ESC HEART FAILURE
ESC Heart Failure (2020)
Published online in Wiley Online Library (wileyonlinelibrary.com) **DOI:** 10.1002/ehf2.13157

ORIGINAL RESEARCH ARTICLE

Impact of telemedicine on the management of heart failure patients during coronavirus disease 2019 pandemic

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Aims Chronic heart failure (HF) is a major comorbidity accounting for an increased severity and mortality related to coronavirus disease 2019 (COVID-19). To reduce the risk of COVID-19 in HF patients, telemedicine has been encouraged.

Methods and results During the COVID-19 pandemic, telemedical management with mainly over-the-phone appointments became a major strategy of follow-up of our HF clinic patients. Previously, the large majority of patients have been seen in the hospital with direct patient-provider contact. We compared both strategies of follow-up, in pre-pandemic (PPP) and pandemic (PP) periods, regarding total mortality and hospitalizations/emergency department (ED) visits due to HF exacerbation. We prospectively studied a cohort of 196 patients. The mean follow-up time in PPP was 1.4 years. In this period, 20 patients died. In PP (follow-up of 71 days), there was one additional death. Total mortality in the first year of follow-up was 12.0%, matching the mortality predicted by the Meta-Analysis Global Group in Chronic Heart Failure score. Considering hospitalizations/ED visits due to decompensated HF, there was no statistically significant difference between PPP and PP. Only one patient was diagnosed with COVID-19.

Conclusions In the light of an increase in telemedical management of this cohort of HF patients, we were able to maintain a low rate of admissions due to HF decompensation, without an increment in mortality. Regarding these results, we encourage the incremental use of telemedicine in HF patients in the context of this or future pandemics and also in situations in which physical consultation might not be possible due to logistic issues.

Keywords Heart failure; COVID-19; Telemedicine

Received: 3 September 2020; Revised: 25 October 2020; Accepted: 22 November 2020
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Introduction

On December 2019, a new coronavirus—severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)—was identified in Wuhan, China,[1] and on March 2020, it has reached pandemic levels.[2]

Although the main manifestation is usually a viral pneumonia, SARS-CoV-2 can also cause cardiovascular complications in a considerable proportion of patients, such as arterial and venous thrombotic complications or even acute myocarditis.[2–4]

Additionally, either patients with cardiovascular risk factors (male gender, advanced age, arterial hypertension, diabetes mellitus, and obesity) or patients with established cardiovascular and cerebrovascular disease have been identified as vulnerable populations with increased morbidity and mortality in the context of coronavirus disease 2019 (COVID-19).[2,5]

Moreover, the risk of SARS-CoV-2 infection may be higher in chronic heart failure (HF) patients, considering that a great proportion has advanced age and the presence of multiple comorbidities is frequent.[2]

Finally, in order to reduce the risk of exposure to SARS-CoV-2, while preventing patient's baseline health from deteriorating at the same time, telemedical follow-up of stable HF patients is recommended, reserving direct patient-provider contact for the emergent/urgent situations.[2,6]

However, the impact of this strategy, which does not correspond to the standard of care, has not been addressed so far, therefore driving our current study.

Methods

Study population, setting, and data collection

The study population consisted of a prospective cohort of patients with chronic HF followed at a single centre (community hospital that covers an area of 600 908inhabitants). This centre has an established HF clinic (HFC), since November 2018, which currently follows more than 200 patients, mainly with reduced left ventricular ejection fraction.

This centre is an Electronic Medical Record Adoption Model stage 7 (Healthcare Information and Management Systems Society Analytics' highest stage certification) and a Joint Commission International-accredited hospital, which facilitated the systematization of all the electronic registries and also the creation of an informatic tool that generates an alert email every time one of the HFC patients is admitted to the hospital. 'Emergency department (ED) visits due to HF decompensation' were defined as admissions to the observation room, with the need for intravenous diuretics (particularly furosemide), whereas 'hospitalizations' were defined as admissions to the ward for intravenous diuretics or to the intensive care unit for inotropic support.

We prospectively followed all the patients included in our HFC, from 1 November 2018 to 22 May 2020.

In the pre-pandemic period (from 1 November 2018 to 12 March 2020), the standard follow-up of the patients consisted of in-person appointments (minimum of one appointment per trimester) with a multidisciplinary approach, including HF trained nurse evaluation, HF physician consultation (by a cardiologist dedicated to HF), with the support of other specialties (internal medicine, respiratory medicine, psychiatry, nephrology, gastroenterology, and nutrition).

All patients in our clinic have also access to a specific phone number (cell phone allocated to the nurse staff) in order to contact the team in case of any alert sign or symptom —according to the action plan (Appendix 1) defined in the pocket book elaborated by the HFC team as a self-monitoring registry of vital signs, symptoms, and weight and as a learning instrument for the patients. There is also a dedicated email of the HFC to facilitate communication.

In some cases, follow-up phone calls are scheduled to check patients' symptoms and to eventually adjust HF drugs, mainly diuretics. Whenever necessary, according to congestion signs and poor response to oral diuretics, patients are admitted to our day hospital in order to have intravenous diuretics (guided by a pre-specified protocol).

During the pandemic period (from 13 March to 22 May 2020), the in-person appointments were drastically reduced, being limited to urgent situations and to patients in New York Heart Association (NYHA) functional classes III/ambulatory IV.

To simplify our approach, all the pre-scheduled appointments were converted to teleconsultations (over-the-phone appointments including drug prescription via email or short message service, with adjustments of drugs in the ambulatory setting) in order to identify which patients would need an in-person care. All teleconsultations were free of charge for the patients (the government decided to include the expenses related to the teleconsultations in the National Health Service budget).

In order to check drug adherence, apart from the telephonic inquiry by the HFC team, we monitored the need for drug prescription renewal.

Every time that the HF team had difficulty reaching any patient by phone, there was a request to the administrative staff to contact the patient later on, in order to avoid absence of clinical evaluation.

To cope with this out-of-hospital management of the majority of the patients (who were mainly NYHA class I and II), many blood tests were made in local laboratories, allowing inclusively home-based phlebotomy.

Regarding other elective diagnostic and therapeutic procedures, if considered an urgent/emergent situation, it was possible to do radiographs/computed tomography, transthoracic or transesophageal echocardiograms, coronary angiograms, implantation or interrogation of cardiac devices, and inclusion on heart transplantation list, but all the stress tests had to be cancelled (including exercise stress test, myocardial scintigraphy, stress echocardiography) due to COVID-19 constraints.

Finally, all patients included in this study freely signed an informed consent form (that has been approved by the institutional ethics committee) authorizing prospective data collection for research purposes.

Statistical analysis

Data analysis was performed using Stata version 14.

For categorical variables, we calculated frequencies and percentages, and for continuous variables, we calculated mean and standard deviation or median and interquartile range.

Proportional Student's *t*-tests were used to analyse the differences between real mortality and estimated mortality.

Chi-squared tests were used to compare ED visits and hospitalizations.

Kaplan–Meier survival curve was computed to analyse general survival.

Significance level was set at 0.05.

Results

Demographic and clinical characteristics of the patients

Information regarding the demographic and clinical characteristics of the patients was obtained in the last

appointment before the pandemic and is presented in *Table 1*. The majority of patients received target doses of HF medication in accordance with the current guidelines.[7,8]

Outcomes in the pre-pandemic vs. pandemic period

In the pre-pandemic period, a total of 160 patients (mean of 10 per month) vs. 43 patients (mean of 20 per month), during the pandemic, had at least one inbound or outbound phone call with a HF dedicated nurse. The relative percentages of inbound/outbound calls were 55%/45% in the pre-pandemic period and 70%/30% during the pandemic.

Regarding medical evaluation, all of the pre-pandemic appointments were inpatient, and during the pandemic, more than 80% of the appointments were done over the phone. By the end of the pandemic period, there was only one patient that we were not able to reach out by phone, and in this case, an in-person appointment was scheduled, via mail post.

We were able to successfully titrate HF medications, such as sacubitril/valsartan, with a close monitoring of ambulatory blood tests results (regarding serum creatinine and potassium levels), registry of blood pressure, weight, and symptoms by the patients. During the follow-up time, we did not notice an increased rate of adverse drug events.

The total mortality in the first year of follow-up of this cohort was 12.0%, which was not significantly different than the mortality predicted by the Meta-Analysis Global Group in Chronic Heart Failure risk score at 1 year (mean value of 12.0% with 6.9% standard deviation).

In the whole pre-pandemic period, there were a total of 20 deaths, and during the pandemic, there was only one additional death, translating into the following survival curve (*Figure 1*).

Regarding hospitalizations (*Figure 2*) and ED visits (*Figure 3*) due to HF decompensation, there was no statistically significant difference between the pre-pandemic and the pandemic period (HF hospitalizations: $P = 0.83$; ED visits: $P = 0.27$).

Furthermore, during the pre-pandemic period, there were seven patients hospitalized and 20 patients treated in the ED due to HF exacerbation, compared with three patients hospitalized and four patients treated in the ED during the pandemic period.

As noted with the population admitted for decompensated HF, the proportion of patients hospitalized due to other diagnosis not HF related was also largely superior during the pre-pandemic period (71 hospitalized and 214 treated in the ED during the pre-pandemic period vs. 11 hospitalized and 52 treated in the ED during the pandemic period).

Across the pandemic period, there was only one patient diagnosed with COVID-19 who was infected in the hospital, in

Table 1 Clinical and demographic characteristics of the patients

Characteristic	*N* = 196
Age (years)	71.4 ± 11.8
Male gender, no. (%)	134 (68%)
Systolic blood pressure (mm Hg)	125 ± 18
Heart rate (beats/min)	65 ± 12
NYHA[a] functional class, no. (%)	
I	35 (18%)
II	118 (60%)
III	41 (21%)
IV (ambulatory)	2 (1%)
Clinical features of heart failure	
Ischaemic aetiology, no. (%)	78 (40%)
Left ventricular ejection fraction (%)	35.6 ± 10.6
Median NT-proBNP (IQR)[b] (pg/mL)	1590 (800–2693)
Medical history, no. (%)	
Arterial hypertension	86 (44%)
Diabetes mellitus	31 (16%)
Dyslipidaemia	39 (20%)
Atrial fibrillation	76 (39%)
Obesity[c]	29 (15%)
Anaemia	26 (13%)
Chronic kidney disease	55 (28%)
COPD	23 (12%)
Medications, no. (%)	
ACEi or ARB	83 (42%)
Sacubitril/valsartan	112 (57%)
Beta-blocker	180 (92%)
Mineralocorticoid receptor antagonist	116 (59%)
Ivabradine	14 (7%)
Digitalis	49 (25%)
Diuretic	88 (45%)
Devices, no. (%)	
Implantable cardioverter-defibrillator	27 (14%)
Cardiac resynchronization therapy	16 (8%)

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; COPD, chronic obstructive pulmonary disease.
Plus–minus values are means ± standard deviation.
[a]New York Heart Association (NYHA) class reflects the status of patients in the last in-person appointment during the pre-pandemic period.
[b]NT-pro-BNP denotes N-terminal pro-B-type natriuretic peptide plasma levels expressed as pg/mL (equivalent to ng/L, SI units) and IQR corresponds to interquartile range.
[c]Obesity is defined as a body mass index (weight in kilogrammes divided by the square of the height in metres) greater than or equal to 30 kg/m^2.

Figure 1 Kaplan–Meier survival curve from 1 November 2018 to 22 May 2020, including the pre-pandemic and the pandemic periods. Dashed line represents the transition between both periods.

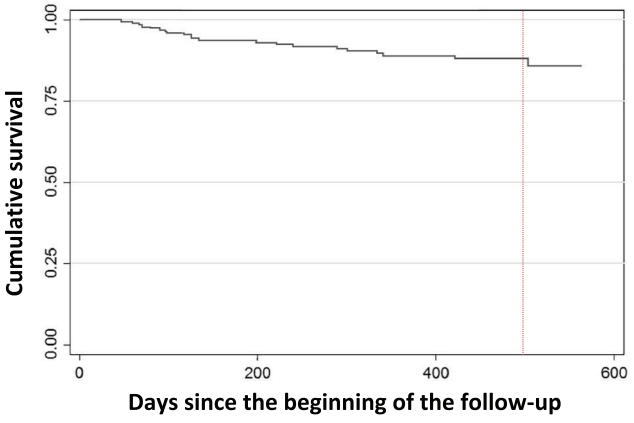


Figure 2 Hospitalizations due to heart failure (HF) decompensation vs. due to other causes (not HF related) in the pre-pandemic period (PPP) and during the pandemic period (PP). *P* = ns denotes a non-significant *P* value.

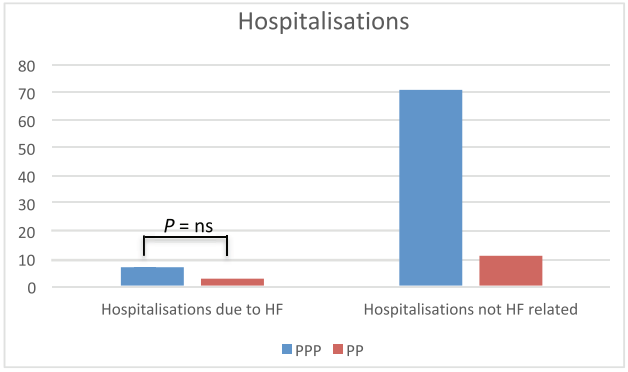
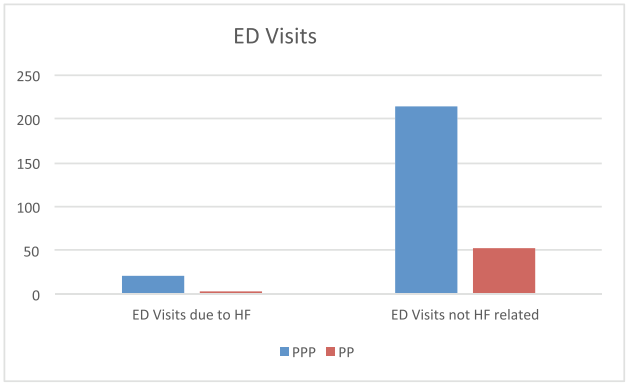


Figure 3 Emergency department (ED) visits due to heart failure (HF) decompensation vs. due to other causes (not HF related) in the pre-pandemic period (PPP) and during the pandemic period (PP). *P* = ns denotes a non-significant *P* value.



the context of a non-HF hospitalization, with a favourable outcome (the patient remained asymptomatic without any cardiovascular or respiratory complications).

Discussion

In Portugal, a state of national emergency was declared from 18 March to 2 May 2020, which implied that only essential services were able to function and the general population was advised to stay at home, having a profound impact on the hospitals' workflow.

On the one hand, the entire health system had to be prepared to face the pandemic and, on the other hand, needed to find a solution to keep caring for the higher-risk patients, including HF patients.

In this context, we immediately adapted our HFC, in order to keep the follow-up of stable patients with the minimum physical contact possible, reserving the in-person evaluation and interventions to unstable patients/urgent situations.

The importance of HFCs in patients' outcomes has already been underlined.[9–11]

Nonetheless, although we also had recently documented a positive impact of our multidisciplinary model on both the quality of life and the morbidity/mortality of HF patients, those results were obtained in a different context, with a fully operational HFC.[12]

In this context, we decided to compare the data before and during the more restrictive phase of the pandemic, in order to evaluate the impact of the change from the previous model with documented clinical success regarding the already mentioned outcomes.

During the pandemic, we heavily intensified the number of teleconsultations of the patients and we were able to manage the majority of them without the need of exposure to the hospital environment.

Despite the significant reduction of in-person consultation and of total hospital admissions (probably as a result of fear of COVID-19), there were no increments in hospitalizations and ED visits due to HF decompensation and no rise in all-cause mortality, which signals that this approach was safe and effective, allowing simultaneously protection of the patients against exposure to SARS-CoV-2.

However, there are some limitations to our study: it is a single-centre observational study, with a small sample size, a short period of follow-up during the pandemic compared with our pre-pandemic period (71 vs. 498 days), and a low event number.

In the face of these preliminary, real-world, positive results, we encourage the incremental use of telemedicine in HF patients, in the context of COVID-19 pandemic or even future pandemics. It is feasible, safe, effective, and also more efficient in terms of access to a frequently overloaded health system. In the near future, this approach could even be expanded to situations in which physical consultation might not be possible due to logistics issues, such as patients who have limited mobility or who have to travel long distances to reach the hospital.

Finally, COVID-19 pandemic demonstrated the need for a paradigm shift in standard care, increasing the application of strategies that keep the patients away from the hospital as much as possible, avoiding not only the risks inherent to hospital setting but also the constraints associated to a more complex level of health care.

Acknowledgements

The authors thank the valuable contribution of Liliana Cruz and Madalena Guimarães in data collection.

Conflict of interest

None declared.

Funding

No funding to declare.

Appendix

Action Plan for Heart Failure patients (English version)

References

1. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020; **323**: 10611069.
2. ESC Guidance for the Diagnosis and Management of CV Disease during the COVID-19 Pandemic. https://www.escardio.org/Education/COVID-19-and-Cardiology/ESC-COVID-19-Guidance (accessed date 18 June 2020).
3. Shi S, Qin M, Shen B, Cai Y, Liu T, Yang F, Gong W, Liu X, Liang J, Zhao Q, Huang H, Yang B, Huang C. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. *JAMA Cardiol* 2020; **5**: 802–810.
4. Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O. Potential effects of coronaviruses on the cardiovascular system: a review. *JAMA Cardiol* 2020; **5**: 831–840.
5. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, Wang H, Wan J, Wang X, Lu Z. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). *JAMA Cardiol* 2020; **5**: 811–818.
6. Hollander JE, Carr BG. Virtually perfect? Telemedicine for COVID-19. *N Engl J Med* 2020; **382**: 1679–1681.
7. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J* 2016; **37**: 2129–2200.
8. Clinical practice update on heart failure 2019: pharmacotherapy, procedures, devices and patient management. An expert consensus meeting report of the Heart Failure Association of the European Society of Cardiology. *Eur J Heart Fail* 2019; **21**: 1169–1186.
9. Fonseca C. A heart failure clinic. *Eur Heart J* 2018; **39**: 826–828.
10. Heart failure clinics are associated with clinical benefit in both tertiary and community care settings: data from the Improving Cardiovascular Outcomes in Nova Scotia (ICONS) registry. *Can J Cardiol* 2009; **25**: e306–e311.
11. Gustafsson F, Arnold JM. Heart failure clinics and outpatient management: review of the evidence and call for quality assurance. *Eur Heart J* 2004; **25**: 1596–1604.
12. Nogueira M, Ferreira F, Raposo A, Mónica L, Cruz L, Guimarães M, Fandinga L, Matias C, Proença G. Impact of a heart failure clinic on morbidity, mortality and quality of life. *Eur J Heart Fail* 2020; **22**: 71.