A SI(R) MODEL FOR COVID-19: A POSSIBLE SCENARIO

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Introduction: Many models of the current Covid-19 epidemic have been made in the recent past, mostly SIR and SEIR. In our opinion, these models have the defect of considering immunity from SARS-Cov-2 as permanent, while, on the basis of our knowledge on coronaviruses, immunity is highly probable to be only temporary, with a prediction between 6 and 12 months. Due to these considerations, we propose a SI(R) model.

The model: The SI(R) model is described by the following ordinary differential system:

$$\begin{cases} \frac{dS}{dt} = -\alpha S(t)I(t) + \rho R(t) \\ \frac{dI}{dt} = \alpha S(t)I(t) - \beta I(t) \\ \frac{dR}{dt} = \beta I(t) - \rho R(t) \end{cases}$$

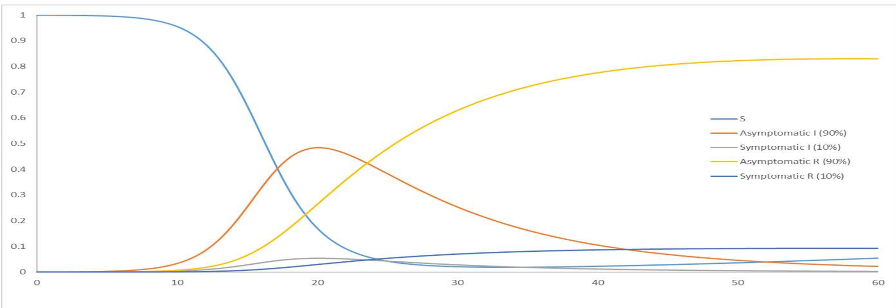
where S, I, R are the proportions of Susceptible, Infected and Recovered in the population, respectively, so that $S + I + R = 1$ at each time; α is the infection rate parameter; β is the removal rate parameter; ρ is the rate of loss of immunity.

The model offers an analytical solution to the problem of finding possible steady states, resulting in the following (positive) endemic equilibrium (under the realistic condition that $\frac{\beta}{\alpha} < 1$): $S_* = \frac{\beta}{\alpha}$; $I_* = \frac{\rho}{\alpha}\frac{\alpha-\beta}{\beta+\rho}$; $R_* = \frac{\beta}{\rho} I_*$.

The parameters: Concerning the parameters, we assumed (taking them from biological literature) the following values: β = 0.1; ρ = 0.003, α = 0.6. Finally, it should be borne in mind that the proportion p of symptomatic subjects in the infected population is currently estimated to be around 0.1.

The steady state: From the above considerations, we have calculated the proportions of the compartments S, I, R at the steady state, that resulted 0.167, 0.222, and 0.811, respectively.

The simulation: Evolution of a SI(R) model according to the parameter estimates proposed is described in the following figure. For a better comprehension, both the Recovered (*R*) and the Infected (*I*) compartments are subdivided into Symptomatic and Asymptomatic subjects (ratio 1:9). *S* indicates the Susceptible compartment.



Discussions and Conclusions: The model, applied to the province of Pesaro-Urbino (a province of Marche region, one of the main outbreaks of the epidemic in Italy) fixing the lockdown day as *t* = 0, has been able to predict the epidemic trend so far.

References:

Rocchi et al. SN (2020) Comprehensive Clinical Medicine, 2: 501–503.

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