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Numerical and Sensitivity Analysis of Modeling the Newcastle Disease Dynamics

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Abstract : Newcastle disease is a highly contagious disease of birds caused by a para-myxo virus. In this paper, we presented Novel quarantine-adjusted incident and linear incident of Newcastle disease model equations. We considered the dynamics of transmission and control of Newcastle disease. The existence and uniqueness of the solutions were obtained. The existence of disease-free points was shown, and the model threshold parameter was examined using the next-generation operator method. The sensitivity analysis was carried out in order to identify the most sensitive parameters of the disease transmission. This revealed that as parameters β,ω, and ʌ increase while keeping other parameters constant, the effective reproduction number R_ev increases. This implies that the parameters increase the endemicity of the infection of individuals. More so, when the parameters μ,ε,γ,δ_1, and α increase, while keeping other parameters constant, the effective reproduction number R_ev decreases. This implies the parameters decrease the endemicity of the infection as they have negative indices. Analytical results were numerically verified by the Differential Transformation Method (DTM) and quantitative views of the model equations were showcased. We established that as contact rate (β) increases, the effective reproduction number R_ev increases, as the effectiveness of drug usage increases, the R_ev decreases and as the quarantined individual decreases, the R_ev decreases. The results of the simulations showed that the infected individual increases when the susceptible person approaches zero, also the vaccination individual increases when the infected individual decreases and simultaneously increases the recovery individual.

Keywords : disease-free equilibrium, effective reproduction number, endemicity, Newcastle disease model, numerical, Sensitivity analysis
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