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Original Article

Acute decompensated heart failure (ADHF) during COVID-19 pandemic-insights from South India

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A B S T R A C T

Aim: This retrospective study compares admissions and outcomes due to acute decompensated heart failure (ADHF) during the COVID-19 pandemic from 25 March to 25 July 2020 with the historical patient control who were admitted during the same period in 2019.

Methods and results: Data of the participating hospitals was collected and analysed from the ICC NHFR (Indian College of Cardiology National Heart Failure Registry) for 2019 and 2020. Total number of ADHF admissions, demographics, aetiology, co-morbid conditions and in-hospital mortality was compared and analysed. A significant decrease in the number of hospital admissions due to ADHF from 2019 to 2020 (1056 vs. 526 respectively) was noted. Incidence of admissions with <40% ejection fraction (EF) reduced in 2020 (72.4% and 80.2% in2020 and 2019)and >40% (EF) increased (27.6% and 19.8% in 2019 and 2020 respectively, $p = 0.0005$). Ischemic heart disease (IHD) was the most common aetiology (78.59% in 2019 and 80.98% in 2020, $p = 0.268$). The in-hospital mortality was numerically higher in 2020 (10%) than in 2019 (8%), but not statistically significant ($p = 0.161$).

Conclusion: This study from the registry shows that the incidence of ADHF admissions during COVID-19 lockdown significantly reduced compared to the previous year. Demographic patterns remained similar but patients presenting with de-*novo* HF increased; IHD was the most common cause. The in-hospital mortality was numerically higher during the lockdown. The impact of lockdown perhaps led to fewer hospitalisations and this is to be factored in future strategies to address health care delivery during such crises.

1. Introduction

Acute decompensated heart failure (ADHF) is a serious medical emergency that requires emergency room visits or hospitalisation.[1,2] Globally, an estimated 64.3 million people are living with heart failure (HF).[3] In India, the prevalence of HF is estimated to be 1%.[4] The data available from global registries and India reveals higher mortality rates and re-hospitalisation in patients with ADHF.[5,6,7] The preliminary data from the country points to suboptimal care and management.

The COVID-19 pandemic caused by SARS-Cov2 has been declared a global public health emergency as it has imposed a huge burden on the public healthcare system, and on medical infrastructure.[8,9,10] By December 2020, over 80 million cases had been

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reported worldwide, and 10 million cases have been reported from India alone, making it the second highest ranked country in terms of total COVID-19 cases. Strict containment measures were adopted to restrain and slow down the spread of infection in India. This included a nationwide lockdown in four phases (Phase 1 from 25 March to 14 April, Phase 2 from 15 April to 3 May, Phase 3 from 4 May to 17 May, and Phase 4 from 18 May to 31 May 2020). However, despite these measures, the numbers of cases continued to rise at an alarming pace all across India.[11]

During lockdown, there was a disruption of routine healthcare services. There are no major studies of ADHF in COVID times. The Indian College of Cardiology National Heart Failure Registry (ICCNHFR) was started in 2018 and is an ongoing registry. The present study from this registry aims to evaluate the effect of lockdown on hospital admissions of patients with ADHF, and compare them with those during the same period in 2019. The demographics, aetiology and in hospital mortality rates during ADHF hospitalisation is studied.

2. Methods

The present study relies on the data from ICCNHFR, from a registry started in August 2018 till date of enrolled patients from various centres across India. This registry has captured data on the demographics, aetiology, comorbid conditions, left ventricular function, medical treatment offered and the in-hospital mortality of consecutive patient admissions with ADHF.[12] The 2019 and 2020 data from the same centres, which participated from southern India, was analysed. It was registered under the clinical trial registry of India (CTRI) (Registration no: CTRI/2019/08/020,972). A retrospective analysis of ADHF patient data, collected online, was done from these seven hospitals which participated in this registry.

All consecutive patients admitted in the coronary care unit (CCU) with ADHF and class IV symptoms were analysed. The proforma captured basic biochemical tests, electrolytes and blood count. The biomarkers like BNP/NT pro-BNP data were not mandatory in the proforma. 2Dechocardiogram was done to capture the left ventricular systolic function. Detailed echo analysis was not available on all patients.

The study analysed the pattern of ADHF admission, demographics, aetiology, comorbid conditions and in-hospital mortality from 25 March 2020 to 25 July 2020, and compared them with the historical patient control who were admitted during the period in 2019. The treatment pattern and discharge medications were also analysed. The temporal trends on mortality were not analysed in view of short duration of study. All patients were a part of on-going registry, and were included only after obtaining approval from the institutional review board (IRB) and the patient's informed consent. The 2020 patient group were mostly screened for COVID-19 from the emergency department and shifted to the Cardiac ICU only if they tested COVID negative. They were not tested for COVID subsequently. The COVID positive patients were all admitted in separate COVID ICU or referred to COVID designated hospitals and were not part of the study.

2.1. Statistical analysis

The continuous variables are presented as mean ± SD (standard deviation), wherever applicable, and the statistical significance was assessed by student's *t*-test. Categorical data are presented as absolute numbers and percentages. Pearson Chi-square test was used to assess the differences in the categorical data such as age groups, aetiology, and comorbid conditions between 2020 and 2019.

3. Results

3.1. Demographic characteristics

There was a significant decrease in the number of hospital admissions for ADHF during the lockdown (25 March to 25 July 2020, $n = 526$ patients) compared to that in 2019 ($n = 1056$; Table 1) during the same period. Comparative weekly admissions are mentioned in Fig. 1. The mean ± SD age of patients in 2020 (60.17 ± 13.67) was lower than that in 2019 (62.64 ± 13.79, $p = 0.001$; Table 1). However, there were no significant gender differences between 2020 and 2019 (Table 1). The patients were grouped according to age in increments of 10 years ranging from ≤40 years to over 81 years to further delineate age as a contributing factor in ADHF for both years. As shown in Table 1,a reduction was observed in ADHF cases in patients above 70 years during the lockdown compared to those in 2019 (29.4% vs. 21.8%, $p = 0.026$ for patient age group >71 to ≤80 years, $p = 0.049$ for age group >80 years).

3.2. ADHF and co-morbidities

Co-morbidities as risk factors for ADHF are well established[13,14,15,16] and the incidence in patients with ADHF is tabulated (Table 1). During lockdown, the present study showed a reduction in ADHF admissions with co-morbid conditions for chronic kidney disease (CKD) ($p = 0.013$), chronic obstructive pulmonary disease (COPD) ($p = 0.006$), cerebrovascular accident (CVA) ($p = 0.009$) and peripheral vascular disease (PVD) ($p = 0.003$) compared to 2019.

3.3. Types of ADHF and their aetiology

Analysis of different types of ADHF admissions during lockdown showed significant reductions in the admission of patients with acute on chronic ADHF, and an increase in *de novo* ADHF as compared to that during 2019 ($p = 0.007$) (Table 2). Incidence of admissions with <40% left ventricular ejection fraction (LVEF) reduced, and >40% LVEF increased ($p = 0.0005$) during the lockdown in 2020, compared with that during the same time in 2019 (Table 2). Ischemic heart disease (IHD) continued to be the major cause of ADHF hospitalisation during the period of study in 2019 and 2020(Table 2).

Table 1
Patient demographics and comorbidities.

Characteristics	2019 ($n = 1056$)	2020 ($n = 526$)	*p*-value
Age (years), mean ± SD	62.64 ± 13.79	60.17 ± 13.67	0.001
Men, n (%)	731 (69.2)	359 (68.3)	0.693
Female, n (%)	325 (30.8)	167 (31.7)	
Age group in years, n (%)			
≤40	68 (6.4)	51 (9.7)	0.187
>40 ≤ 50	144 (13.6)	73 (13.9)	0.895
>50 ≤ 60	242 (22.9)	143 (27.2)	0.006
>61 ≤ 70	292 (27.7)	144 (27.4)	0.908
>71 ≤ 80	211 (20.0)	81 (15.4)	0.026
>80	99 (9.4)	34 (6.4)	0.049
Co-morbidities, n (%)			
CVA	56 (5.3)	13 (2.5)	0.009
CKD	172 (16.3)	61 (11.6)	0.013
PVD	46 (4.4)	8 (1.5)	0.003
COPD	82 (7.8)	22 (4.2)	0.006
CLD	4 (0.4)	4 (0.8)	0.313

CKD, chronic kidney disease; CLD, chronic lung disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; NS, not significant; PVD, peripheral vascular disease; SD, standard deviation.

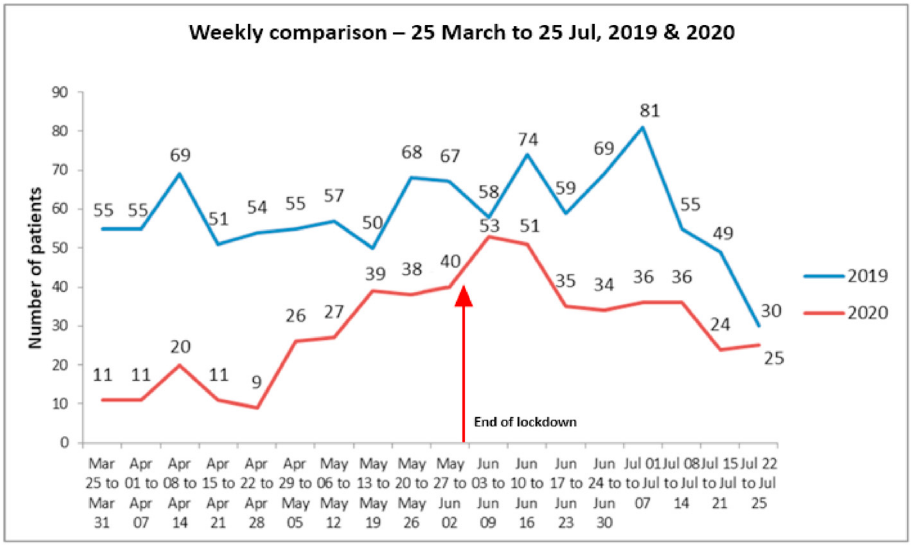

Fig. 1. Trends in ADHF admissions

Table 2
Type and aetiology of HF and left ventricular function.

Characteristics	2019 ($n = 1056$)	2020 ($n = 526$)	p-value
Types of HF, n (%)			
Acute on Chronic	637 (60.3)	280 (53.2)	0.007
de-novo	419 (39.7)	246 (46.8)	
LVEF,			
<40%	847 (80.2)	381 (72.4)	0.0005
>40%	209 (19.8)	145 (27.6)	
Aetiology of HF, n (%)			
CHD	3 (0.28)	2 (0.38)	0.748
RHD	44 (4.16)	34 (6.46)	0.045
DCM	142 (13.44)	46 (8.74)	0.006
HTHD	12 (1.14)	5 (0.95)	0.736
IHD	830 (78.59)	426 (80.98)	0.268
RCM	2 (0.19)	1 (0.19)	0.998
Unknown	23 (2.18)	12 (2.28)	0.895

CHD, congenital heart disease; DCM, dilated cardiomyopathy; HF, heart failure; HTHD, hypertensive heart disease; IHD, ischemic heart disease; LEVF, left ventricular ejection fraction; NS, not significant; RCM, restrictive cardiomyopathy; RHD, rheumatic heart disease.

Table 3
ADHF discharge medications for both years.

Treatment, n (%)	2019 ($n = 1056$)	2020 ($n = 526$)	p-value
Diuretics	899 (85.1)	426 (80.9)	0.03
ACEI/ARB	420 (39.8)	216 (41.0)	0.621
ARNI	28 (2.7)	44 (8.4)	0.0001
Beta−blocker	641 (60.7)	354 (67.3)	0.0105
MRA	594 (56.3)	306 (58.1)	0.466
Ivabradine	123 (11.6)	59 (11.2)	0.800
Aspirin	732 (69.3)	322 (61.2)	0.0013
Clopidogrel	636 (60.2)	253 (48)	0.0001
NOAC	14 (1.3)	10 (1.9)	0.378
OAC	92 (8.7)	44 (8.3)	0.817
Anti-arrhythmics	71 (6.7)	26 (4.9)	0.164

ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blockers; ARNI, angiotensin receptor and neprisyln inhibitor; MRA, mineraloid receptor antagonists; NOAC, novel oral anticoagulant; NS, not significant; OAC, oral anticoagulant; ADHF, acute decompensated heart failure.

3.4. Treatment patterns for ADHF patients

Ace inhibitors (ACEi) Angiotensin receptor blockers (ARB), mineral ocorticoid receptor blockers (MRA) usage was the same in 2019 and 2020. However, in 2020, higher percentage of patients were discharged on angiotensin receptor neprilysin inhibitor (ARNI) (2.7% vs. 8.4%, $p = 0.0001$) and beta−blockers (60.7% vs. 67.3%, $p = 0.0105$). The percentage of patients discharged on diuretics (85.1% vs. 80.9%, $p = 0.03$), aspirin (69.3% vs. 61.2%, $p = 0.0013$), and clopidogrel (60.2% vs. 48%, $p = 0.0001$) reduced (Table 3). The length of hospital stay was longer in 2019 (5.89 days) than in 2020 (4.82 days).

3.5. Association between gender, age groups and mortality

In this study, the overall in-hospital mortality rate was comparable for years, 2019 and 2020 (Fig. 2A). The in-hospital mortality in females was higher during the study period in 2020 and 2019; however, this difference was not statistically significant (Fig. 2B). A subgroup analysis revealed an increase in the mortality for the age group, 41–50 years in 2020 (13.7%) compared to 2019 (4.2%, $p = 0.011$) (Fig. 2C). However, a reduction in the mortality rates in the elderly patients (>80 years) during 2020 (11.8%) was observed compared to 2019 (15.2%)

4. Discussion

Annual rates of ADHF hospitalisations have been on the rise worldwide. Various comorbidities are prevalent in ADHF[13,16] and several studies have shown higher in-hospital mortality rates for ADHF.[6,7,17,18] The present study shows reduction in the absolute number of ADHF hospital admissions during lockdown (25th March to 31st May 2020) compared to the same period in 2019; the trend continued after lockdown ended as well (Fig. 1). A reduced rate of hospitalisation was noticed in many countries during Covid pandemic.[19–22]

Bromage et al, reported initial data on ADHF admissions during COVID pandemic from UK.[23] Reduced rates of hospitalisations were reported from HF referral centres in London by Cannata et al,[22] Hall et al,[24] and Frankfurter et al,[25] showed similar trends in US and Canada. The present study is the largest reported observational study from a registry of ADHF during COVID.

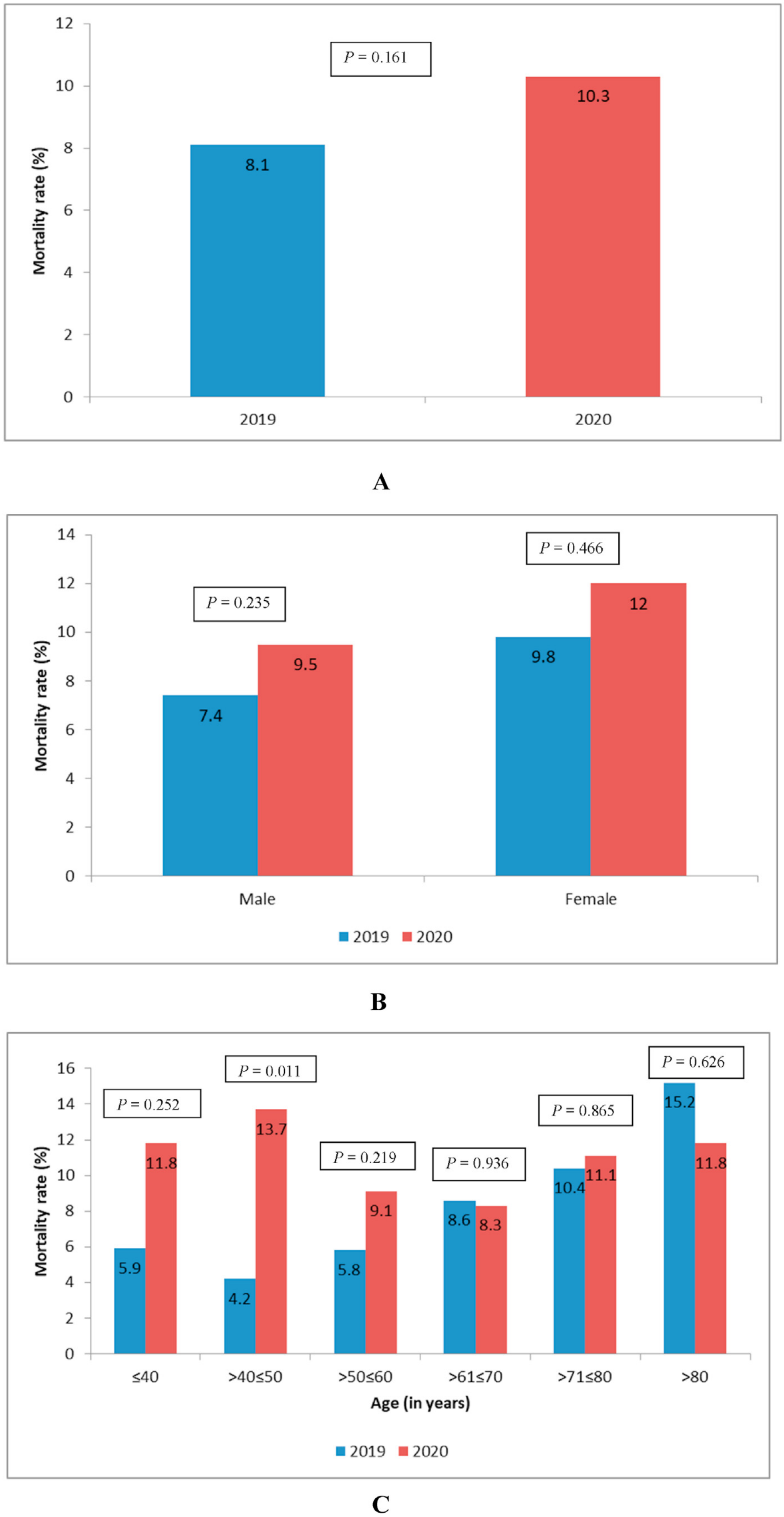

Fig. 2. In hospital mortality rate for ADHF admissions (2019 & 2020) by age and gender.

The reasons for the reduction in the hospitalisation rates with ADHF in 2020 could be multifactorial. Whether this was due to the lockdown or due to an actual reduction in ADHF cases, is yet to be elucidated. The unavailability of public transport to reach hospitals due to lockdown could be the major factor. It is likely that many patients were attended to locally by their family physicians and could not reach the tertiary care centres. Only the very sick who needed critical care reached the tertiary care hospitals. There have been reports of increase in the out-of-hospital cardiac arrests during COVID. The fear of acquiring COVID in the hospitals probably led to fewer hospital admissions. In some hospitals, cardiac units were also converted to COVID wards, which in turn affected cardiology services.

However, unlike the UK study, the mortality rates were not significantly different in both comparative years. A resurgence of HF admissions following lock down was not seen in this study. The studies reported so far have not elaborated on the aetiology and comorbid conditions. The present study shows IHD as the most common cause for ADHF admissions during 2019 and 2020.

There were changes in the demographic patterns. This study had relatively younger patients and fewer females compared to the study from UK.[22] Similar demographic patterns have been reported by a single centre recently in the country by Choudhary et al,[21] Incidence of co-morbidities such as COPD, CVA, PVD, and CKD reduced during the lockdown. Many previously diagnosed HF patients would have been treated by local physicians. Patients presenting with *de novo*HF and HFpEF (LVEF>40%) was more in 2020. As COVID, testing was not routinely done after admission, the effect of viral infection and deterioration could not be analysed.

Use of ACE(i), ARB and MRA remained the same in both comparison years. Beta-blocker use has increased and a trend towards increasing use of ARNI is observed. All the same, only limited inferences could be drawn on GDMT use because of small numbers in the study group.

Though the study did not show any major differences in the mortality, it showed interesting trends in different age groups. There was an increase in the mortality rates in 41–50 years age group in 2020 compared to 2019 (13.7% vs. 4.2%, $p = 0.011$). However, there was a decrease in mortality for the age group >80 years in 2020 (11.8%) compared to that in 2019 (15.2%) Fig. 2c. Many elderly patients probably were unable to reach the hospitals and hence this mortality figures could be an underestimation. In view of the short duration of the study, the temporal trends in mortality and various prognostic factors were not analysed.

Lockdown resulted in limited availability of public transport. The in-hospital mortality rate of ADHF is much higher than mortality due to COVID. Hence, increase in awareness is needed to convey that hospitalisation is important for situations like ADHF even during pandemic.

4.1. Study limitations

A major limitation of our study was the fewer number of centres involved, and for a limited time period. Another limitation is not acquiring adequate data collection on cardiac biomarkers. Though most of the patients were screened for COVID from the emergency department before admission into CCU, routine COVID testing was not repeated. It is a methodological limitation. The data was from the CCU and there could be a presentation bias. As it is a retrospective registry data, it is prone to treatment bias and medication bias. The availability of medication in the hospitals during pandemic is unknown. It is likely that many deaths would have occurred in COVID designated hospitals or at home. The important follow up data on hospital readmissions was not easy to capture during COVID and were subsequently not analysed.

5. Conclusion

The present study showed decrease in ADHF admissions during COVID-19. The aetiology remained the same, IHD being the most common. More patients had *de novo* HF in 2020. The mortality rate was marginally high. Use of guideline directed medical therapy was mostly the same with a slight increase in beta-blocker usage. Public education regarding availability of emergency services may be important during such situations in the future.

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Declaration of competing interest

Authors declare no conflict of interest for this manuscript.

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References

1. Gregg C. Fonarow, eliot Corday. Overview of acutely decompensated congestive heart failure (ADHF): a report from the adhere registry. *Heart Fail Rev*. 2004;9(3):179–185.
2. Ziaeian Boback, Fonarow Gregg C. Epidemiology and aetiology of heart failure. *Nat Rev Cardiol*. 2016;13(6):368–378.
3. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392:1789–1858.
4. Chaturvedi Vivek, Parakh Neeraj, Seth Sandeep, et al. Heart failure in India: the INDUS (India ukieri study) study. *J Pract Cardiovasc Sci*. 2016;2(1):28–35.
5. Pillai Harikrishnan Sivadasan, Ganapathi Sanjay. Heart failure in South Asia. *Curr Cardiol Rev*. 2013;9(2):102–111.
6. Sanjay Ganapathi, Jeemon Panniyammakal, Agarwal Anubha, et al. In-hospital and three-year outcomes of heart failure patients in South India: the trivandrum heart failure registry. *J Card Fail*. 2018;24(12):842–848.
7. Harikrishnan Sivadasanpillai, Sanjay Ganapathi, Anees Thajudeen, etal. Clinical presentation, management, in-hospital and 90-day outcomes of heart failure patients in Trivandrum, Kerala, India: the Trivandrum Heart Failure Registry. *Eur J Heart Fail*. 2015;17(8):794–800.
8. Guan Wei-jie, Ni Zheng-yi, Hu Yu, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med*. 2020;382:1708–1720.
9. Paul Keeley, Buchanan Deans, Clare Carolan, et al. Symptom burden and clinical profile of COVID-19 deaths: a rapid systematic review and evidence summary. *BMJ Support Palliat Care*. 2020;10(4):381–384.
10. Papoutsi Eleni, Giannakoulis Vassilis G, Ntella Vasiliki, et al. Global burden of COVID-19 pandemic on healthcare workers. *ERJ Open Res*. 2020;6, 00195-2020.
11. Ram Venkata S, Babu Giridhara R, Prabhakaran Dorairaj. Covid-19 pandemic in India. *EurHeart J*. 2020;41(40):3874–3876.
12. Jayagopal PB, Manjunath CN, Raghu TR, et al. Rationale, methodology, and design of Indian College of cardiology national heart failure registry. *J Indian College Cardiol*. 2020;10(2):75–78.
13. van der Wal Haye H, M van Deursen Vincent, Peter van der Meer, Voors Adriaan A. Comorbidities in heart failure. *Handb Exp Pharmacol*. 2017;243:35–66.
14. Haeusler Karl Georg, Laufs Ulrich, Endres Matthias. Chronic heart failure and ischemic stroke. *Stroke*. 2011;42(10):2977–2982.
15. Díez Javier de Miguel, Morgan Jorge Chancafe, García Rodrigo Jiménez. The association between COPD and heart failure risk: a review. *Int J Chronic Obstr Pulm Dis*. 2013;8:305–312.
16. Ssentongo Paddy, Ssentongo Anna E, Heilbrunn Emily S, et al. Association of cardiovascular disease and 10 other pre-existing comorbidities with COVID-19 mortality: a systematic review and meta-analysis. *PloS One*. 2020;15(8), e0238215.
17. Dokainish Hisham, Teo Koon, Zhu Jun, et al. Global mortality variations in patients with heart failure: results from the International Congestive Heart Failure (INTER-CHF) prospective cohort study. *Lancet Glob Health*. 2017;5:e665–e672.
18. Chopra Vijay K, Mittal Sanjay, Bansal Manish, et al. Clinical profile and one-year survival of patients with heart failure with reduced ejection fraction: the largest report from India. *Indian Heart J*. 2019;71:242–248.

19. Mafham Marion M, Spata Enti, Goldacre Raphael, et al. COVID-19 pandemic and admission rates for and management of acute coronary syndromes in England. *Lancet*. 2020;396:381–389.
20. Baldi Enrico, Giuseppe Maria Sechi, Mare Claudio, et al. COVID-19 kills at home: the close relationship between the epidemic and the increase of out-of-hospital cardiac arrests. *Eur Heart J*. 2020;41(32):3045–3054.
21. Rahul Choudhary DM, Mathur Rohit, Sharma Jai Bharat, et al. Impact of Covid-19 outbreak on clinical presentation of patients admitted for acute heart failure in India. *Am J Emerg Med*. 2021;39:162–163. Temporal trends in decompensated heart failure and outcomes during COVID-19.
22. Cannatà Antonio, Bromage Daniel I, Rind Irfan A, et al. Temporal trends in decompensated heart failure and outcomes during COVID-19: a multisite report from heart failure referral centres in London. *Eur J Heart Fail*. 2020;22: 2219–2224.
23. Bromage DI, Cannata A, Rind IA, et al. The impact of COVID-19 on heart failure hospitalization and management: report from a Heart Failure Unit in London during the peak of the pandemic. *Eur J Heart Fail*. 2020;22:978–984.
24. Hall ME, Vaduganathan M, Khan MS, et al. Reductions in heart failure hospitalizations during the COVID-19 pandemic. *J Card Fail*. 2020;26(6):462–463.
25. Frankfurter Claudia, Buchan Tayler A, Kobulnik Jeremy, et al. Reduced rate of hospital presentations for heart failure during the Covid-19 pandemic in Toronto, Canada. *Can J Cardiol*. 2020;36(10):1680–1684.