An age grouped time-varying compartmental model for CoViD-19 vaccination strategy

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Background:
Compartmental models are the simplest in the mathematical study of infectious disease dynamics. Using an age-stratified compartmental model allows us to understand which population groups to target and to what extent to act, in order to achieve predefined goals in line with policy and/or health choices. In fact, the vaccination strategies of most countries are age dependent. With this study we want to show that the optimal vaccination strategy should be different depending on the type of health or social objective to be achieved.
Methods:
A time varying susceptible-infected-recovered-deceased (SIRD) compartmental models, stratified into ten age groups of ten years was developed on Italian data. An optimal vaccination strategy was obtained minimizing deaths or infectious starting from April 11, 2021, considering the total doses due to Italy by the European contract for each type of vaccine from April to June. The efficacy of each vaccine and the days between administration and the beginning of immunization were also considered.
Results:
On April 11, about 75% of over-80 Italian population have received at least the first dose of vaccine. Concerning the minimization of death, the model gives the priority to the older people (>60-year-old). This confirms the Italian vaccination strategy by completing the remaining vaccinations of over-80s and then vaccinating those between 60 and 80. Instead, if the priority were to reduce the infected, the model would recommend vaccinating the most of over-80s and the classes aged 20-30 and 40-60.
Conclusions:
In conclusion, the use of this model can help to vary vaccine strategies by adopting targeted approaches to effectively achieve specific objective. For example, given the different age destination of some vaccine types, a good vaccination strategy might have been to vaccinate the over 90s with one type of vaccine to protect them from high risk of death while simultaneously vaccinating younger people to contain the spread.
Key messages:
- The modelling approach is an excellent decision support tool for pandemic containment.
- The compartmentalized model stratified by age allows to act more efficiently on subpopulations.