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LETTER

The prevalence, risk factors and outcome of cardiac dysfunction in hospitalized patients with COVID-19

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Dear Editor,

Coronavirus disease 2019 (COVID-19) is an emerging outbreak caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Although sharing considerable similarities with SARS, cardiac injury was more frequently reported in SARS-CoV-2 [1]. However, the incidence and clinical significance of cardiac insufficiency in COVID-19 have not yet been well described. The purpose of our study was to purse the prevalence, risk factors and outcome of cardiac dysfunction in hospitalized patients with COVID-19.

We included 157 consecutive adult patients who were diagnosed with COVID-19. Clinical data were obtained from electronic medical records. Left ventricular (LV) and right ventricular (RV) structure and function were evaluated using bedside transthoracic echocardiography. Heart failure (HF) was classified into heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF). The definitions of HF and RV dysfunction were based on the American Heart Association Guidelines [2, 3].

RV dysfunction was found in 40 (25.5%) unselected patients, 26 (28.9%) patients requiring high flow oxygen and 15 (41.7%) patients requiring mechanical ventilation. HF was presented in 28 (17.8%) unselected patients consisting of 24 (15.3%) HFpEF and 4 (2.5%) HFrEF, 22 (24.4%) patients requiring high flow oxygen and 11 (30.6%) patients requiring mechanical ventilation. 9 (5.7%) patients had biventricular dysfunction. Clinical and echocardiographic characteristics of patients with COVID-19 are shown in Supplementary Tables 1 and 2. Compared with patients without cardiac insufficiency,those with cardiac insufficiency had more comorbidities and complications as well as poorer prognosis. A multivariate logistic regression analysis revealed that acute respiratory distress syndrome (ARDS) was independently predictive of cardiac dysfunction (Supplementary Table 3), which contributed to higher mortality (Fig. 1a). Moreover, LV and RV dysfunction were more frequent in patients with elevated high-sensitivity troponin I (hs-TNI) than those without (Fig. 1b). During hospitalization, 23 patients died. The incidence of LV and RV dysfunction were higher in non-survivors than survivors (Fig. 1c). The mortality was 3.0% for patients without cardiac dysfunction and normal hs-TNI levels, 6.7% for those with cardiac dysfunction and normal hs-TNI levels, 13.3% for those without cardiac dysfunction but elevated hs-TNI levels, and 64.0% for those with cardiac dysfunction and elevated hs-TNI (Fig. 1d, e). In multivariate Cox analysis, hs-TNI elevation, mechanical ventilation and RV dysfunction were independent predictors of higher mortality (Supplementary Table 4).

Our study demonstrated that the prevalence of RV dysfunction was higher than that of LV dysfunction in patients with COVID-19. Direct viral damage, aggravation of a systemic inflammatory response, and hypoxemia may all contribute to cardiac injury. Furthermore, RV function can be worsened by increased afterload, which are likely involve ARDS, hypoxic pulmonary vasoconstriction, microthrombi within the pulmonary vasculature and microvascular injury [4, 5]. Additionally, our findings revealed that mortality was highest

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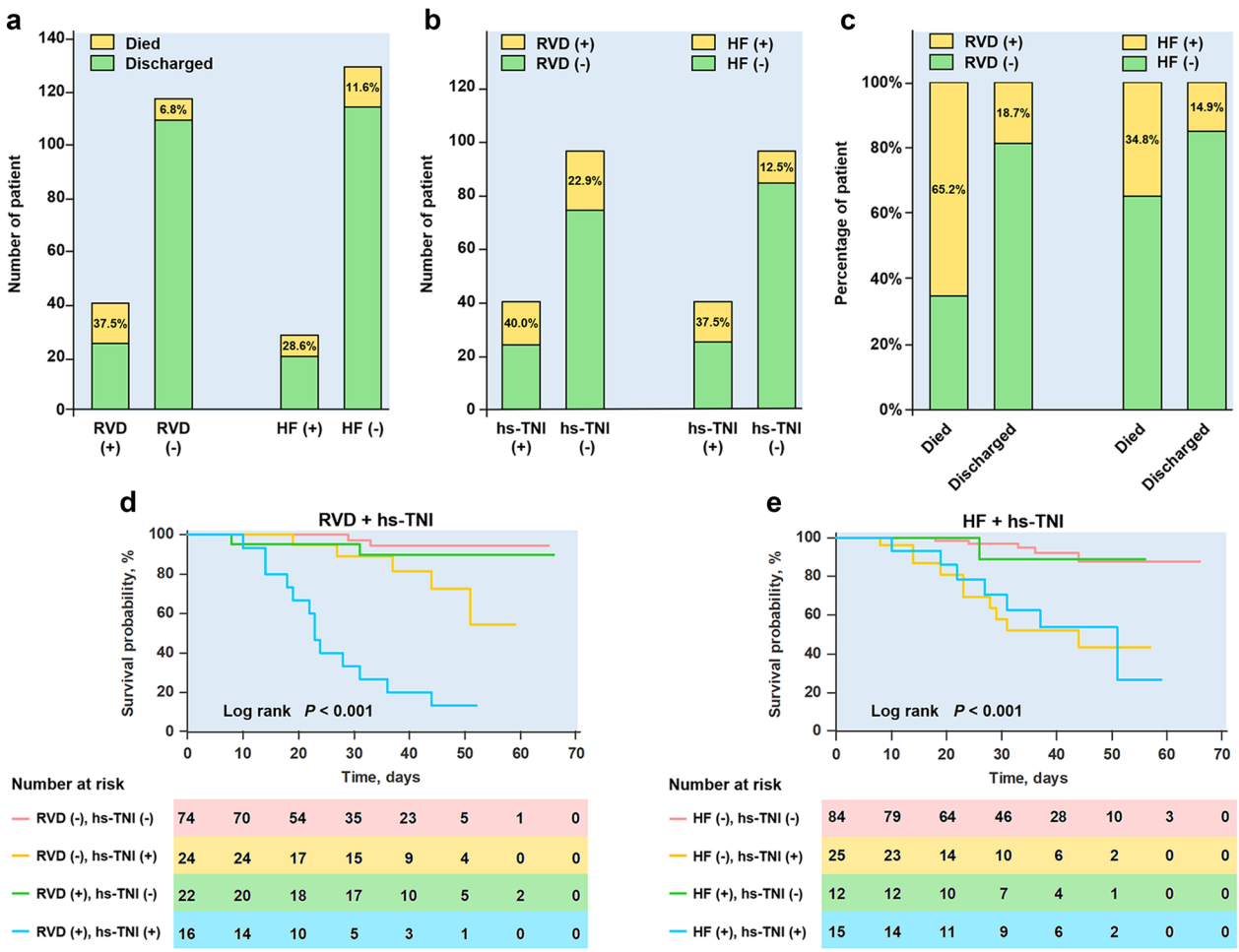

Fig. 1 **a** Bar graphs illustrate the mortality of patients with/without right ventricular dysfunction (RVD) and patients with/without heart failure (HF). **b** Bar graphs show the prevalence of RVD and HF in patients with/without elevated high-sensitivity troponin I (hs-TNI). **c** Bar graphs demonstrate the incidence of RVD and HF in non-survivors and survivors. **d** Kaplan–Meier curves in COVID-19 patients with/without RVD and with/without elevated hs-TNI Levels. **e** Kaplan–Meier curves in COVID-19 patients with/without HF and with/without elevated hs-TNI Levels

in patients with increased troponin associated with RV dysfunction. Elevations of cardiac troponin and RV dysfunction were independently predictive of higher mortality, highlighting the significance of closely monitoring the changes of cardiac troponin and RV function. In summary, elevated cardiac troponin together with RV dysfunction may be crucial for risk stratification of COVID-19 patients and should be taken into consideration when applying prevention and therapy.

Electronic supplementary material

The online version of this article (https://doi.org/10.1007/s00134-020-06205-0) contains supplementary material, which is available to authorized users.

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Author contributions

LZ and MX contributed to the conception and design of the study. ML and HL contributed to the acquisition of data. YL and MLcontributed to the analysis and interpretation of the data. The first draft was written by YL and HL, and all authors revised the manuscript substantially. All authors read and approved the final manuscript. YL, HL and ML contributed equally and shared first authorship.

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Compliance with ethical standards

Conflicts of interest
The authors declared no conflict of interest.

Ethical approval
The study was approved by Union hospital Tongji Medical College, Huazhong University of Science and Technology Ethics Committee (KY-2020–02.06).

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