The Crosstalk between SARS-CoV-2 Infection and the RAA System in Essential Hypertension—Analyses Using Systems Approach

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Abstract

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), responsible for the coronavirus disease of 2019 (COVID-19) pandemic, has affected and continues to affect millions of people across the world. Patients with essential arterial hypertension and renal complications are at particular risk of the fatal course of this infection. In our study, we have modeled the selected processes in a patient with essential hypertension and chronic kidney disease (CKD) suffering from COVID-19, emphasizing the function of the renin-angiotensin-aldosterone (RAA) system. The model has been built in the language of Petri nets theory. Using the systems approach, we have analyzed how COVID-19 may affect the studied organism, and we have checked whether the administration of selected anti-hypertensive drugs (angiotensin-converting enzyme inhibitors (ACEIs) and/or angiotensin receptor blockers (ARBs)) may impact the severity of the infection. Besides, we have assessed whether these drugs effectively lower blood pressure in the case of SARS-CoV-2 infection affecting essential hypertensive patients. Our research has shown that neither the ACEIs nor the ARBs worsens the course infection. However, when assessing the treatment of hypertension in the active SARS-CoV-2 infection, we have observed that ARBs might not effectively reduce blood pressure; they may even have the slightly opposite effect. On the other hand, we have confirmed the effectiveness of arterial hypertension treatment in patients receiving ACEIs. Moreover, we have found that the simultaneous use of ARBs and ACEIs averages the effects of taking both drugs, thus leading to only a slight decrease in blood pressure. We are a way from suggesting that ARBs in all hypertensive patients with COVID-19 are ineffective, but we have shown that research in this area should still be continued.

Keywords: **SARS-CoV-2**; **essential hypertension**; **mathematical modeling**; **Petri nets**