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COVID-19 Management

Towards Post-COVID-19: Lessons and Challenges for Hospitals and Healthcare Infrastructures

There is evidence of viral assaults possible repetitiveness in the foreseeable future. Prevention and preparedness are essential, especially for the health sector. Learning from the dramatic experience of Italy with COVID-19, this article addresses the major aspects of the role of the health technicians who, in parallel with the managerial and medical staff have responded to the continuously changing needs, providing appropriate care environments for the infected and protection for other patients and operators.

Framework

It is largely known that Italy has been the first, and for some time, the most affected country in the Western World by COVID-19, a new coronavirus strain that has never previously been identified in humans, before being reported in Wuhan, China, in December 2019.

Why Italy, why so intensively, why concentrated at first only in the Northern part, largely in the plain of the River Po (Pianura Padana)? What is the genesis of the specific virus, its evolution and effects? These and others questions will be the matter of long studies and intense discussions among specialists, politicians and media of all kinds.

This article, without under evaluating the importance and centrality of disciplines like virology, epidemiology, infectious diseases, intends to focus mostly on the field of knowledge and experience of the writer, that is Healthcare Built Environment and Governance of the complexity, such as any healthcare system, made more complex by a furious pandemic, as the one in which we are still immersed.

This pandemic explosion has, in fact, highlighted the importance of the health facilities systems and hospitals in the first place, and their constant management, as relevant part of the whole governance of this dramatic and complex moment. We are reporting in detail the experience of one of the authors, directly working in the battlefield of a major hospital in the North of Italy.

Preparedness for a Mass Crisis Situation Such as a Pandemic

The preparedness of the healthcare built environment in Italy, with its similarities to other countries in Europe, is the point of departure and the appropriate answer can only come by analysing the recent epidemiological history.

In the past century, the so-called "short century," when World War I was still going on, precisely starting in January 1918, a deadly pandemic influenza, identified for the first time in Kansas, exploded, lasting 36 months, that is, till December 1920. It infected over 500 million people – around one third of the world's population at the time. The death toll has had, and still has, a rough estimate: at least 25 million people, but possibly even up to 50 or more.

It is now scientifically proven that this pandemic, that put the entire world on the verge of collapse, was due to an avian virus, AH1N1.

Italy, already hit by the large number of war casualties, suffered a number of deaths - between 350 and 600,000 - produced by the pandemic. The overlapping with the war and then the post-war socio-political situation, triggered a strict censure and the health impact of the so called Spanish flu scientists define as a lost occasion to learn and make scientific progress.

The second pandemic came after World War II, called the Asian flu, virus AH2N2, isolated in China, that was fortunately reduced in its impact by a vaccine, produced in record time.

In 1968 the Hong Kong flu, an avian flu similar to the Asian flu, produced a large number of deaths in the Asian area within two years, but extended in the US with about 34,000 victims.

At the end of 2002, SARS (Severe Acute Respiratory Syndrome) a coronavirus SARS-Cov. spread very fast, mostly in the Asian part of the world. Its presence seemed to be defeated rapidly.

In 2016, however, the European Centre for Disease Prevention and Control was warning that "SARS and related viruses need to be globally monitored and response capacities need to be maintained"(ecdc.europa.eu/en/publications-data/severe-acute-respiratory-syndrome-annual-epidemiological-report-2016-2014-data). This alert did not receive great attention in Italy and generally in Europe.

The Swine Flu Pandemic has been the last warning. The virus was identified as a new strain of AH1N1 (the second appearance after the Spanish Flu). It lasted about 20 months and provoked great panic, but it was dismissed, when it became clear that its lethality rate was lower than the normal flu.

The explosive effects on Italian hospitals of COVID-19 can be vividly appreciated reading this insert written by Eng. Daniela Pedrini from her direct experience while being responsible for the technical sector of a major hospital in the North of Italy (Box 1).

THE MINUTE BY MINUTE FIGHT WITH THE VIRUS

From the daily experience of Eng. Daniela Pedrini.

With the impetuous spread of COVID-19, Italian hospital structures have found themselves in need of reorganising hospital networks and assistance activities to face the health emergency within a few days and sometimes a few hours. They have begun to transform many of their wards into intensive, sub-intensive and inpatient areas to accommodate the ever increasing number of patients. The rapid spread of the infection and the sudden influx of people at high infectious risk, made it necessary to immediately increase the number of beds, particularly intensive care units, localised in specifically equipped wards, with separate routes and dedicated teams.

The organisational and technical effort put in place to ensure a timely response can be fully understood considering that dedicated operators were hired and trained, when in parallel departments were closed, transformed and reopened in a few hours, renovations completed in a few days, beds made available, equipment installed, protection devices distributed, risk prevention and reduction measures adopted, lines of activity interrupted or suspended, citizens contacted for services rescheduling, managing personnel working in remote areas. Decisions to be taken, organisational solutions to be shared and realisation to be constantly monitored. All this, continuously and relentlessly.

Activating a department or a pavilion for the management of positive COVID-19 patients, within a hospital, means immediately moving entire departments, setting up multi-professional teams, guaranteeing the Personal Protective Equipment (PPE) provision, even a hundred times more than the usual number, training the dressing and undressing teams, identifying different dirty/clean materials' routes with adequate signals and informing all staff, do urgent work to upgrade the electrical system, oxygen system and room ventilation and obtain negative pressure, if necessary, install all the equipment, and in parallel separate the paths and find location for the other patients (transplants, oncology, etc) ensure the continuation of treatments that cannot be postponed, while protecting them from the risk of being infected.

In this context, everyone becomes fundamental and must work in harmony: main health managers, teams of professionals, directors and coordinators of the departments and services involved, nursing service, the technical services, clinical engineering, risk management, pharmacy, etc. The whole must be like an orchestra, realising a dynamic "system management" in action operating in the field.

With regard to the technical sector, some of the main activities to adapt the hospital network include:

- Activation of pre-triage in emergency areas, day-hospitals for cancer and access points with temporary structures (tents, prefabricated boxes) to create an obligatory and differentiated path for those who access normal care and those who are afflicted by respiratory symptoms, fever and cough and who can be suspected of having coronavirus.
- Creation of completely separate areas in the emergency rooms or external areas with Civil Protection tents equipped from an electrical point of view, medicinal gases, nurses' calls and remote controlled CCTVs connected with the Control Room and toilets to host suspected COVID-19 patients and avoid the possibility of contagion with patients present for other pathologies.
- Transformation of operating rooms and recovery rooms into intensive care units for COVID-19 patients.
- Realisation of passages and temporary boxes with dirty/clean filters to allow the dressing and undressing of the staff.
- Reversal of air flows in departments equipped with forced ventilation, construction of dedicated systems or use of extractors positioned on windows to create negative pressure environments.
- Application of the guidelines published by WHO (WHO Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected, Interim Guidance, 25 January 2020), specifying the environmental characteristics to prevent airborne contagion in environments:

• where aerosol therapy is practiced: perform procedures in an adequately ventilated room, with natural ventilation with air flow of at least 160 L/s per patient to be obtained by opening doors and windows or in negative pressure rooms with at least 12 air changes per hour and controlled direction of air flow when using mechanical ventilation;
• where aerosol therapy is not practiced: single hospital rooms, with natural ventilation with air flow of at least 160 L/s per patient to be obtained by opening doors and windows.
- Enhancement of the storage capacity of oxygen tanks and supplementary racks for cylinders, implementation of power lines and reduction panels to allow simultaneous operation of CPAP breathing systems and non-invasive ventilation (NIV).
- Adjustments of electrical systems to current regulations for resuscitation, implementation of electrical outlets for each bed, integration of special systems for patient management (nurse call, network points, video surveillance for remote monitoring).
- Creation of areas for dialysis dedicated to COVID-19 patients.
- Implementation of cold rooms for the storage of corpses in mortuary chambers.
- Adaptation of laboratories for specific tests for COVID-19.
- Identification and implementation of areas for the storage and distribution of PPE for staff.
- Identification and implementation of areas for storage and collection of waste.
- Identification of lifts to be dedicated exclusively to COVID-19 patient paths.
- Separation of COVID-19 and non-COVID-19 areas and related paths with many different solutions
- Identification of dining rooms and dedicated areas for dressing, undressing equipped with screens and mirrors on wheels for specific staff training.
- Installation of plexiglass panels for all front offices, information points, acceptance points, drug distribution, etc.
- Sketching of clear explanatory plans of the location and of the routes relating to the various COVID-19 areas, continuously updated, available to healthcare personnel on the company intranet.
- Installation of sanitary equipment for new intensive, sub-intensive and inpatient therapies, IT equipment, computers, furniture (armchairs, trolleys, etc), phones, two-way radios, tablets, smartphones.
- Development of management software and specific dashboards for bed control in monitoring.

This is only a short list of the continuous and constant activities that have involved and still involve hospital technicians to assure that the whole environment of the hospital is suitable for hosting COVID-19 patients and safe for medical and non medical staff and all the other hospital patients.

To summarise, we can say that in the war with the coronavirus, there are two advanced lines that fight side by side day and night: those who are in the trenches fronting the enemy and those who prepare safe trenches for them, meticulously, but quickly and respond as much as possible to the continuously changing needs.

Box 1: Insert written by Eng. Daniela Pedrini, Dipartimento Tecnico Direzione Progettazione, Sviluppo e Investimenti Azienda Ospedaliero-Universitaria di Bologna, Policlinico S. Orsola - Malpighi; President of the "Società Italiana dell'Architettura e dell'Ingegneria per la Sanità" (SIAIS).

Moving in another part of the Italian Health sector, in 1988 the Italian Government, considering the conditions of its post-war hospitals, decided to make a relevant allocation of public funds to finance a plan for modernising the structural and technological health care infrastructure of the National Health Service, to respond with increasingly appropriate, modern and safe structures and technologies, to the health needs of the community and to the expectations of operators and community assisted by the national health service, created in 1978.

There were two phases up to 1998 and then till about 2010, during which several hospitals were built, others rehabilitated in several regions. Then, almost coinciding with the end of the second financing of the above programme, the health sector started to be considered too expensive and in the last decade, precisely starting in 2010 the National Health Service (Sistema Sanitario Nazionale) was one of the victims of a new austerity, called "spending review," that produced, among others, a big loss in human and technical resources. Furthermore, in this period there was also a very relevant expansion of privatisation, facilitated also by the public support. The end result has been that in Italy, and probably for similar reasons also in other European countries, the improvement of hospitals was stopped. Some good examples of new buildings and plants were realised, but according to standard models for standard needs. To adapt even recent structures to the new needs of a pandemic can be called non-preparedness and certainly will be the first lesson for post COVID-19, also because scientists keep stressing that pandemics like the present and the preceding ones, mostly put aside in our memories, will occur again in a time span maybe not too long.

We should now be aware that we need to elaborate new models of hospitals and of management of health systems. Awareness and preparedness are the goals of the post-pandemic society. In the final part we will get back to the lessons we are learning for rethinking the health care built

environment.

The Chain of Command in the Health System and the COVID Challenge

Another issue is taking space in the public debate, probably not only in Italy, of taking advantage of what the pandemic is teaching us as occasion for an objective evaluation regarding the health systems governance.

Italy has had, since 2001 with the reform of the Constitution, a decentralised health system. Issues have arisen during these nearly 20 years with regard to the decentralisation, that can be called more properly classifed as "regionalisation" of the health system. Among others one of the major goals that was supposed to be achieved with such important measures was the reduction, if not disappearance, of the differences between the quality of care in the North and in the South regions, which appear to have increased, not decreased in the last period.

The pandemic fortunately has not hit very hard, up to now, the Southern Regions and especially the two major islands Sicily and Sardinia. The circumstances of such a positive situation are still not clear and a matter of debate.

What is clear is that the present decentralisation has been the source of some problems in the fight against COVID-19, but there is also the possibility that restarting a country is an even bigger challenge, considering that Italy suffers and will suffer from the massive hit of the pandemic. Focusing our analysis again on the health system, there is no doubt that the cut in funds for the health system in the past ten years and the consequent reduction of medical and non-medical personnel, the impoverishment of the territorial health services, including GPs, have influenced the heavy consequences of the pandemic. The discussion will necessarily go on, as it has to be in a democracy, but it is fundamentally important that the lessons of the dramatic period will be learned. In the conclusion, we will give our synthetic view.

Atmospheric Pollution and Coronavirus

Another aspect that has raised and still raises questions, is the strikingly uneven distribution of the spread of infection. The plain of the River Po encompasses the regions with the first and highest number of people infected, of patients needing intensive care, and also the highest number of deaths. The research of a scientific explanation of such distribution is going on, producing a scientific and frequently non-scientific debate.

The pandemic is slowly reducing its impact. This is why it can be considered the right moment to start a deep evaluation of factors which may have been at the base of the way the situation evolved.

The Regions Lombardy, Veneto, Emilia-Romagna and Piedmont, that is the major part of the Northern area, are the most industrialised parts of Italy. Lombardy, especially the city of Milan, are the centre of international trade and commerce, therefore they have been the first and most exposed to the

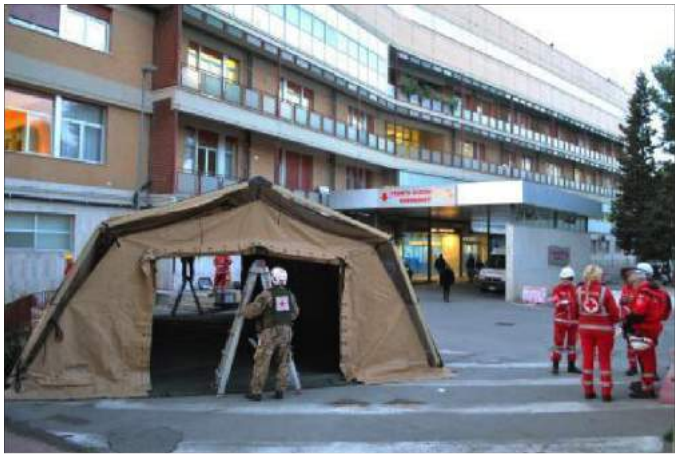

Figure 1: Urgent construction of tents for pre-triage of persons suspected of being infected by COVID-19

Figure 2: Health operators in their protected garments

coronavirus infection. Officially in China the "epidemic" was acknowledged in February, but probably from December, as we now know, it was going around and probably not only in China.

But, for too long a time, we, the Europeans at least, were looking to the far away province of Hubei and its major city Wuhan, as if they were another world.

It was only the first seriously infected patient on February

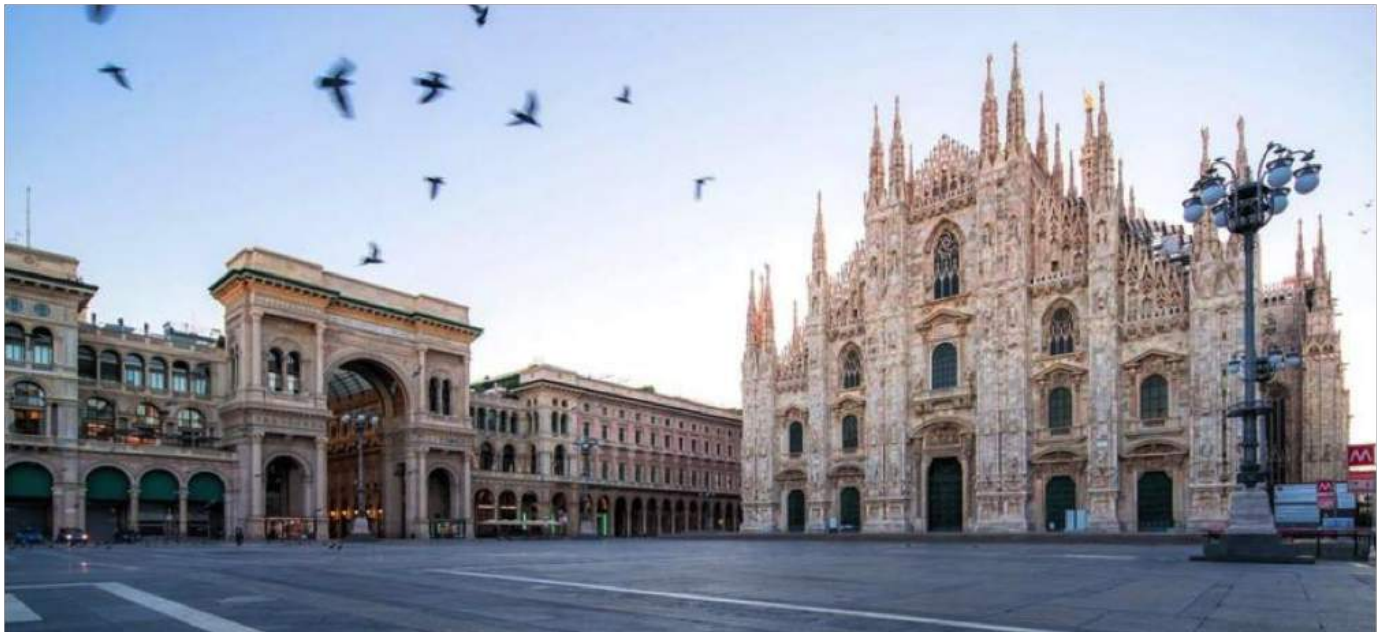

Figure 3: The empty square of the Milan Cathedral after the lockdown measures

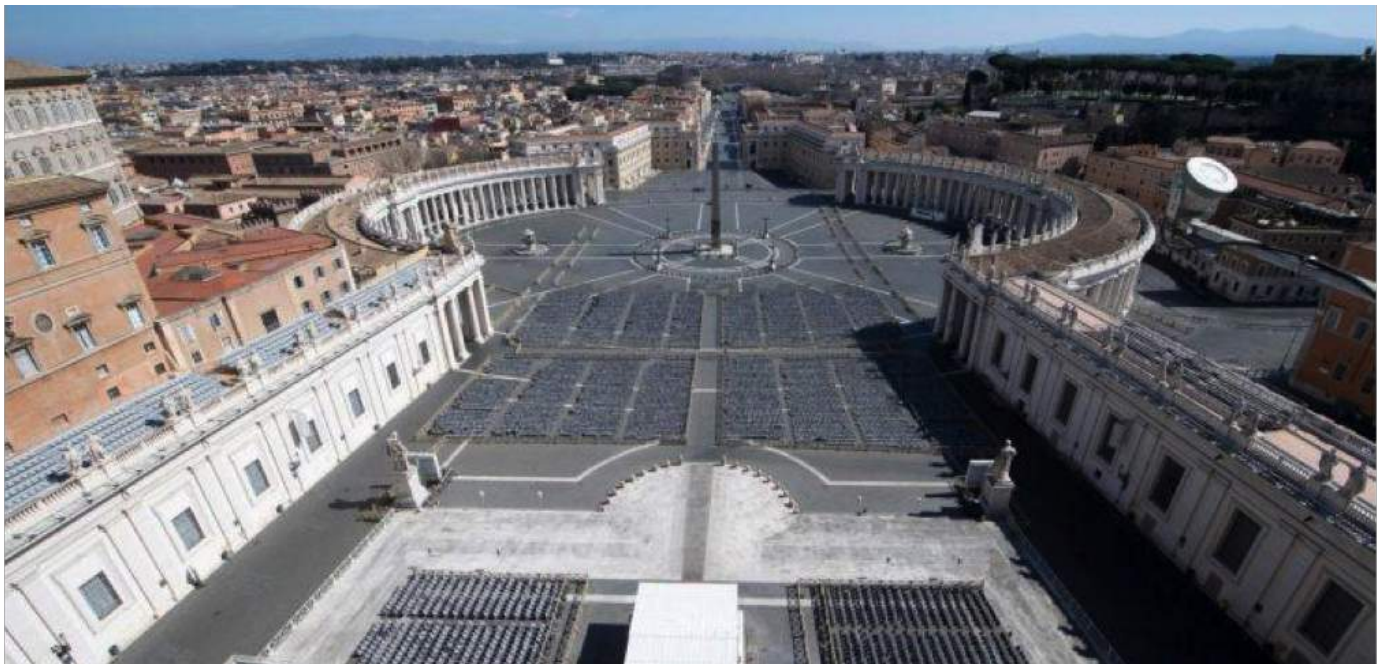

Figure 4: San Pieter Square in Rome.

28, that started to produce the alarm, with the first diagnosis of coronavirus infection. The contagious virus has rapidly spread in the Northern regions of Italy as we know, creating disruption in most hospitals in the above mentioned regions. Many scientists are relating this fast and localised spread with the environmental situation of this area that has affected and debilitated the inhabitants, making it more easy to be attacked by the virus.

We must also take into account that Northern Italy is one of the most polluted areas of Europe because of the sum of different factors: climatic and geographic conditions, industrial development, traffic from urban, to international. The aerial photography of the usual atmospheric pollution level and the situation after more than one month of restriction on all kinds of traffic can show the impact of the later factor on the situation of the area.

Even the most prudent of scientists underline that "a subject living in an area with high levels of pollutant is more prone

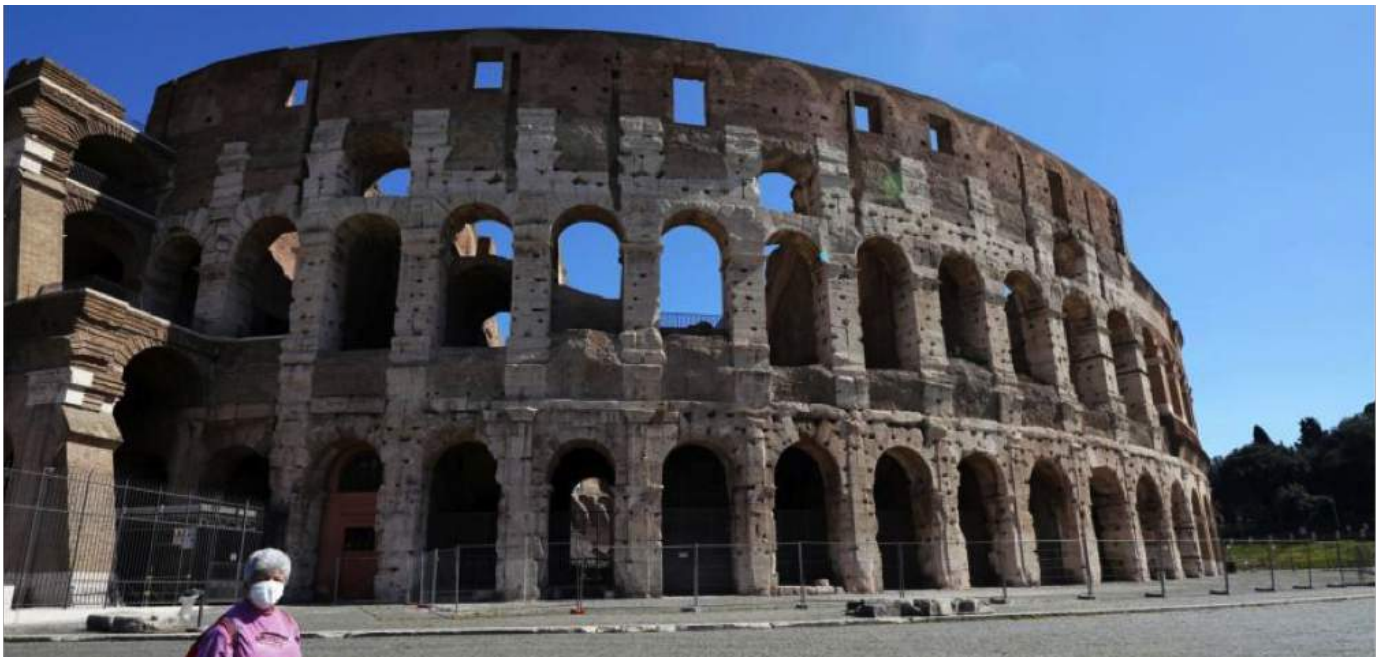

Figure 5: The Colosseum

to develop chronic respiratory conditions and susceptible to any infective agent" (Conticini et al. 2020) and conclude that studies are urgently needed to evaluate the role of atmospheric pollution in certain populations.

Conclusions

Examining some of the lessons that Italy, and maybe other countries, should learn from the way COVID-19 has impacted Italy, we have started with the situation of the healthcare built environment, namely hospitals, to expand the urgently needed reorganisation of the public healthcare system of Italy and trying to understand in a more systemic approach the whole complexity of the situation. We have also touched an issue regarding the need to change the way we live in our planet. Far before COVID-19, it was known that pollution was causing not only in the Northern part of Italy, but in many other parts of the world illnesses and death.

Hence, we put together all our conclusions: the first lesson is that this dramatic period we are going through requires the courage to change: those who work in the health sector have to re-think the architectural models. The technicians have made miracles in adapting the present hospitals to dramatically meet new needs, and in future have to be encompassed in the planning and design processes. Governance of the health systems has to take into account the need of less fragmentation, strong national and European coordination and the realisation that any spending review forms for the health sector should be devised and envisaged in restarting the economy. We have to take into account that this time we have to move in a sustainable way, with prevention and preparedness as goals in addition to an economic development focused on respecting people, community and environment. This way, we should respect the saying of Machiavelli and take advantage of a dramatic crisis. ■

Author: **Prof. Arch. Simona Agger Ganassi**
Member of the Council of Health Care Without Harm –Europe (HCWH –EU)
Member of the Board, European Health Property Network (EuHPN)
Member of the National Council of SIAIS | **Italy**
simona.agger@gmail.com | www.euhpn.eu | www.noharm-europe.org | www.siais.it

Key Points

- COVID-19/Coronavirus is a very contagious virus of the AH1N1 strain.
- Pandemic is an infectious disease widespread over a whole country or the world.
- Healthcare infrastructures refer to the complex system of healthcare assets, including hospitals.
- Health technicians include architects, engineers, professionals with technical knowledge working in health.
- Governance in health systems refers to rule-making related functions carried out by decisions makers.
- Atmospheric pollution refers to pollutants present in the air in high quantity and influencing health.

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