Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

strategy is associated with significantly lower all-cause mortality and HFH than the conservative approach.

Disclosures

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Right Ventricular Dysfunction in Critically Ill Patients With COVID-19

Right ventricular (RV) dysfunction is a common complication in patients with acute respiratory distress syndrome (ARDS) occurring in 22% to 50% of patients.[1] RV dysfunction in the context of ARDS is attributed to increased pulmonary vascular resistance and is associated with increased mortality in patients with ARDS even when lung protective ventilation strategies are employed.[1−3] Severe COVID-19 is characterized by ARDS and respiratory failure of varying severity.[4,5] In patients with COVID-19, RV dysfunction was found in 39% of 100 consecutively hospitalized patients on echocardiograms performed within 24 hours of hospital admission.[6] Although RV dysfunction is reportedly common in patients with COVID-19,[6,7] whether it is associated with worse outcomes is unknown.

We reviewed medical records of patients admitted to the intensive care unit for COVID-19 at 2 hospitals (University of Michigan, Ann Arbor, Michigan [n = 286] and Hackensack University Medical Center, Hackensack, New Jersey [n = 359]) between March 1, 2020 and April 25, 2020. We identified 282 patients who required mechanical ventilation and had an echocardiogram performed during their hospitalization. Data abstracted from echocardiogram reports included the summary description of RV size and systolic function, tricuspid annular plane systolic excursion, and estimated RV systolic pressure in addition to left ventricular ejection fraction. We compared clinical characteristics and outcomes between patients with and without evidence of RV dysfunction using the t test or Mann−Whitney U test for continuous variables and the chi-square or Fischer's exact test for categoric variables. Two-tailed $p \leq 0.05$ were considered statistically significant. Analyses were performed using SPSS 24 (IBM, New York, New York). The institutional review board at each institution approved this research and waived the requirement for informed consent.

Overall, the mean age of the cohort was 62 (SD 13) and included 183 men (64.9%). Of the 282 hospitalized patients for COVID-19 who were mechanically ventilated and had an echocardiogram, 61 had evidence of at least mild RV dysfunction (21.6%) (Table 1). Only 6 patients (2.1%) showed signs of severe RV dysfunction. Patients with signs of RV dysfunction were more likely to have a history of congestive heart failure (16.4% vs 3.6%, $p < 0.001$) and have a lower body mass index but otherwise had no significant differences in clinical characteristics compared with patients without RV dysfunction. There was no statistically significant difference in the incidence of acute kidney injury requiring renal replacement therapy in patients with RV dysfunction (6.6%) compared with those without RV dysfunction (9.5%, $p = 0.47$). Most importantly, in-hospital mortality was similar between patients with and without RV dysfunction (62.3% compared with 59.7%, respectively; $p = 0.72$). Among patients with abnormal RV function who died (n = 38), only 4 (10.5%) had severe RV dysfunction.

Little is known about the incidence and outcomes of RV dysfunction in critically ill patients with COVID-19. A prospective cohort of 1,216 patients from 69 countries found 33% of patients with suspected or confirmed COVID-19 had echocardiographic evidence of RV dysfunction but did not report whether RV dysfunction impacted outcomes.[7] In another study of 100 consecutive patients hospitalized for COVID-19 who underwent echocardiography within 24 hours of admission, both RV dysfunction and left ventricular dysfunction were common (39% and 16%, respectively).[6] Sequential echocardiograms in 20 patients with clinical deterioration revealed worsening of RV function indexes; however, the association with in-hospital mortality was also not reported.[6]

Our estimate of the incidence of RV dysfunction in patients with COVID−19-related respiratory failure (21.6%) is similar to that previously reported in patients with ARDS with or without COVID-19.[1] The mechanism of RV dysfunction is likely independent of the specific viral illness and related to hypoxic vasoconstriction of the pulmonary vasculature, increased positive end-expiratory pressure, hypercapnia, and acidosis.[1] We found RV dysfunction

Table 1
Characteristics of patients who developed RV dysfunction

Variable	RV Dysfunction		P-Value
	Yes (N = 61)	No (N = 221)	
Baseline Demographics			
Age (years) – mean (SD)	64 (±12)	62 (±14)	0.49
Male sex – no.	39 (63.9%)	144 (65.2%)	0.86
Black – no.	12 (19.7%)	26 (11.8%)	0.23
Body mass index (kg/m^2) – mean (SD)	30 (±7)	32 (±8)	0.06
Body mass index (kg/m^2) – no.			
<30	33 (55.0%)	82 (37.8%)	
30-34	14 (23.3%)	56 (25.8%)	
35-39	7 (11.7%)	43 (19.8%)	0.017
≥40	6 (10.0%)	36 (16.6%)	
Coexisting Conditions – no.			
Smoking history	17 (27.9%)	65 (29.4%)	0.48
Diabetes mellitus	30 (49.2%)	91 (41.2%)	0.26
Hypertension	41 (67.2%)	135 (61.1%)	0.38
Coronary artery disease	12 (19.7%)	32 (14.5%)	0.32
Congestive heart failure	10 (16.4%)	8 (3.6%)	<0.001
Hospital admission eGFR – mean (SD)	60 (±33)	67 (±30)	0.12
Echocardiographic Parameters			
LVEF, % - mean (SD)	59 (±18)	59 (±14)	0.92
LVEF <45%, - no.	3 (18.8%)	10 (18.2%)	0.96
RV systolic function – no.			<0.001
Normal	0 (0.0%)	218 (100.0%)	-
Mildly decreased	44 (72.1%)	0 (0.0%)	
Moderately decreased	11 (18.0%)	0 (0.0%)	
Severely decreased	6 (9.8%)	0 (0.0%)	
RV dilation – no.			<0.001
None	34 (57.6%)	160 (86.5%)	-
Mild	15 (25.4%)	20 (10.8%)	
Moderate	9 (15.3%)	3 (1.6%)	
Severely decreased	1 (1.7%)	2 (1.1%)	
TAPSE, mm – mean (SD)	15 (±2)	21 (±3)	<0.001
RVSP, mmHg – mean (SD)	42 (±15)	37 (±14)	0.06
Outcomes – no (%)			
AKI requiring renal replacement therapy	4 (6.6%)	21 (9.5%)	0.47
In-hospital mortality	38 (62.3%)	132 (59.7%)	0.72

Abbreviations: AKI, acute kidney injury, eGFR, estimated glomerular filtration rate, LVEF, left ventricular systolic ejection fraction, RV, right ventricle, SD, standard deviation, TAPSE, tricuspid annular plane systolic excursion

was not a major determinant of in-hospital mortality, despite the selection of a high-risk population and a reported mortality of over 50%. The lack of an association may be related to the low number of patients with severe RV dysfunction. Accurate assessment or RV function is also challenging with echocardiography, and other functional monitoring systems may provide a more precise picture of the overall health of the RV, as was used in the Fluids and Catheters Treatment Trial, for example, to determine the increased mortality burden of RV dysfunction.[3]

Our study has limitations, the most important being the lack of systematic echocardiographic evaluation, lending a risk of selection bias and potential overestimation of RV dysfunction. The echocardiographic imaging of the RV is often challenging, especially in the setting of mechanical ventilation, which could have impacted the accuracy of RV function assessment.

Overall, the incidence of RV dysfunction in patients with COVID−19-related critical illness is similar to that seen in patients with non−COVID-19 ARDS and is not a marker of worse outcomes in this setting.

Author Contributions

Samantha K. Brenner and Salim S. Hayek conceived of the study design and had access to all of the source data. SSH conducted the statistical analysis. Samantha K. Brenner and Salim S. Hayek created the tables and drafted the article. All authors contributed to data collection, critically reviewed the article, and provided substantive feedback.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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Impact of Timing of Infective Endocarditis After Transcatheter Aortic Valve Implantation on Mortality

It is well established that infective endocarditis (IE) after transcatheter aortic valve implantation (TAVI) is associated with significantly increased mortality (1-year mortality rates as high as 50%) and stroke rates.[1,2] Existing studies have determined the predictors of IE after TAVI and mortality in patients with IE after TAVI.[1,2] Stortecky et al[3] determined that the incidence of IE after TAVI was highest in the early procedural/periprocedural period (≤100 days). Similar findings were shown by Mentias et al.[4] In our study, we aimed to assess the impact of timing of IE after TAVI on in-hospital mortality.

We identified all the hospitalizations in patients who underwent TAVI who developed IE within 1 year of the procedure using the Nationwide Readmission Database (NRD) from the year 2014 to 2017. Time-to-IE was defined as the timing between the date of TAVI procedure to admission for IE. The primary outcome was in-hospital mortality during the hospitalization for IE. Nonlinear spline regression was performed to assess the impact of timing to IE after TAVI on in-hospital mortality. All the analysis was conducted using R 4.0.3. This study was exempted from the approval of the institutional review board because it used anonymized and deidentified data in a publicly available database.

A total of 906 weighted hospitalizations for IE after TAVR within 1 year of the procedure were identified from 2014 to 2017 using the NRD. The mean time-to-IE after TAVI in the study population was 108.85 (78.50) days. The in-hospital mortality rate was 12.36% (n = 112). Of the 906 hospitalizations, 261 were admitted with IE within 50 days, 235 from 51 to 100 days, 179 from 101 to 150 days, 110 from 151 to 200 days, 61 from 201 to 250 days, and 60 from 251 to 365 days. The in-hospital mortality in the groups were 15.61%, 10.87%, 17.36%, 6.54%, 2.93%, and 5.25%, respectively (Figure 1). We compared the baseline characteristics and in-hospital outcomes between the hospitalizations with IE within and after 150 days after TAVI (Figure 1). Patients with time-to-IE <150 days were more likely to be hospitalized in larger hospitals; however, there were no statistically significant differences in co-morbidities and incidence of *Staphylococcus aureus* endocarditis. Hospitalizations after 150 days after TAVI with IE was associated with significantly decreased in-hospital mortality rates (5.62% vs 14.81%, p = 0.006) and new dialysis requirements (3.13% vs 8.50%, p = 0.042) than hospitalizations within 150 days. However, there were no statistically significant differences in stroke (3.16% vs 5.40%, p = 0.313), acute kidney injury (37.22% vs 37.92%, p = 0.881), blood transfusion (19.43% vs 21.12%, p = 0.685), and the mean length of stay (11.82 [11.16] vs 10.12 [8.67] days, p = 0.142) between the 2 groups. Figure 1 depicts the adjusted nonlinear spline regression curves for impact of timing of IE on in-hospital mortality, respectively.

The results of our nationwide analysis suggest that there is a decrease in in-hospital mortality with increasing time-to-IE after TAVI. Using a nationwide dataset, we identified a cutoff of approximately 150 days after which the mortality rates were higher in patients hospitalized with IE after TAVI. This is the first study to identify an association between time-to-IE after TAVI with in-hospital mortality. Previous studies have shown that the incidence of *S. aureus* endocarditis was higher in early hospitalization[2] and that could potentially explain higher mortality; however, in our study, there were no significant differences in the incidence of *S. aureus* endocarditis rates. Further, there were no significant differences in baseline co-morbidities and risk factors. In fact, patients with time-to-IE <150 days were hospitalized at larger hospitals.

Our study has several limitations. First, using the NRD, we were unable to determine the outcomes of hospitalizations for late IE that occurred >1 year after TAVI procedure. Second, we were unable to account for mortality after discharge from the hospital. Third, using the NRD, we were unable to identify clinical, echocardiographic, and hemodynamic characteristics that could explain increased mortality rates in hospitalizations within 150 days after