atrial secondary tricuspid regurgitation: insights into the EuroTR registry. *JACC Cardiovasc Interv*. 2024;17:2781–2791.

5. Stolz L, Kresoja KP, von Stein J, et al. Residual tricuspid regurgitation after tricuspid transcatheter edge-to-edge repair: insights into the EuroTR registry. *Eur J Heart Fail*. 2024;26(8):1850–1860.

6. Taramasso M, Benfari G, van der Bijl P, et al. Transcatheter versus medical treatment of patients with symptomatic severe tricuspid regurgitation. *J Am Coll Cardiol*. 2019;74:2998–3008.

7. Wild MG, Stolz L, Rosch S, et al. Transcatheter valve repair for tricuspid regurgitation: 1-year results from a large European real-world registry. *J Am Coll Cardiol*. 2025;85(3):220–231.

8. Praz F, Borger MA, Lanz J, et al. 2025 ESC/EACTS guidelines for the management of valvular heart disease. *Eur Heart J*. 2025;46(44):4635–4736.

9. Heitzinger G, Dreyfus J, Dannenberg V, et al. Left ventricular ejection fraction and benefit of tricuspid valve interventions—insights from the international TRIGISTRY. *Eur J Heart Fail*. 2025;27(11):2634–2643.

10. Kresoja KP, Lauten A, Orban M, et al. Transcatheter tricuspid valve repair in the setting of heart failure with preserved or reduced left ventricular ejection fraction. *Eur J Heart Fail*. 2020;22:1817–1825.

11. Masiero G, Arturi F, Ceni S, et al. Invasive hemodynamics and risk stratification in T-TEER: moving beyond ESC thresholds: EuroTR registry insights. *Circ Cardiovasc Interv*. 2025;19(1):e015964.

12. Stolz L, Kresoja KP, von Stein J, et al. Impact of pulmonary hypertension on

outcomes after transcatheter tricuspid valve edge-to-edge repair. *JACC Cardiovasc Interv*. 2025;18(3):325–336.

13. Kar S, Makkar RR, Whisenant BK, et al. Two-year outcomes of transcatheter edge-to-edge repair for severe tricuspid regurgitation: the TRILUMINATE pivotal randomized controlled trial. *Circulation*. 2025;151:1630–1638.

14. Lurz P, Hahn RT, Kodali S, et al. Tricuspid valve replacement outcomes by baseline tricuspid regurgitation severity: the TRISCEND II trial. *Eur Heart J*. Published online August 29, 2025. https://doi.org/10.1093/eurheartj/ehaf676

15. Stocker TJ, Hertell H, Orban M, et al. Cardiopulmonary hemodynamic profile predicts mortality after transcatheter tricuspid valve repair in chronic heart failure. *JACC Cardiovasc Interv*. 2021;14:29–38.

16. Sisinni A, Freixa X, Arzamendi D, et al. Impact of precapillary component of pulmonary pressure in tricuspid transcatheter edge-to-edge repair: results from TRI-SPA. *JACC Adv*. 2025;4:102153.

KEY WORDS left ventricular dysfunction, pulmonary hypertension, right ventricular dysfunction, treatment algorithm, T-TEER

APPENDIX For the EuroTR Investigators list, please see the online version of this paper.