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MAIN CARDIAC COMPLICATIONS IN ELDERLY INFECTED BY SARS-COV-2: A SYSTEMATIC REVIEW

Principais complicações cardíacas em idosos infectados pelo SARS-CoV-2: uma revisão sistemática

Principales complicaciones cardíacas en ancianos infectados por SARS-CoV-2: una revisión sistemática

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ABSTRACT

Objective: to understand the main complications of SARS-CoV-2 in the elderly cardiac system. **Methods:** systematic literature review conducted in 2020. **Results:** the most prevalent cardiac complications in the elderly population were myocarditis, arrhythmias, heart failure, acute infarction, cardiogenic shock, acute myocardial injury and cardiorespiratory arrest. The main cardiac biomarker was troponin, showing an elevation above the 99th percentile, evidencing the need for treatment in the Intensive Care Unit. **Final Considerations:** the appearance of this virus has caused great damage in the health field, especially the elderly population, who is at high risk of death when contracting this disease. Therefore, it is important to stick to the measurement of serum troponin in the target audience and perform longitudinal monitoring, using telecardiology for this purpose, since they reduce the chances of contamination between infected and health professionals.

DESCRIPTORS: Coronavirus infections; Aged; Heart Diseases; Telecardiology.

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RESUMO

Objetivo: compreender as principais complicações ocasionadas pelo vírus SARS-CoV-2 no sistema cardíaco do público idoso. **Métodos:** trata-se de uma revisão sistemática da literatura de abordagem qualitativa e característica descritivo-exploratória realizada no ano de 2020. **Resultados:** as complicações cardíacas mais prevalentes na população idosa foram miocardite, arritmias, insuficiência cardíaca, infarto agudo, choque cardiogênico, lesão miocárdica aguda e parada cardiorrespiratória. O principal biomarcador cardíaco foi a troponina, apresentando elevação superior ao percentil 99^o, evidenciando a necessidade de tratamento em Unidade de Terapia Intensiva. **Considerações Finais:** o aparecimento desse vírus causou grande prejuízo no campo da saúde, especialmente a população idosa, que apresenta risco elevado de óbito ao contrair essa doença. Destarte, é de extrema importância se ater a mensuração da troponina sérica no público alvo e realizar monitorização longitudinal, utilizando para tal a telecardiologia, uma vez que diminuem as chances de contaminação entre infectado e profissional de saúde.

DESCRITORES: Infecções por coronavírus; Idoso; Cardiopatias; Telecardiologia.

RESUMEN

Objetivo: comprender las principales complicaciones del SARS-CoV-2 en el sistema cardíaco anciano. **Métodos:** revisión sistemática de la literatura realizada en 2020. **Resultados:** las complicaciones cardíacas más prevalentes en la población anciana fueron miocarditis, arritmias, insuficiencia cardíaca, infarto agudo, shock cardiogénico, lesión miocárdica aguda y parada cardiorrespiratoria. El principal biomarcador cardíaco fue la troponina, mostrando una elevación por encima del percentil 99, evidenciando la necesidad de tratamiento en la Unidad de Cuidados Intensivos. **Consideraciones finales:** la aparición de este virus ha provocado un gran daño en el campo de la salud, especialmente en la población anciana, que se encuentra en alto riesgo de muerte al contraer esta enfermedad. Por tanto, es importante ceñirse a la medición de troponina sérica en el público objetivo y realizar un seguimiento longitudinal, utilizando para ello la telecardiología, ya que reducen las posibilidades de contaminación entre los infectados y los profesionales sanitarios.

DESCRIPTORES: Infecciones por coronavirus; Anciano; Cardiopatías; Telecardiología.

INTRODUCTION

Cardiovascular diseases have long been seen as a worldwide public health problem¹ and have challenged the health system to seek innovative strategies for the clinical management of patients with heart disease in order to improve the quality of life of this portion of the population, since data from the World Health Organization (WHO) emphasize the occurrence of 18 million deaths annually due to this pathology.² Consequently, the discovery of a new virus in Hubei province, China, at the end of 2019 brought with it even more concerns in this regard, since it has the power to affect the cardiovascular system and raise the mortality rate of this community.

Thus, the current scenario has made the work of health professionals difficult due to the rapid transmissibility of the so-called SARS-CoV-23 that officially caused a pandemic, as decreed by the World Health Organization on March 11, 2020.³ According to this health body, on September 4 of the same year the number of confirmed cases of this disease was 26,121,999 and the number of deaths, 864,618.²

Therefore, with this emergency crisis installed, this challenge has become even more difficult, since the public health system has been overburdened by an exponential number of infected individuals, unavailability of beds to meet the demand in question, lack of financial and material resources, such as mechanical ventilators and personal protective equipment, and uncertainties regarding the treatment of this disease, Covid-19, since so far no effective vaccine has been found.⁴

This situation has negatively impacted the lives of all individuals, especially those who have underlying heart disease and require rapid care, since the case fatality rate caused by Covid-19 is considered higher in this collectivity, reaching 10.5%.⁵ Thus, despite presenting a tropism for pulmonary cells, the virus has caused severe consequences in the cardiovascular system, including acute coronary syndromes, myocardial injury, myocarditis, arrhythmias, heart failure, and cardiogenic shock.⁶

China was the first country to show myocardial injury through the elevation of specific biomarkers, especially troponin I, in 12.2% of the first 41 confirmed cases.⁶⁻⁷ The main comorbidities found were: heart disease, hypertension, diabetes mellitus, and cerebrovascular diseases⁸ emphasizing that these groups present the most severe form of the disease, especially when coupled with the factor advanced age, requiring treatment in Intensive Care Unit.

It is believed that the injury to the cardiomyocytes is caused by the systemic inflammatory response with release of numerous cytokines with the potential to destabilize atherosclerotic plaques, and may also cause an imbalance between supply and demand for oxygen, in addition to direct impact on the myocardium by binding to receptors of the Angiotensin Converting Enzyme 2 (ACE2) in the cardiac tissue.⁹⁻¹⁰

In addition to the myocardial disorders originated and/or intensified because of the pandemic, depending on the severity of the clinical outcomes, the SARS-CoV-2 virus can cause cardiac arrest as demonstrated by a study conducted in Italy during this period, reporting a 58% increase in Cardiorespiratory Arrest

(CRA) in out-of-hospital settings compared to the same period in January in 2019¹¹. It is noted then that this increase has a strong association with the emergence of this new virus and its power of infectivity, leading to a poor prognosis of the health situation, especially those who already have some disability in the heart, such as heart failure, which in turn was present in 23% to 49% of the sample studied with CA.

That said, it is clear that the cardiac complications of Covid-19 are potentially fatal, especially in the elderly population. Thus, it is clear that, along with the demographic transition, there has been an increase in the life expectancy of individuals in this age group; however, parallel to this fact, the number of chronic noncommunicable diseases has increased, which is worrisome, since the mortality rate from Covid-19 can be 9 times higher in chronic patients.

Moreover, a prospective cohort study conducted at Renmin University Hospital in January, China, included the participation of 416 patients with a mean age of 64 years and showed that most of them were hypertensive and diabetic, elucidating the appearance of acute myocardial injury in 19.7% of this population, triggered by coronavirus¹³. Thus, it is evident the need to seek strategies to significantly improve the clinical management of infected patients who are hospitalized, in addition to designing an effective plan to promote and protect the health of non-positive chronic patients who need to continue their treatments, but follow the recommendation to stay at home, since the hospital environment is considered a place with high risk of contracting the virus¹⁴.

Thus, the guiding objective of this study is to understand the complications caused by the SARS-CoV-2 virus in the cardiac system of the elderly, and the interest in the study is evidenced by the fact that it is an emerging problem not fully understood, with provisions still uncertain in the area of cardiology.

METHODS

A systematic review of qualitative literature with a descriptive-exploratory approach was carried out in 2020, aiming to understand the cardiac complications caused by SARS-CoV-2 in individuals with pre-existing comorbidities, especially the elderly. This type of study allows the gathering of several studies that emphasize the same theme, guiding the development of the text in order to answer a specific question, indicating new directions for future investigations. Thus, the guiding question of the research will seek answers about “what are the main complications caused by the SARS-CoV-2 virus in the cardiac system of the elderly?”

The databases used were PubMed/Medline (Medical Literature Analysis and Retrieval System Online), Scielo (Scientific Electronic Library Online) and Electronic Journals. The descriptors used were as follows: Covid-19. Elderly Population. Cardiopathies. The crossing of the terms occurred as follows: “Covid-19 OR heart diseases”, “Covid-19 OR oldman”, “Telecardiology OR heart”.

The literature review took place in September 2020, seeking to describe the main cardiac complications caused by SARS-CoV-2

in the elderly population. At first, the guiding question of the review was established, aiming to better understand the cardiac complications caused by the emerging virus in the elderly public, since it is a population in growing demographic transition.

Next, the databases were pre-established to proceed with the search for the articles to be reviewed. The search resulted in 78 articles, of these only 36 fit the study proposal, being 1 found in PubMed, 3 in Scielo, and the others in Electronic Journals. Full articles from 2017 onwards were included, with no language restrictions, and that addressed the complications affecting the cardiac system due to SARS-CoV-2, especially in the elderly, excluding texts in the form of abstracts, expanded abstracts, and studies conducted in animals.

Subsequently, the analytical reading method was initiated to collect pertinent and coherent information with the theme, from the already selected articles, proceeding with the tabulation of these in electronic media, to then perform a critical summary of the data, using for this the systematic reading method. Finally, the construction of ideas and the subsequent conclusion of the data was carried out and interpreted, seeking to answer the questions raised.

RESULTS AND DISCUSSION

In summary, this literature review allowed to highlight the most prevalent complications in the cardiac system arising from coronavirus infection, whose pathophysiological mechanism is triggered by systemic inflammation that allows the viral surface spike protein to bind to ACE2 receptors on myocardial cells, thus damaging the heart muscle and compromising its functionality. Thus, the association between heart disease and adverse outcomes in patients with Covid-19 is evident, and the group at highest risk of morbidity and mortality is the elderly with chronic noncommunicable diseases, especially systemic arterial hypertension (SAH), diabetes mellitus (DM), and cardiovascular disease (CVD).¹³

Cardiac complications can occur directly, with the infiltration of SARS-CoV-2 into the heart tissue resulting in inflammation and consequent cell death, or indirectly by causing stress in the respective organ, stemming from systemic respiratory inflammation resulting in hypoxemia.¹⁵ In this context, besides the elevation of troponin I, a cardiac biomarker with elevation higher than the 99th percentile altered in infected cardiac patients, other markers are elevated, namely interleukin 6 (IL-6), lactate dehydrogenase, C-reactive protein, d-dimer, prolactin, and leukocytes.¹⁶⁻¹⁷

According to the aforementioned articles, it can be noticed that the emergency crisis caused by SARS-CoV-2 raised the scientific society's concern, especially the cardiological one, leading to several studies regarding the cardiac impact caused by this virus. Such initiative can be explained by the fact that the elderly population has grown worldwide, and along with it, the prevalence of cardiovascular diseases, making this age group even more vulnerable, besides the evidence pointing to a higher mortality rate in cardiac patients infected by the coronavirus.

Example 1: Table 1 – Score of the main cardiac complications of SARS-CoV-2 in the elderly. Barra do Mendes, BA, Brazil, 2020

Author	Middle Ages From Sample	Pre-existing Comorbidities	Cardiac Complications (%)
Huang et al. 2020 ⁽⁷⁾	64 years old	DM SAH CVD	Acute Heart Injury (12%)
Guo et al. 2020 ⁽¹⁷⁾	58,5 years old	SAH DM CVD	Cardiac Injury (27,8%)
Wang et al. 2020 ⁽²⁴⁾	56 years old	SAH CVD DM	Arrhythmias (44,4%)
Shi et al. 2020 ⁽¹³⁾	64 years old	SAH DM CVD	Cardiac Injury (19,7%)
Arentz et al. 2020 ⁽³⁴⁾	70 years old	DM CHF	Cardiomyopathy (33%)
Yang et al. 2020 ⁽³⁵⁾	59,7 years old	CVD	Cardiac Injury (23%)

*Systemic Arterial Hypertension (SAH), Diabetes Mellitus (DM), Cardiovascular Diseases (CVD), and Congestive Heart Failure (CHF).

According to the data explored from the tabulated articles, the most prevalent comorbidities are Systemic Arterial Hypertension, Diabetes Mellitus, and Cardiovascular Diseases resulting from multifactorial dysfunctions linked mainly to the population's lifestyle, making them susceptible in periods of emerging crisis. According to the review of articles, the most prevalent cardiac complications in the elderly population with underlying disease were: myocarditis, acute coronary syndrome, arrhythmias, heart failure, cardiogenic shock, acute myocardial injury, and cardiac arrest.

In this follow-up, a prospective cohort study conducted in April 2020, in 187 patients diagnosed with Acute Myocardial Infarction, revealed positive test for Covid-19 in 17% of them, emphasizing increased mortality with cardiovascular involvement in this portion of the sample compared to patients negative for SARS-CoV-2 (25% vs 3.8%), through the elevation of inflammatory markers.¹⁸ Most patients who contract the virus need specialized treatment in the Intensive Care Unit¹³, particularly when they present Severe Acute Respiratory Syndrome indicating the need to receive invasive mechanical ventilation with FiO₂ at 100% in the first 5 minutes, and closed subglottic suction system, aiming to minimize as much as possible the risk of contaminating health care professionals, since the virus dissemination occurs through contact with respiratory droplets contaminated by this virus¹⁹.

One of the most frequent complications in heart disease patients who contracted the coronavirus was severe arrhythmia, observed in a study with 138 patients, with higher prevalence in individuals in the ICU, corroborating the data from a retrospective study with the participation of 187 infected patients, which

showed the appearance of malignant ventricular arrhythmias in the sample studied.^{17,20} In this context, the electrocardiographic examination is of great importance in the diagnosis and differentiation of these abnormalities^{13,21} and leads to appropriate clinical management according to the particularities of each patient, besides being essential in monitoring patients taking hydroxychloroquine, a drug that has been used to minimize the symptoms present in the clinical picture of Covid-19.²²

Subsequently, a cohort study of 150 individuals with a mean age of 58.5 years reported the presence of irreversible myocardial damage and heart failure in 7% of this public, associated once again with high troponin levels, linking this data to the frequent occurrence of other complications, such as ventricular tachycardia, ventricular fibrillation, or severe hemodynamic instability, which may evolve to shock and consequently cause multiple organ failure. In this context, it is essential that these patients are treated quickly in order to minimize the impact caused to the heart and other organs.¹⁷

Thus, to be successful in clinical management, it is essential to recognize the symptoms of Covid-19 early on, whose characteristic manifestations are fever, dry cough, and dyspnea, and there may also be arthralgia, nasal congestion, and diarrhea, among others.³ This information has been disseminated frequently to the population in order to spread knowledge about the disease and induce people to seek the health system in cases that are really indicated, speeding up care and aiming to improve the signs and symptoms.

That said, regarding shock, one of the complications evidenced, it is essential that those affected receive minimally invasive hemodynamic monitoring associated with electrocardiographic

monitoring and evaluation of biomarkers of low tissue perfusion, since hypoxia is considered the most likely cause of cardiac arrest in the infected.²³ A study of 138 patients with a mean age of 56 years hospitalized with Covid-19 showed a mortality rate of cardiac arrest in 4.3% of cases, accompanied by infarction, acute heart failure, and myocarditis, especially arrhythmias (16.7%) and acute cardiac injury (7.2%).²⁴

Thus, there is no doubt that the damage caused by SARS-CoV-2 in the cardiac system deserves attention and further studies on this issue, since this is a new virus that has a high rate of transmissibility, and although its lethality is considered low in the general population, between 0.3 to 7.2%, in patients with heart disease, these levels are considered worrisome and can reach 10.5%.^{13,24} Such an attitude would help in developing strategies for health services to deal with possible future epidemics, which may present a pattern similar to the current crisis, in order to improve health actions, as well as the quality of life of individuals, besides having a stock of material and financial resources to meet the affected demand, emphasizing the Intensive Care Units.²⁵

Following this line of reasoning, the review of a meta-analysis including data from 341 patients, including the elderly, infected with Covid-19 demonstrated that those with myocardial injury required ICU admission more frequently (22.2%) compared with patients without cardiac disorders (2.0%), further evidencing a higher incidence of heart failure and high mortality rates in critically ill patients reaching 59%.¹⁶ Given this situation, it is necessary that professionals be aware of the care to be provided to these patients, especially when heart failure is present, avoiding administering excessive intravenous fluids.^{19,26-27}

Thus, parallel to the biological damage, another problem evidenced by the pandemic was the overcrowding of hospital beds, especially those in the ICU, a fact that led government entities to invest in the construction of new beds through field hospitals; however, the public health system is still at risk of collapse due to the damage caused by SARS-CoV-2.^{2,28}

In this vein, the emergency crisis caused by Covid-19 and its cardiovascular impacts, has directed attention to telecardiology, an area that has gained prominence in this scenario, due to the restriction of in loco care (hospital) since it is considered an environment with high risk of contamination, as well as due to the measures of social distance.²⁹⁻³⁴

Thus, telemonitoring via Smartphone was already a reality practiced by health professionals in the virtual monitoring of patients with heart disease, proving to be an efficient strategy, positively impacting the monitoring of this public, and aims to complement and not “replace” the traditional management.³⁰ A study conducted in the year 2017 using this system that made available an informative cholesterol app, hemodynamic pre-intervention videos, and telemonitoring itself to treat heart failure, evidenced better self-learning and self-care, reduced cholesterol levels, and improved NYHA (New York Heart Association) class in these patients.³¹

It is well known that this type of service through telecardiology has several functionalities, such as managing a drug therapy or

therapeutic plan, monitoring the patient’s clinical picture, discussing treatment options, care pathways, as well as functioning as a health education tool, disseminating important information about diseases and forms of prevention, besides allowing the patient to make use of the “connection” mode, in the middle of the aggravation of his pathology in order to receive guidance on prioritized access to an in-depth consultation.³²

In this aspect, regarding acute myocardial infarction, an injury that can even be caused by coronavirus infection, telemedicine allows early electrocardiographic recording both at home and pre-hospital avoiding delay in care and consequently reducing the mortality rate of this community. Thus, telecardiology can be considered an ally for primary and specialized care, being extremely useful in this pandemic scenario, especially for individuals at high risk, because it reduces exposure to the virus and also helps in the control of underlying diseases.³¹

This technological resource led the Brazilian Ministry of Health to publish, on April 1, 2020, a decree emphasizing telemedicine as a tool for teleguidance, teleconsultation, and telemonitoring in the midst of the pandemic. Therefore, the use of this technology is mandatory as an emergency support to issues related to biological risks caused by the pandemic, thus pushing telecardiology to become a standard operating mode in order to act against cardiac complications caused by SARS-CoV-2.³²⁻³⁵

CONCLUSION

The arrival of the coronavirus in Brazil brought with it several implications for public health, due to its potential for contamination and/or infection. With the growing curve of the virus dissemination, health care facilities have exceeded their maximum capacity and have become overcrowded. Thus, strategic measures were implemented by government authorities aiming to reduce the chain of transmission of SARS-CoV-2, namely social distancing, isolation, and lockdown, as well as hand hygiene, mask use, and respiratory etiquette.

Despite the adoption of these measures, Covid-19 has caused great damage in the field of health, especially to the elderly population, as they have a high risk of death when contracting this disease, especially those who have pre-existing comorbidities, especially cardiovascular pathologies. In this follow-up, the main cardiac complications caused by the virus were: myocarditis, acute coronary syndrome, myocardial injury, arrhythmias, heart failure, acute infarction, and cardiogenic shock, which can lead to cardiorespiratory arrest and multiple organ dysfunction.

According to research, one of the possible pathophysiological mechanisms of the virus is the attachment to lung cells triggering systemic inflammation with release of numerous cytokines, promoting an imbalance between supply and demand for oxygen, thus damaging the heart tissue. In this context, cardiac biomarkers were found at elevated levels, especially troponin, in most Covid-19 positive cardiac patients.

Thus, it is of utmost importance to stick to the measurement of serum troponin in patients admitted with this infection and to

perform longitudinal monitoring during hospitalization, using telecardiology for this purpose, since it decreases the chances of contamination between the infected and the healthcare worker. This tool also works as a preventive strategy, because it allows the telemonitoring of patients with non-positive heart diseases, avoiding that they go to the hospital, a place considered to be at high risk of contamination.

We conclude emphasizing the need to develop more research on the impacts caused by this virus in the cardiac system, since it has a high mortality rate in individuals who have diseases in this system, in order to improve their quality of life, using telecardiology as an ally.

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REFERENCES

- Viana PAS, Neto JDC, Novais CT, Guimarães IF, Lopes YS, Reis BC. Perfil de Pacientes Internados para Tratamento de Insuficiência Cardíaca Descompensada. *SANARE Rev. Políticas Públicas*. [Internet]. 2018 [acesso em 2 de setembro de 2020]; 17(1). Disponível em: <https://sanare.emnuvens.com.br/sanare/article/view/1218>.
- World Health Organization (WHO). Coronavirus disease 2020 (COVID-19). [Internet]. 2020 [cited 2020 mar 11]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>.
- Zheng YY, Ma YT, Zhang JY, Xie X. COVID-19 and the cardiovascular system. *Nat. Rev. Cardiol.* [Internet]. 2020 [cited 2020 mar 5]; 17(1). Available from: <https://www.nature.com/articles/s41569-020-0360-5.pdf>.
- Tasca R, Massuda A. Estratégias para reorganização da Rede de Atenção à Saúde em resposta à Pandemia COVID-19: a experiência do Sistema de Saúde Italiano na região de Lazio. *Rev APS*. [Internet]. 2020 [citada em 15 de abril de 2020]; 2(1). Disponível em: <https://apsemrevista.org/aps/article/view/65/44>.
- Rezende D. COVID-19 e pacientes com doenças cardiovasculares. *Arq Bras Cardiol.* [Internet]. 2020 [citado em 13 de julho de 2020]; 114(5). Disponível em: <http://ref.scielo.org/8h4wdw>
- Bansal M. Cardiovascular disease and COVID-19. Elsevier Public Health Emergency Collection. [Internet]. 2020 [cited 2020 mar 5]; 14(3). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7102662/>.
- Huang C, Wang Y, Li X. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. [Internet]. 2020 [cited 2020 jan 24]; 395(1). Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30183-5/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30183-5/fulltext).
- Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L, Wei Y, Li H, Wu X, Xu J, Tu S, Zhang Y, Chen H, Cao B. Clinical course and risk factors for mortality of adult in patients with COVID-19 in Wuhan, China: a retrospective cohort study. Elsevier Public Health Emergency Collection. [Internet]. 2020 [cited 2020 mar 28]; 395(10229). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7270627/>.
- Tavazzi G, Pellegrini C, Maurelli M, Belliato M, Sciutti F, Bottazzi A, Sepe PA, Resasco T, Camporotondo R, Bruno R, Baldanti F, Paolucci S, Pelenghi S, Iotti GA, Mojoli F, Arbustini E. Myocardial localization of coronavirus in COVID-19 cardiogenic shock. *Eur J Heart Fail.* [Internet]. 2020 [cited 2020 apr 10]; 22(5). Available from: <https://onlinelibrary.wiley.com/doi/full/10.1002/ejhf.1828>
- Long B, Brady WJ, Koyfman A, Gottlieb M. Cardiovascular complications in COVID-19. *Am J Emerg Med.* [Internet]. 2020 [Cited 2020 apr 18]; 38(7). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7165109/>.
- Baldi E, Sechi GM, Mare C, Canevari F, Barancaglione A, Primi R, Kelersy C, Palo A, Contri E, Ronchi V, Beritta G, Reali F, Parogni P, Facchin F, Rizzi U, Bussi D, Ruggeri S, Visconti LO, Savastano S. COVID-19 kills at home: the closed relationship between the epidemic and the increase of out-of-hospital cardiac arrests. *European Heart Journal*. [Internet] 2020. [cited 2020 may 18]; 41(32). Available from: <https://solaci.org/pt/2020/07/09/europcr-2020-as-mortes-subitas-aumentam-o-dobro-ou-o-triplo-ao-passo-que-os-infartos-diminuem/>.
- Costa JA, Silveira JA, Santos SCM, Nogueira PP. Implicações Cardiovasculares em Pacientes Infectados com Covid-19 e a Importância do Isolamento Social para Reduzir a Disseminação da Doença. *Arq Bras Cardiol.* [Internet] 2020. [citado em 15 de abril de 2020]; 114(5). Disponível em: <https://doi.org/10.36660/abc.20200243>.
- 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.* [Internet]. 2020 [cited 2020 jul 1]; 5(7). Available from: <https://jamanetwork.com/journals/jamacardiology/fullarticle/2763524>.
- Boukhris M, Hillani A, Moroni F, Annabi MS, Addad F, Ribeiro MH, Mansour S, Zhao X, Ybarra LF, Abbate A, Vilca LM, Azzalini L. Cardiovascular Implications of the COVID-19 Pandemic: A Global Perspective. *Can J Cardiol.*

- [Internet]. 2020 [Cited 2020 may 16]; 36(7). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7229739/>.
15. Neto JAF, Marcondes-Braga FG, Moura LZ, Figueiredo AMS, Figueiredo VM, Mourilhe-Rocha R, Mesquita ET. Doença de Coronavírus-19 e o Miocárdio. Sociedade Brasileira de Cardiologia. [Internet]. 2020 [citado em 6 de maio 2020]; 114(6). Disponível em: <http://publicacoes.cardiol.br/portal/abc/portugues/2020/v11406/pdf/11406012.pdf>.
 16. Lippi G, Lavie CJ, Sanchis-Gomar F. Cardiac troponin I in patients with coronavirus disease 2019 (COVID-19): Evidence from a meta-analysis. *Prog Cardiovasc Dis*. [Internet]. 2020 [cited 2020 mar 10]; 63(3). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7127395/>.
 17. 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*. [Internet]. 2020 [cited 2020 mar 27]; 5(7). Available from: file:///C:/Users/Pc/Downloads/jamacardiology_guo_2020_oi_200026.pdf.
 18. Solano-López J, Zamorano JL, Sanz AP, Amat-Santos I, Sarnago F, Ibañes GE, Sanchis J, Blas JRR, Gómez-Hospital JA, Martínez SS, Maneiro-Melón NM, Gaitán RM, D'Gregorio JG, Salido L, Mestre JL, Sanmartín M, Sánchez-Recalde A. Risk factors for in-hospital mortality in patients with acute myocardial infarction during the COVID-19 outbreak. *Rev Esp Cardiol*. [Internet]. 2020 [cited 2020 aug 22]; 73(12). Available from: <https://www.revespcardiol.org/en-risk-factors-for-in-hospital-mortality-avance-S1885585720303546>.
 19. Ministério da Saúde (BR). Protocolo de Manejo clínico da Covid-19 na atenção especializada. Secretaria de Atenção Especializada à Saúde. [Internet]. 1. ed. Brasília: Ministério da Saúde; 2020 [acesso em 4 de setembro de 2020]. Disponível em: file:///C:/Users/Pc/Downloads/manejo_clinico_covid-19_atencao_especializada.pdf.
 20. Clerkin KJ, Fried JA, Raikhelkar J, Sayer G, Griffin JM, Masoumi A, Jain SS, Burkoff D, Kumaraiah D, Rabbani L, Schwartz A, Uriel N. COVID-19 and Cardiovascular Disease. *Rev Circulation*. [Internet]. 2020 [cited 2020 mar de 20]; 141(20). Available from: <https://pubmed.ncbi.nlm.nih.gov/32200663/>.
 21. Ruffell D. Coronavirus SARS-CoV-2: filtering fact from fiction in the infodemic. *Wiley Public Health Emergency Collection*. [Internet]. 2020 [cited 2020 apr 9]; 594(7). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7164109/>.
 22. Pacheco RL, Pachito DV, Bagattini AM, Riera R. Hidroxicloroquina e Coroquina para Covid-19. Revisão Sistemática Rápida. [Internet]. 2020 [citado em 21 de maio de 2020]; Disponível em: https://docs.bvsalud.org/biblioref/2020/06/1099475/rs_rapida_hidroxicloroquina_covid19_atualizacao_21_05_20.pdf.
 23. Costa IBSS, Bittar CS, Rizk SI, Filho AEA, Santos KAQ, Machado TIV, Andrade FTA, González TB, Arévalo ANG, Almeida JP, Bacal F, Oliveira GMM, Lacerda MVG, Barberato SH, Chagas ACP, Rochitte CE, Ramires JAF, Filho RK, Hajjar LA. O Coração e a COVID-19: O que o Cardiologista Precisa Saber. *Arq Bras Cardiol*. [Internet]. 2020 [acesso em 6 de setembro de 2020]; 114(5). Disponível em: <https://www.scielo.br/j/abc/a/F5BDXsNWzSjwbzqfV6WPQbF/?lang=pt#>.
 24. 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*. [Internet]. 2020 [cited 2020 Feb 7]; 323(11). Available from: <https://jamanetwork.com/journals/jama/fullarticle/2761044>.
 25. Lima LMGC, Sousa MS, Lima KVB. The genomic discoveries of SARS-CoV-2 and their implications for the COVID-19 pandemic. *J Health Biol Sci*. [Internet]. 2020 [cited 2020 may 5]; 8(1). Available from: https://www.researchgate.net/publication/341389454_As_descobertas_genomicas_do_SARSCoV_e_suas_implicacoes_na_pandemia_de_COVID19/link/5ee6645b458515814a5e86cb/download.
 26. Driggin E, Madhavan MV, Bikdeli B. Cardiovascular Considerations for Patients, Health Care Workers, and Health Systems During the COVID-19 Pandemic. *J Am Coll Cardiol*. [Internet]. 2020 [cited 2020 mar 18]; 75(18). Available from: <https://pubmed.ncbi.nlm.nih.gov/32201335/>.
 27. Murthy S, Gomersall CD, Fowler RA. Care for Critically Ill Patients With COVID-19. *JAMA*. [Internet]. 2020 [cited 2020 mar 11]; 323(15). Available from: <https://pubmed.ncbi.nlm.nih.gov/32159735/>.
 28. Agência Nacional de Vigilância Sanitária. (Brasil). Portaria nº1.514, de 15 de junho de 2020. Define os critérios técnicos para a implantação de Unidade de Saúde Temporária para assistência hospitalar – HOSPITAL DE CAMPANHA-voltadas para os atendimentos aos pacientes no âmbito da emergência pela pandemia da COVID-19. *Diário Oficial da União* 16 jun 2020; Seção 1.
 29. Sociedade Brasileira de Cardiologia (SBC). Diretriz da Sociedade Brasileira de Cardiologia de Telemedicina em Cardiologia – 2019. [Internet]. 2019 [acesso em 5 de setembro de 2020]. Disponível em: <http://publicacoes.cardiol.br/portal/abc/portugues/2019/v11305/pdf/11305022.pdf>.
 30. Machadeiro LT. Dispositivos e Sistemas de Telemonitorização: panorama atual e tendências futuras. [Mestrado em Ciências Biomédicas]. Covilhã (Portugal): Universidade da Beira Interior; 2017. [acesso em 5 de setembro de 2020]. Disponível em: https://ubibliorum.ubi.pt/bitstream/10400.6/6688/1/5601_11556.pdf.

31. Bautista G, Kobayashi RM, SIMONETTI, S. H. Ações educativas do Enfermeiro ao cardiopata mediado pelas Tecnologias de Informação e Comunicação (TIC). *J Health Inform.* [Internet]. 2017 [acesso em 4 de setembro de 2020]; 9(2). Disponível em: <http://www.jhi-sbis.saude.ws/ojs-jhi/index.php/jhisbis/article/viewFile/466/309>
32. Smith AC, Thomas E, Snoswell CL, Haydon H, Mehrotra A, Clemensen J, Caffery LJ. Telehealth for global emergencies: Implications for coronavirus disease 2019 (COVID-19). *J Tele med Telecare.* [Internet]. 2020 [cited 2020 mar 20]; 26(5). Available from: <https://journals.sagepub.com/doi/full/10.1177/1357633X20916567>.
33. Agência Nacional de Vigilância Sanitária (Brasil). Resolução n°56, de 1 de abril de 2020. Dispõe sobre o atendimento médico por Telemedicina durante a pandemia de SARS-CoV2/COVID-19. Diário Oficial da União 1 abr 2020; Seção 1.
34. Arentz M, Yim E, Klaffl, Lokhandwala S, Riedo FX. Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State. *JAMA.* [internet]. 2020 [cited 2020 mar 19]; 323(16). Available from: <https://jamanetwork.com/journals/jama/fullarticle/2763485>
35. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, Wu Y, Zhang L, Yu Z, Fang M, Yu T, Wang Y, Pan S, Zou X, Yuan S, Shang Y. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *Lancet Resp Med.* [Internet]. 2020 [cited 2020 may 1]; 8(1). Available from: [https://www.thelancet.com/journals/lanres/article/PIIS2213-2600\(20\)30079-5/fulltext#](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30079-5/fulltext#).