Considerations about current evolution of SARS-nCOV-2 epidemic in Italy.

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INTRODUCTION

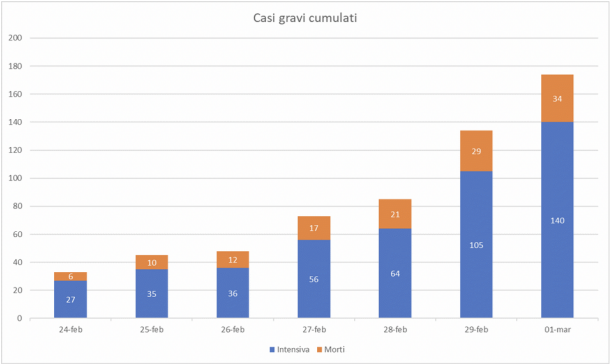
In February 2020, a novel coronavirus SARS-nCOV-2 outbreak was identified in the North of Italy, whose size suggested a dramatically advanced stage of virus spreading at the time when the first patient was identified (on February 20th). As from that date, every day, an increasingly higher number of infections was observed so that the threshold of 1,000 infected subjects was overcome within 10 days.

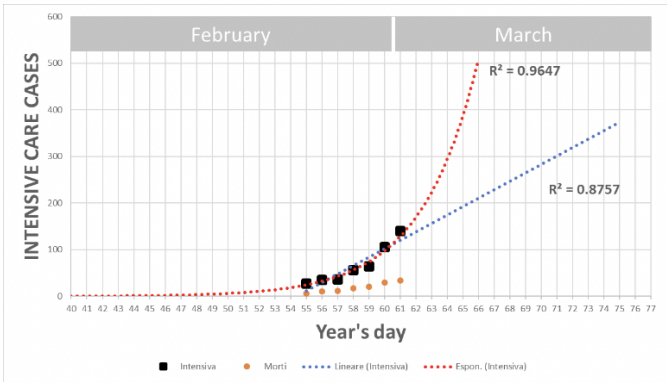
At first, initial strategy of subject sampling for testing was inconsistent all over the national territory. In Veneto, for example, subjects were tested based on geographical criteria (concentric circles around regional districts and, at times, around hospitals), whereas, in other Regions, testing was carried out based on the possibility of being infected due to subjects' closeness to identified cases. Strategy was then changed and made consistent, and based on testing symptomatic subjects only.

There is however one piece of data that, for obvious reasons, is not biased by the differences in subject sampling outlined above, meaning the number of subjects hospitalized in intensive care units (ICUs). This is also true for the number of deaths, which, since it is still very low, is liable to greater statistical fluctuations in terms of daily evolution.

ANALYSIS

Both the number of deaths and that of patients hospitalized in ICUs are based on bulletins issued by the Protezione Civile (Civil Protection Department) as from February 24th, which has since informed Italians about the trend of the epidemic. The two graphs below show changes in both numbers as from February 24th:



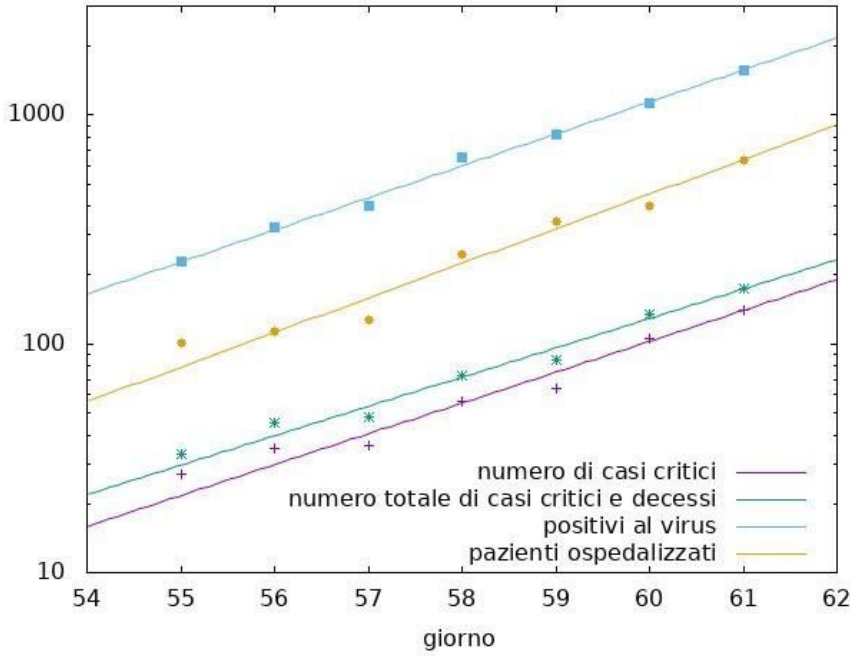


As shown on the graph on the right-hand side, with the X axis reporting the number of days elapsed since the beginning of the year, increase in the number of severe patients over time has been estimated to the best by an exponential curve, with doubling time approaching 2.6 days (for comparative purposes, a linear extrapolation of data has also been shown). Doubling time matches typical time of exponential trend multiplied by log(2) value, which equals approximately 0.69.

By extending exponential curve extrapolation to the next few days, which statistical indicators show as reliable (undoubtedly so and only for quite short periods of time) and much more reliable than a linear or power-law behavior, one can observe how the number of ICU beds increases very rapidly in the first week of March, thus depicting an emergency scenario for territorial healthcare infrastructures given that at least 350 ICU beds may be needed by March 5th (and even more in the following weeks).

On the other hand, by analyzing the exponential curve retrospectively, it is possible to observe how the first few cases should date back to around February 10th, which, by taking the ratio between severe infected cases and time to development of infection-related symptoms into account, suggests that current epidemic cannot have started later than in the last ten days of January (with the possibility it might have started even before if severe cases in locations other than those currently monitored escaped from observation).

In order to analyze the evolution of severe cases and establish whether consistent with that of the total number of hospitalizations and total number of infected patients, relevant extrapolation can be repeated. Analysis provides with curves that, less than a scaling constant, show comparable trend. In all evaluated cases, analysis implying exponential growth is preferred to a power law.

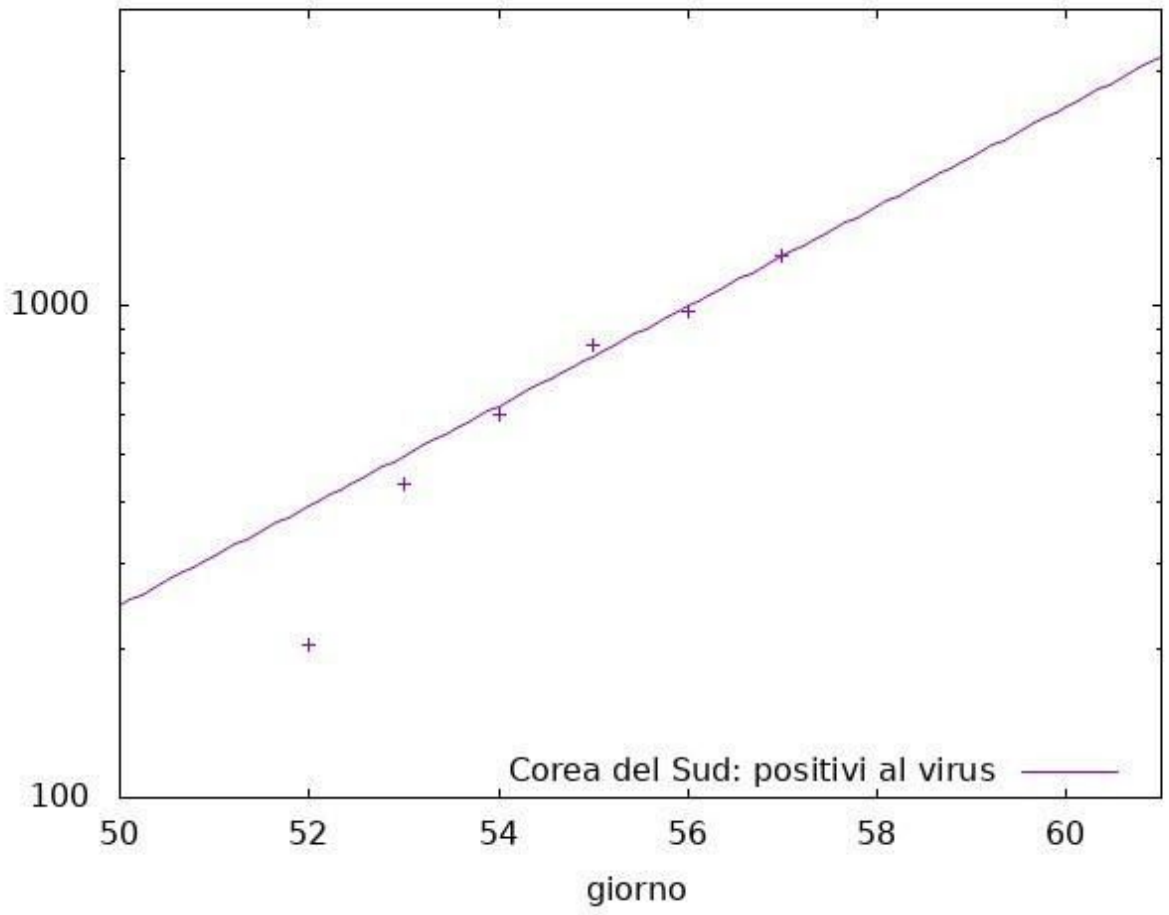


Legend:

Purple line: number of critical cases; green line: total number of critical cases and deaths; blue line: positive cases; yellow line: hospitalized patients.

The graph above has a linear scale on the X axis and a logarithmic scale on the Y axis. On the graph, exponential trend (exp(a*(t-t0)) thus results in a straight line. As one can observe, the four different values are all fully compatible with exponential trend in the days observed. Chi-square value per degree of freedom is always in the order of one, with doubling time that always ranges between 1.9 and 2.6 days for all four analyzed cases.

The trend observed in Italy can be compared against the epidemic growth that has been observed in South Korea, where population age structure and the level of healthcare offered appear to be comparable to those in Italy.



Legend

Purple line: confirmed positive cases in South Korea

The graph above shows exponential fitting to values of the number of positive patients. The first two days cannot be included as they sum cases from previous days. Fit evaluated as from day 54 provides with results that are comparable to what observed for Italy: chi-square value per degree of freedom is in the order of one, doubling time is in the order of 3.0 days, with a delay that is comparable to delay observed in Italy. Impact of the spread of the virus is once again to be backdated properly.

Based on what shown, we can conclude that, in the North of Italy, an epidemic outbreak in its early stage of exponential growth is currently underway; growth is still not being affected by the containment measures that have been implemented, whose efficacy can only be evaluated after one week from implementation given period of incubation and viral charge detection in newly infected subjects.

RECOMMENDATIONS

Contrary to what has been anticipated by some institutions, and as clearly shown by considerations above, current epidemic is still in its first stage of development. Thus, far

from getting rid of necessary mitigations measures, taking the following recommendations into account is more crucial than ever:

a. In Lombardy, the western portion of Veneto and the northern territory of Emilia-Romagna, and the mainly so in large towns such as Milan and those counting many infections such as Savona, the average number of likely potentially productive contacts (two-meter distance between an infected subject and a non-infected subject) should be kept as low as possible. This mainly implies reducing the frequency of all casual contacts with a large number of unknown people: in that respect, the role of remote work, of reducing unneeded activities and movements, of avoiding gatherings and extending schools' and universities' closure has been duly highlighted. Although these measures cannot avoid the spread of the infection in the long term, they can indeed reduce the number of daily new cases, thereby avoiding that the healthcare system is further burdened by new and even severe cases. In that sense, extending red-zone area and making quarantine indications even more stringent might prove beneficial in terms of reducing the number of deaths.
b. Currently available system to detect new infections, via a PCR test that is carried out locally and then evaluated by a central lab, risks being soon overburdened, even in the case testing is limited to symptomatic patients. Since it is vital to keep tract of good quality diagnostic information in order to foresee the development of the epidemic, it is advisable to switch second-level confirmation from central labs, as there are very few of them, to peripheral labs that could share samples to be confirmed between themselves.
c. Information provided to the general public should aim at explaining how individual risk of severe health consequences remains low on average in the most affected areas and almost absent in the rest of the country. However, if it is multiplied by the number of people exposed to the virus, such low risk can rapidly drain our healthcare resources, thereby making it difficult for the NHS to cure most critical patients and jeopardizing the health of patients who have been hospitalized for other reasons. Institutional communication and mass communication should therefore invite people to take personal responsibility in applying all suggested measures, in particular in relation to the need to raise social barriers as per previous paragraph for all those who live in Regions with known epidemic outbreaks and mainly so in the large towns of these Regions.