Cardiovascular Adverse Effects of Hepatitis C Treatment: A Mathematical Model and Numerical Simulations

Chaimae El Mourabit

National School of Applied Science, Sultan Moulay Slimane University, Beni Mellal, Morocco

Nadia Idrissi Fatmi

National School of Applied Science, Sultan Moulay Slimane University, Beni Mellal, Morocco

Abstract:

Hepatitis C virus (HCV) is a blood-borne pathogen that poses a substantial global health burden. It often progresses to severe liver-related complications, including liver failure, cirrhosis, and hepatocellular carcinoma, with the potential for fatal outcomes if untreated. The introduction of direct-acting antivirals (DAAs) has revolutionized the treatment landscape for HCV. These antiviral agents offer a targeted approach by inhibiting specific viral proteins essential for HCV replication, resulting in exceptionally high cure rates and minimal side effects compared to earlier therapies. Consequently, DAAs have become the cornerstone of hepatitis C treatment, providing hope for the eradication of the disease in treated individuals. Despite their remarkable therapeutic success, concerns regarding the potential adverse effects of DAAs on cardiac health have emerged. These adverse effects, collectively termed cardiotoxicity, encompass a range of cardiac abnormalities, including arrhythmias, and other structural or functional changes in the heart. To investigate this issue, we developed a mathematical model to analyze the progression of hepatitis C infection and assess the potential cardiotoxic risks associated with DAA therapy. The model was rigorously examined to demonstrate the positivity and boundedness of its solutions, ensuring biological relevance and mathematical validity. Equilibrium points were identified, and their stability was analyzed using the Routh-Hurwitz criteria, which confirmed the existence of an asymptotically stable equilibrium point. Additionally, numerical simulations were conducted to validate and illustrate the findings, providing a deeper understanding of the system's dynamics.