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Cardiorenal Syndrome: the bidirectional heart-kidney axis

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Abstract: Cardiorenal syndrome is configured as a set of disorders that affect the heart and/or kidneys, and induce a series of events that alter the entire pre-existing axis between the two systems. Accurate diagnosis and adequate monitoring of patients with cardiovascular and renal diseases have become increasingly frequent. Systems are increasingly interconnected, and paying attention to changes has become fundamental. The objective of this article is to characterize cardiorenal syndrome, highlighting its clinical, pathophysiological, diagnostic, and therapeutic management aspects. Dogs and cats are susceptible to kidney changes that alter blood flow, which can interfere with cardiac function, and the reverse may also occur, particularly if dogs/cats already have the organ affected by other diseases. Furthermore, a series of systemic events can end up interfering even more with the communication between the two systems. The monitoring and follow-up of cardiac and/or nephropathic patients are of fundamental importance in determining the best therapeutic management to be instituted, thereby avoiding complications and injuries to other organs, preventing aggravations to the patient's clinical condition, and reducing their life expectancy.
Keywords: heart-kidney axis, cardiac injuries, kidney injuries

1. Introduction

Domestic animals, such as dogs and cats, are susceptible to various pathophysiological conditions, among which renal and cardiovascular disorders are particularly significant due to the interdependence of these systems in maintaining overall homeostasis. The bidirectional heart-kidney axis ensures an adequate blood supply to the kidneys, allowing for proper kidney function. As a result, any changes in renal blood flow are closely linked to cardiac output (CO). Additionally, kidney diseases such as chronic kidney disease (CKD) often lead to hypertension and the progressive, harmful activation of the renin-angiotensin system (RAS), which can impact cardiovascular function. When an animal with heart disease develops some degree of kidney dysfunction as the disease progresses, or when a patient with kidney disease exhibits signs of heart failure, this condition is recognized as cardiorenal syndrome (CRS). CRS is considered a complex disorder affecting both the heart and kidneys, triggering a series of compensatory mechanisms aimed at correcting the dysfunctions present. These mechanisms result in alterations in blood flow, kidney filtration, and systemic blood pressure regulation (Lopes, 2016).

Because CRS involves two organ systems connected by the bidirectional axis, diagnosing the condition is challenging, and its therapeutic management is equally complex. Treating one system can have a direct impact on the function of the other. Among canine heart diseases, myxomatous valve degeneration, especially mitral valve disease, and acquired conditions like dilated cardiomyopathy are the most notable. In feline cardiology, hypertrophic cardiomyopathy (HCM) is the most prevalent form of heart disease (Luis Fuentes et al., 2020; Sousa et al., 2025). Regarding kidney disorders, CKD stands out as a major concern, regardless of its underlying cause. It leads to a decline in glomerular filtration rate and is recognized as the leading cause of death in cats over five years old (O'Neill et al., 2016). This article aims to provide an overview of CRS, highlighting its characteristics, the recognized subtypes of the disease, and current diagnostic and therapeutic strategies.

2. Cardiorenal syndrome (CRS)

According to Ronco et al. (2010), CRS is defined as a pathophysiological disorder affecting both the heart and kidneys, where acute or chronic dysfunction in one organ can lead to acute or chronic changes in the other. In veterinary medicine, discussions have expanded this concept to include not just the heart but the entire cardiovascular system. As a result, the term "cardiovascular-renal disorder" (C_VRD) has been proposed (Pouchelon et al., 2015). Regardless of whether it is referred to as CRS or C_VRD, both terms recognize that the process is triggered by a primary condition that may originate from the cardiovascular system, the kidneys, or even a systemic disorder such as sepsis. This primary dysfunction is sufficient to cause significant effects on both the heart and kidneys. According to Aronson (2012) and Orvalho & Cowgill (2017), cardiac and renal dysfunctions can co-occur, as these systems are interdependent. Thus, heart conditions can impact kidney function, and vice versa.

Even in humans, where CRS is better understood, uncertainties persist regarding its mechanisms, clinical presentations, and progression (Ronco & Di Lullo, 2014). Rangaswami et al. (2019) note that identifying the initial cause and the subsequent effects leading to either acute or chronic CRS remains a challenging task. Orvalho & Cowgill (2017) state that CRS in both humans and animals shares many similarities, particularly concerning the initial triggering event, its consequences, and the process of progressive

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