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SARS-COV-2 INFECTION IN ITALY: ITS PROGRESSION FROM FEBRUARY TO MAY 2020

Dr.Emilia Caputo
Institute of Genetic and Biophysics- IGB, CNR
Via PietroCastellino 111, 80131, Naples,
Italy
emilia.caputo@igb.cnr.it

Dr. Luigi Mandrich
Research Institute on Terrestrial Ecosystem-IRET,
CNR Via Pietro Castellino 111, 80131, Naples,
Italy
luigi.mandrich@cnr.it

ABSTRACT

At the end of 2019 in China, a severe infection was reported from the city of Wuhan, caused by a new type of coronavirus, termed SARS CoV-2. At the beginning, the measures to adopt for the infection containment were not clear and the intense trade and tourism exchanges from and to China leaded the SARS CoV-2 virus spreading across several countries in the world by January 2020. Italy has been one of the first European countries to be affected.

Using the official data from the Italian Civil Protection Department, here it was compared the SARS-CoV-2 spreading in two Italian regions: Lombardia and Campania. Lombardia was the first region to be affected and the progression of the infection was dramatic compared to Campania region, where the lockdown measures adopted by the Italian Government, closing all not-essential commercial activities, schools and requiring social distancing leaded to a reduction of the viral infection progression. The lockdown phase was overcome after about 50 days of emergency status.

Analysis of data indicated 17-folds more infections and 39-folds more deaths by SARS-CoV-2 in Lombardia than in Campania region, respectively. At the end of lockdown phase (May 3)there was a flattening of the contagion curve in Campania more than in Lombardia, indicating that the lockdown and social distancing were the best remedy against the spread of the pandemic if actuated before the burst of infection.

General Terms: SARS-CoV-2 infection, analysis of contagion

Keywords: SARS-CoV-2; COVID-19; infection progression; lockdown strategy, pandemic

1. INTRODUCTION

On 11 March 2020 the World Health Organization (WHO) declared pandemic the infection by SARS-CoV-2, since it was present in all continents and it was expanding at a very high speed. Despite its spreading, WHO declared that the pandemic could be controlled (www.who.int). At the end of April, it was reported that the confirmed cases were about 3350000, the confirmed deaths were about 240000, and the countries or territories carrying cases were 215 (http://covid19.who.int).

In late December 2019, in the city of Wuhan (China) abnormal pneumonia were diagnosed. Later on, the causative agent was identified as a new coronavirus with a positive stranded RNA, phylogenetically similar to the Severe Acute Respiratory Coronavirus Syndrome (SARS-CoV). Since it was the second SARS-CoV identified, it has been indicated as Severe Acute Respiratory Syndrome

Coronavirus 2 or SARS-coV-2 (1). COVID-19 disease is characterized by several typical symptoms, such as fever (over 37.5 °C), weakness, dyspnea, dysgeusia, muscle soreness and dry cough (2).

Now days, it is well known that SARS-CoV-2 transmits through droplets and contact with infected patients, who can be asymptomatic in many cases or showing mild symptoms (3). This infection has been showed to be lethal mainly for people with chronic diseases (4). The incubation time is between 5 and 16 days before showing symptoms (5) and the virus seems to be vital in the environment for several hours (6). For all these reasons, during the first phase of progression the identification of the viral infection and the control of its transmission has been very difficult.

To reduce the infection spreading in Wuhan, people was forbidden to leave from their house and all the services were stopped; it was prevented to entering and leaving from the city until the number of infections decreased to zero and the quarantine lasted over two months. Being the district of Wuhan inhabited from about 11 million and being rich of industries and commercial activities, many people had contact with the population of Wuhan before the quarantine, allowing the virus infection spreading in other districts of China, in Asia and in Europe (7).
Italy was one of the first European countries to record SARS CoV-2 cases, starting from February 18, 2020; in some regions the rate of infection has been very high causing a dramatic health emergency, which prompted the Italian Government to decree a very strict closure of some areas, indicated as “red zone”. Since March 9, considering the rapid progression of infection, a strong lockdown extended to the whole nation was adopted, prohibiting the population to leave their municipality.
Here, we analyzed the data about infected, recovered and dead people by SARS CoV-2 from February 18 up May 3, 2020, and released by the Italian Civil Protection Department(www.protezionecivile.gov.it), which is the department in charge of handling emergencies in Italy. In particular, we compared the national data, with those of Lombardia, the first region to be invested by the infection and of Campania region, where the first case has been reported later on February 25. This study shows what happened in the first phase of contagion in Italy and the difference among the different regions.
The Lombardia region has been invested in a very dramatic manner by the infection, whereas in Campania the infection delay allowed to organize medical controls and social distancing rules, leading to control and reduce the effect of this emerging infection.

2. ANALYSIS OF INFECTION IN ITALY

In Italy, the first cases of SARSCoV-2 infection were reported in Rome, where two Chinese tourists (8), coming back from China resulted infected; since then, in few days two clusters of infection were detected in Lombardia region and near the city of Padua.

Lombardia region, with Milan as main city, is one of the most industrialized and rich zone in Italy, where the numerous commercial activities and the high traveling of people may likely represent the main causes of the high spread of infection (figure 1). Lombardia and Campania are the two regions selected to study the progression of SARS CoV-2 infection, as example of first cluster of infection and cluster of attenuated infection due to lockdown decree by the Italian Government. These two regions are distant about 600 km.

Figure 1. Administrative geographical map of Italy. Italy is divided into 20 regions, each managed independently by a Governor elected by the people.

The phylogenetic analysis of the first two SARS CoV-2 strains isolated in Italy indicated that they derived from other SARS CoV-2 strains isolated in Europe, in particular isolated in Germany, Spain, Finland and France (9), indicating the presence of the virus in Europe from December 2019, and evolved in the strains isolated.

Based on these evidences, it is possible to speculate that in February 2020, when the first cases of SARS CoV-2 were isolated in Lombardia, in the population were present few hundred people already infected. This allowed the epidemic to expand explosively in Lombardia in few days and then to the other regions of Italy. In fact, after one week, all the regions of north Italy presented clusters of infection, followed by the regions in the middle and in south Italy.

Considering the dramatic progression of infection in north Italy, the national Government decree the closure of all non-essential work activities and a strict social distancing, reducing the possibility of contact and therefore of contagion between people. In this way, the progression of infection in the regions, like Campania (figure 1) has been reduced more than 15-folds compared to Lombardia (see below Table 1).

During the lockdown phase, people were permitted only to leave from their home to buy food and medicine, while only essential work activities were allowed (hospitals, security, food markets, hardware and electronic stores, agriculture, farms, public transports by trains, bus and metro).

The lockdown phase continued up to May 3. During this time, the reproduction number R_0 (10) of the virus reached the maximum value of about 3.0 and at the end of lockdown R_0 was less than 1.0 (Italian Health Minister, www.salute.gov.it). The second phase, began from May 4, i.e. with slow opening of commercial activities and people allowed to move in the own region.

With the end of lockdown phase in Italy, it has been possible to analyze the official data (www.protezionecivile.gov.it) regarding the progression of SARS CoV-2 infection during these 55 days. In Table 1, data related to the infection were reported., such as the number of SARS CoV-2 infected people, the testing swabs made, the number of COVID-19 patients, the patients recovered and deaths.

Table 1. **Infection's data**. **Parameters related to the infection in Italy, in Lombardia and in Campania regions, from February 18 to May 3, 2020.**

	Population *	# testing swabs**	# SARS CoV-2 infected**	Population/SARS CoV-2 infected (%)	Population/# testing swabs (%)	# testing swabs/# SARS CoV-2 infected	# SARS CoV-2 recovered**	# SARS CoV-2 dead**	SARS CoV-2 infected/ SARS CoV-2 dead (%)
Italy	**60,360,000**	**2,153,777**	**210,179**	**0.35**	**3.6**	**9.8**	**81,654**	**28,884**	**13.7**
Lombardia	**10,060,000**	**410,857**	**77,528**	**0.77**	**4.1**	**18.9**	**26,371**	**14,231**	**18.3**
Campania	**5,802,000**	**90,543**	**4,498**	**0.08**	**1.6**	**5.0**	**1,394**	**364**	**8.1**

* data from "Istituto Italiano di Statistica" (www.istat.it)

** data from Italian Civil Protection Department (www.protezionecivile.gov.it)

In Table 1 are reported the data of population, the number of infected, recovered and dead people by SARS CoV-2, the number of testing swabs made, and the rate among these parameters. These data showed that the infection by SARS CoV-2 was very different among the regions of Italy; in fact, in Lombardia has been recorded about 35 % of the total infected people in Italy, whereas in Campania only 2.5 % of cases. More dramatic were the data related to the death. About 50 % cases were recorded in Lombardia compared to the only 1 % in Campania. These data suggest that the progression of infection was very early and fast in Lombardia, leading to the collapse of hospitals that were unable to adequately assist and treat patients, increasing dramatically the number of deaths. This trend was also indicated by the percentage ratio between the number of infected and the number of deaths for SARS CoV-2 (18 % in Lombardia *vs* 13 % in Italy and 8 % in Campania), and the ratio between the population and the number of infected, which are 0.77 % in Lombardia and 0.35 % and 0.08 % in Italy and Campania, respectively.

Compared to the number reported in Table 1, it is important to note that people infected and completely asymptomatic were not included. A Chinese study from Xu and colleagues reported that the percentage of completely asymptomatic SARS CoV-2 infected

individuals were about 5 % based on a cohort study of people tested by oral swabs (11). People completely asymptomatic are the major vehicle of contagion in the population. However, data about asymptomatic and poorly symptomatic patients in Italy are missing. Furthermore, the number of deaths caused by SARS CoV-2, may be underestimated since during the maximum contagion many people died at their homes, without carried out oral swabs or serological tests. Therefore, it is difficult to estimate how many people died. In some cases, depending on the severity of the infection, it has been hypothesized that the deaths from COVID-19 could have been in a range between 30 to 50 % more than the official data (report from IstitutoItaliano di Statistica, www.istat.it).

In Figure 2 are reported the graphs (in logarithmic scale) related to the progression of infection, based on the number of infected (black line), recovered (blue line) and dead people (red line) by SARS CoV-2, from February 18 up to the end of lockdown (May 3).

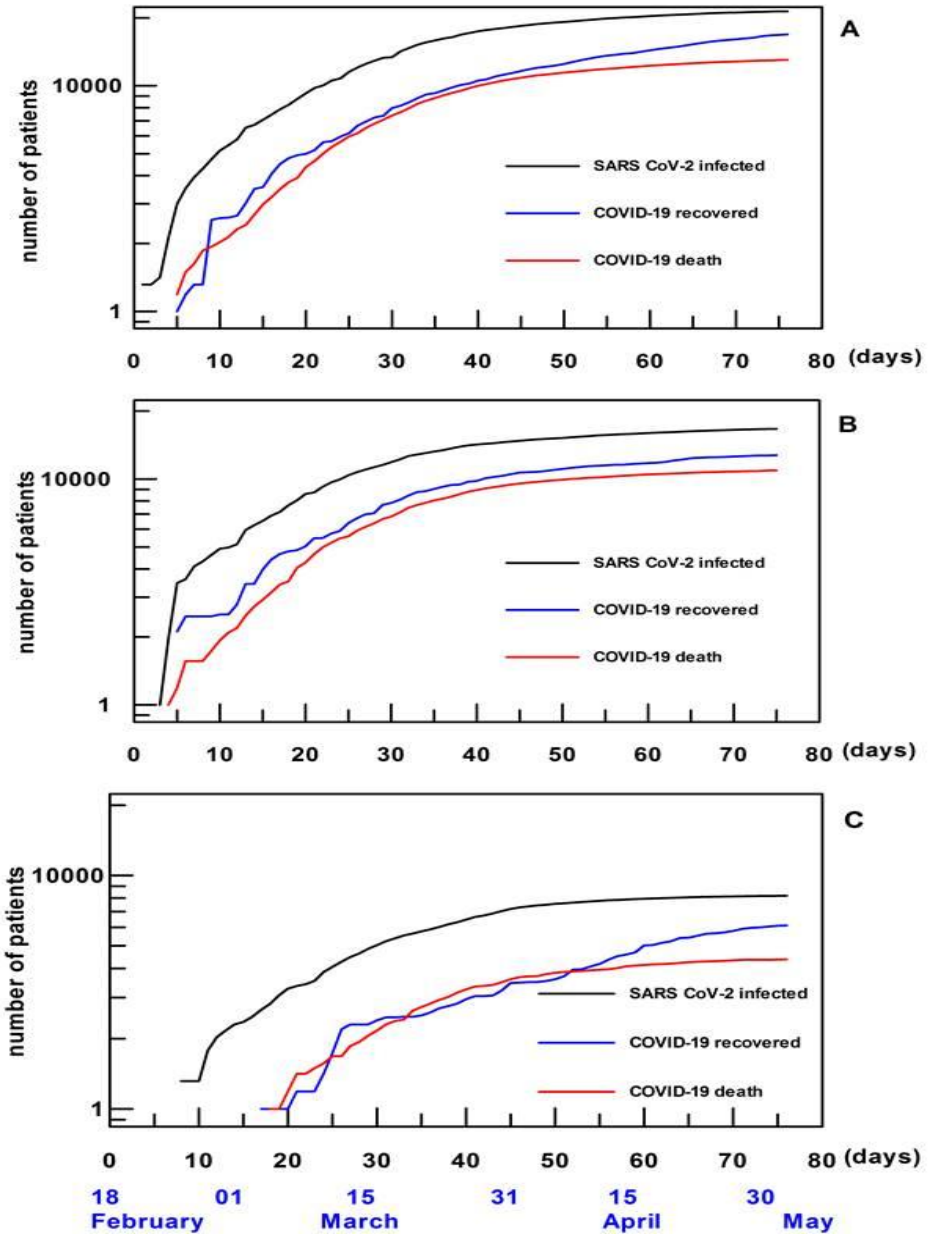

Figure 2. Progression of infection.Data related to A) Italy; B) Lombardia region; C) Campania region. All the data come from Italian Civil Protection Department (www.protezionecivile.gov.it).

At the end of February, there was a burst of infection in Lombardia and after 60 days (April 30) there was still an increasing phase of contagions, even if it was less than to the ones recorded at the beginning of March (Figure 2 B). The national data indicated that after 50 days (April 6-7) there was a flattening of the contagion curve (Figure 2 A), and at the same time an increase of recovered patients. In Campania the situation was different because the maximum of infection was recorded from February 10 and March 25 and after 60 days it was completely flat, reporting only a few dozens of cases for day (Figure 2 C); regarding the recovered by SARS CoV-2 there was a robust increment since March 20 (Figure 2 C).

In Figure 3, it was analysed the contagion from a different numeric point of views; in fact we reported the data related to the "actual infected" people, defined as the difference among the total number of infected people minus the total number of people recovered and deaths by COVID-19, recorded day by day, and reported as percentage respect to the maximum number of "actual infected" for Italy, Lombardia and Campania, respectively.

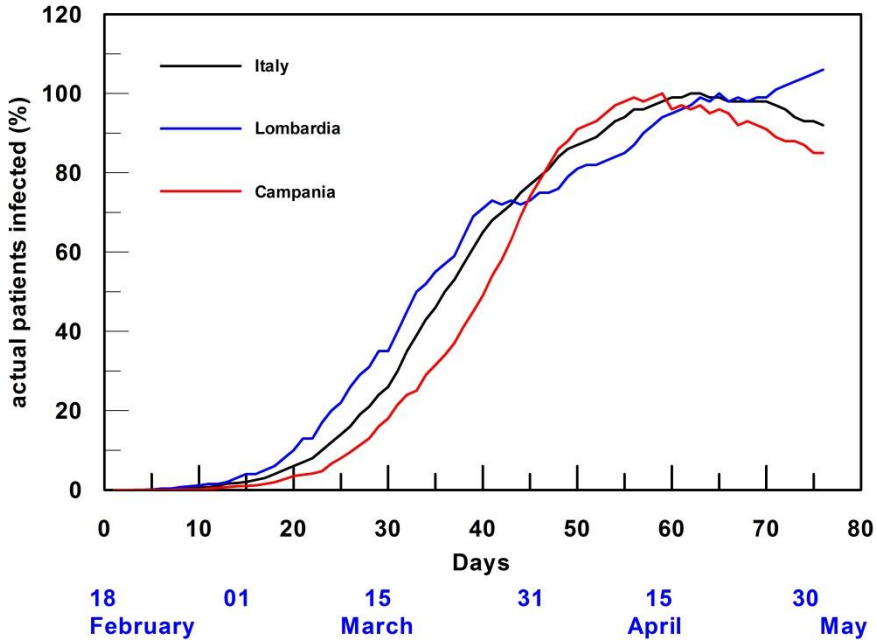

Figure 3. Progression of "actual infected" by SARS CoV-2.

In particular, the peak was achieved April 16 in Campania, April 19 in Italy, and apparently April 20 in Lombardia, because after a week of constant number of "actual infected" this value increased, and at May 3 was 107 %. The trend observed in Lombardia could be due to a different cluster of infection, which broke out at different times. A similar situation was observed around March 20, when there was a peak of contagion in the city of Bergamo (in Lombardia). Here, when was observed a stabilization of contagion, in another city in Lombardia there was a new cluster of infection (Brescia) (Figure 3, days 40). Around April 20 the number of contagion in Brescia was stable, but a new cluster started in Milan giving an increase of the "actual infected" number of people.

At the end of lockdown phase (May 3), the "actual infected" were 92 % for national data, 107 % in Lombardia and 85 % in Campania, respectively.

3. CONCLUSIONS

In conclusion, we can state that the lockdown and the social distancing realized by the Italian Government and lasted about 50 days, allowed to limit the progression of the infection and avoided the collapse of the hospitals, but in the first region, invested by the infection, the trend was dramatic and very different compared to the rest of Italy.

At the end of the lockdown phase, the infection curves flattened in Italy and in many regions, in some of these no new cases have been recorded for more than a week, but not yet in Lombardia. However, it is important to consider that there are cases of small towns in Lombardia, where during the emergency did not record contagions, such as Ferrara Erbognone, near the city of Pavia. Thousand inhabitants live in Ferrara Erbognone, and this town is somewhat isolated from other cities. This sort of natural isolation and social distancing may more likely explain the zero contagions reported in this part of Italy. Situations like this reinforce the idea that lockdown and social isolation are the best remedy against the spread of the pandemic.

In Italy the lockdown adopted by the Government, the social distancing and the use of masks, given the possibility to keep under control the infection, to start the challenge to found drug therapies. Some of these are based on drugs used for other diseases, like antivirals, anticoagulants and IL-6-targeting therapies (12-14). In parallel, many research started to develop and test vaccines against SARS CoV-2 (15-17). However, it takes a few months to get an effective vaccine, and for this reasons it is important to follow rules of sanitation and social distancing.

Currently, an effective treatment seems to be the use of plasma from recovered patients that contains neutralizing SARS CoV-2 antibodies (18). The limit of this treatment is that not all recovered people can donate plasma and therefore the availability of plasma for therapies will be always insufficient.

Authors contributions

Authors contributed equally in the design of the study, the preparation and analysis of the data, and drafted the manuscript.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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