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The Coronavirus 2019 (COVID-19) pandemic, caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) virus, has resulted in unprecedented morbidity and mortality worldwide. While COVID-19 typically presents as viral pneumonia, cardiovascular manifestations such as acute coronary syndromes, arterial and venous thrombosis, acutely decompensated heart failure (HF), and arrhythmia are frequently observed. Many of these complications are associated with poorer outcomes, including death. Herein we review the relationship between cardiovascular risk factors and outcomes among patients with COVID-19, cardiovascular manifestations of COVID-19, and cardiovascular complications associated with COVID-19 vaccination.

Use and Prognostic Implications of Cardiac Troponin in COVID-19 **163**

Laura De Michieli, Allan S. Jaffe, and Yader Sandoval

Myocardial injury is common in patients with COVID-19 and is associated with an adverse prognosis. Cardiac troponin (cTn) is used to detect myocardial injury and assist with risk stratification in this population. SARS-CoV-2 infection can play a role in the pathogenesis of acute myocardial injury due to both direct and indirect damage to the cardiovascular system. Despite the initial concerns about an increased incidence of acute myocardial infarction (MI), most cTn increases are related to chronic myocardial injury due to comorbidities and/or acute nonischemic myocardial injury. This review will discuss the latest findings on this topic.

Review of Immunologic Manifestations of COVID-19 Infection and Vaccination **177**

Valeriya Pozdnyakova, Brittany Weber, Susan Cheng, and Joseph E. Ebinger

We herein summarize currently available and clinically relevant information regarding the human immune responses to SARS-CoV-2 infection and vaccination, in relation to COVID-19 outcomes with a focus on acute respiratory distress syndrome (ARDS) and myocarditis.

The Direct and Indirect Effects of COVID-19 on Acute Coronary Syndromes **185**

Thomas A. Kite, Susil Pallikadavath, Chris P. Gale, Nick Curzen, and Andrew Ladwiniec

The novel SARS-CoV-2 has directly and indirectly impacted patients with acute coronary syndrome (ACS). The onset of the COVID-19 pandemic correlated with an abrupt decline in hospitalizations with ACS and increased out-of-hospital deaths. Worse outcomes in ACS patients with concomitant COVID-19 have been reported, and acute myocardial injury secondary to SARS-CoV-2 infection is recognized. A rapid adaptation of existing ACS pathways has been required such that overburdened health care systems may manage both a novel contagion and existing illness. As SARS-CoV-2 is now endemic, future research is required to better define the complex interplay of COVID-19 infection and cardiovascular disease.

A Review of ST-Elevation Myocardial Infarction in Patients with COVID-19 197

Nima Ghasemzadeh, Nathan Kim, Shy Amlani, Mina Madan, Jay S. Shavadia, Aun-Yeong Chong, Alireza Bagherli, Akshay Bagai, Jacqueline Saw, Jyotpal Singh, and Payam Dehghani

The Coronavirus disease 2019 (COVID-19) pandemic has led to a significant increase in worldwide morbidity and mortality. Patients with COVID-19 are at risk for developing a variety of cardiovascular conditions including acute coronary syndromes, stress-induced cardiomyopathy, and myocarditis. Patients with COVID-19 who develop ST-elevation myocardial infarction (STEMI) are at a higher risk of morbidity and mortality when compared with their age- and sex-matched STEMI patients without COVID-19. We review current knowledge on the pathophysiology of STEMI in patients with COVID-19, clinical presentation, outcomes, and the effect of the COVID-19 pandemic on overall STEMI care.

Mechanical Circulatory Support in COVID-19 205

Kari Gorder, Wesley Young, Navin K. Kapur, Timothy D. Henry, Santiago Garcia, Raviteja R. Guddeti, and Timothy D. Smith

Despite aggressive care, patients with cardiopulmonary failure and COVID-19 experience unacceptably high mortality rates. The use of mechanical circulatory support devices in this population offers potential benefits but confers significant morbidity and novel challenges for the clinician. Thoughtful application of this complex technology is of the utmost importance and should be done in a multidisciplinary fashion by teams familiar with mechanical support devices and aware of the particular challenges provided by this complex patient population.

Extracardiac Prothrombotic Effects of COVID-19 213

Rohan Kankaria, Cristina Sanina, Mohamed Gabr, Jose Wiley, and Anna E. Bortnick

COVID-19 infection triggers a heightened inflammatory response which in turn, increases thrombosis and thromboembolism. Microvascular thrombosis has been detected in various tissue beds which may account for some of the multi-system organ dysfunction associated with COVID-19. Additional research is needed to understand which prophylactic and therapeutic drug regimens are best for the prevention and treatment of thrombotic complications of COVID-19.

Impact of COVID-19 on Acute Myocardial Infarction Care 221

Raviteja R. Guddeti, Mehmet Yildiz, Keshav R. Nayak, M. Chadi Alraies, Laura Davidson, Timothy D. Henry, and Santiago Garcia

The global health crisis caused by the COVID-19 pandemic has evolved rapidly to overburden health care organizations around the world and has resulted in significant morbidity and mortality. Many countries have reported a substantial and rapid reduction in hospital admissions for acute coronary syndromes and percutaneous coronary intervention. The reasons for such abrupt changes in health care delivery are multifactorial and include lockdowns, reduction in outpatient services, reluctance to seek medical attention for fear of contracting the virus, and restrictive visitation policies adopted during the pandemic. This review discusses the impact of COVID-19 on important aspects of acute MI care.

Impact of Coronavirus Disease 2019 Pandemic on Cardiac Arrest and Emergency Care 231

Murtaza Bharmal, Kyle DiGrande, Akash Patel, David M. Shavelle, and Nichole Bosson

The incidence of both out-of-hospital and in-hospital cardiac arrest increased during the coronavirus disease 2019 (COVID-19) pandemic. Patient survival and neurologic

outcome after both out-of-hospital and in-hospital cardiac arrest were reduced. Direct effects of the COVID-19 illness combined with indirect effects of the pandemic on patient's behavior and health care systems contributed to these changes. Understanding the potential factors offers the opportunity to improve future response and save lives.

Mechanical Complication of Acute Myocardial Infarction Secondary to COVID-19 Disease **241**

Abdulla A. Damluji, Nikhil R. Gangasani, and Cindy L. Grines

The aggressive inflammatory response to COVID-19 can result in airway damage, respiratory failure, cardiac injury, and multiorgan failure, which lead to death in susceptible patients. Cardiac injury and acute myocardial infarction (AMI) secondary to COVID-19 disease can lead to hospitalization, heart failure, and sudden cardiac death. When serious collateral damage from tissue necrosis or bleeding occurs, mechanical complications of myocardial infarction and cardiogenic shock can ensue. While prompt reperfusion therapies have decreased the incidence of these serious complications, patients who present late following the initial infarct are at increased for mechanical complications, cardiogenic shock, and death. The health outcomes for patients with mechanical complications are dismal if not recognized and treated promptly. Even if they survive serious pump failure, their CICU stay is often prolonged, and their index hospitalization and follow-up visits may consume significant resources and impact the health care system.

Myocarditis Following COVID-19 Vaccination **251**

Constantin A. Marschner, Kirsten E. Shaw, Felipe Sanchez Tijmes, Matteo Fronza, Sharmila Khullar, Michael A. Seidman, Paaladinesh Thavendiranathan, Jacob A. Udell, Rachel M. Wald, and Kate Hanneman

Myocarditis is an established but rare adverse event following administration of messenger RNA–based coronavirus disease 2019 (COVID-19) vaccines and is most common in male adolescents and young adults. Symptoms typically develop within a few days of vaccine administration. Most patients have mild abnormalities on cardiac imaging with rapid clinical improvement with standard treatment. However, longer term follow-up is needed to determine whether imaging abnormalities persist, to evaluate for adverse outcomes, and to understand the risk associated with subsequent vaccination. The purpose of the review is to evaluate the current literature related to myocarditis following COVID-19 vaccination, including the incidence, risk factors, clinical course, imaging findings, and proposed pathophysiologic mechanisms.

Cardiovascular Health Care Implications of the COVID-19 pandemic **265**

Zahra Raisi-Estabragh and Mamas A. Mamas

The coronavirus disease 2019 (COVID-19) pandemic has challenged the capacity of health care systems around the world, including substantial disruptions to cardiovascular care across key areas of health care delivery. In this narrative review, we examine the implications of the COVID-19 pandemic for cardiovascular health care, including excess cardiovascular mortality, acute and elective cardiovascular care, and disease prevention. Additionally, we consider the long-term public health consequences of disruptions to cardiovascular care across both primary and secondary care settings. Finally, we review health care inequalities and their driving factors, as highlighted by the pandemic, and consider their importance in the context of cardiovascular health care.