

This accepted version of the article may differ from the final published version.

This is an Accepted Manuscript for *Disaster Medicine and Public Health Preparedness* as part of the Cambridge Coronavirus Collection

DOI: 10.1017/dmp.2020.51

**2019-ncov's epidemic in middle province of northern Italy: impact, logistic & strategy in the first line hospital**

Gagliano Annalisa. MD (1), Villani Pier Giorgio MD (2) , Co' Francesca M. MD (3), Paglia Stefano MD (3), Bisagni Pietro A. G. MD (1), Perotti Gabriele.M. MD (4), Storti Enrico MD (2), Lombardo Massimo MD (5)

1.ASST Lodi Department of Surgery- Complex unit of General & Thoracic Surgery, Lodi – Italy

2. ASST Lodi Department of Emergency & critical care unit of Anesthesia & resuscitation, Lodi-Italy

3.ASST Lodi Department of Emergency & critical care unit of Emergency Department, Lodi -Italy

4.ASST Lodi Chief medical Officer, Direction & Management, Lodi -Italy

5.ASST Lodi General Director, Direction & Management, Lodi-Italy

Corresponding author:

Gagliano Annalisa MD

Complex Unit of General & Thoracic Surgery

ASST Lodi, Lodi Major Hospital

Largo Donatori del Sangue, 1, 26900 Lodi –Italy-

e-mail address: [annalisa.gagliano@asst-lodi.it](mailto:annalisa.gagliano@asst-lodi.it)

phone number: +39 0371 372277

fax number: +390371372167

## ABSTRACT

The novel coronavirus (2019-nCoV) began in China in early December 2019 and rapidly has spread to many countries around the globe, with the number of confirmed cases increasing every day. An epidemic has been recorded since February 20 in a middle province in Northern Italy (Lodi's province, in the low Po Valley). The first line Hospital had to redesign its logistical and departmental structure to respond to the influx of 2019-ncov positive patients who needed hospitalisation. Logistical and structural strategies were guided by the crisis unit, managing in 8 days from the beginning of the epidemic to prepare the hospital ready to welcome more than 200 positive COVID19 patients with different ventilatory requirements, keeping clean emergency access lines and restoring surgical interventions and deferred urgent ordinary activity.

## Key words

2019-ncov , emergency, strategy, public health

## OBJECTIVE

In early December 2019, the first pneumonia cases of unknown origin were identified in Wuhan, the capital city of Hubei province. The pathogen has been identified as a novel enveloped RNA betacoronavirus<sup>2</sup> that has currently been named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which has a phylogenetic similarity to SARS-CoV. Patients with the infection have been in the hospital, in family and work environments and in communities. The World Health Organization (WHO) has recently declared coronavirus disease 2019 (Covid-19) a public health emergency of international concern<sup>1</sup>. At the end of January 2020, mainland China reported 11,791 confirmed cases of novel coronavirus (COVID-19) infections, causing 259 deaths<sup>2</sup>. Initially, were thought to zoonotic transmission, however, recently published evidence the human-to-human transmission that increased exponentially by travel, with many cases detected in other parts of the world. This geographic expansion beyond the initial epicenter of Wuhan provides an opportunity to study the natural history of COVID-19 infection<sup>3</sup>. In relation to the transmission risk of 2019-ncov (4), on 25 January 2020 the Italian Ministry of health issued the first order with prophylactic measures against the new Coronavirus (2019-nCoV), after the first one many ordinances and regulatory circulars defined both prevention measures of behavioral and treatment rules for suspected cases. On 20 February 2020 the first case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was confirmed in Italy in Codogno's hospital ( a little city of Lodi's province in the low Po Valley) from this moment defined as "red zone" ( no entry or leave zone including 10 cities around Codogno, with quarantine commitment for all citizens). This represented the starting point for extraordinary measures of national and regional management evolving on the basis of the infections registered.

## METHODS

From the first diagnosis the Emergency Department (ED) of Codogno's Hospital was closed and all the routine and elective activity was interrupted "freezing" the Hospital at the time zero of diagnosis maintaining the care for patients already hospitalized within the hospital ensuring normal care and management. The influx of patients was then diverted to the Major Hospital in Lodi, which became the first-line hospital from that moment. It's necessary to change the hospital organization to manage the eventual epidemic and identify the institutional interfaces. Two tracks to follow: the first management of the Territorial Social Health Company (ASST); the second institutional: region and government. From that moment the management of the hospital was entrusted

to the crisis unit. Lombardy Region Government transferred to Lodi Major Hospital crisis unit complete decision making power, without Hospital ethic approval, in relationship of needing and emergency situation. This was the key of the strategy and the master and commander for the change success. The crisis unit was formed involving: hospital government (general, health, nursing), directors of department, logistics heads, representatives of critical units in the management of positive 2019-ncov patients and press coordinator. Direct collaboration with prefecture, law enforcement, civil protection, city, province and amongst regional governments. Indirectly with government and Ministry of Health and higher health institutes. The critical points present at time zero from the first diagnosis arose at various levels:

- Sanitary: how many patients in which distribution, with what type of presentation
- Staff: who came into contact with positives in quarantine, to whom and when to buffer, how many available for the various areas
- Logistic: which and how many drugs, which and how many consumer supplies, how many and which ventilation systems ,how much oxygen, possibility of rapid re-supplies
- Structural: possibility of structural changes within the Hospital and any destination use change, materials, workforce

The main problem immediately encountered was the fluidity and rapidly of requests and the need to change the hospital on the basis of needs. It is almost impossible to redesign areas and management from the beginning. The defined structure was therefore a fixed structure of the management unit (crisis unit) 2 meetings per day at 10 am and 4 pm to verify progress and needs and to respond and check the effectiveness of the maneuvers put in place. The Major Hospital has 300 beds organized in 9 Departments, of which 6 belonging to the Health Department, one to the Administrative Department and two to the Social Health Department. The Intensive therapy has 7 beds and in ordinary activity , the Emergency department has near 80000 access for year with a population of the low Po Valley nearly to 250000 people. What and how must be this changed?

At the same time, the emergency department collected data on access and real needs of patients, operating from day zero a carefully and timely collection of epidemiological and

health data and initiated a process of change in management of triage method and the managing of patients.

This model set made it possible to completely change the hospital's characteristics in 8 days.

We analyze the changes made area by area and illustrating logistic and needs.

### Emergency Department

The Director of the ED instituted from the first case a careful data collection of the number and trend of patient access. In the first day we received patients with a rate of high flux access every 12 hours for a total number of 120. Patients accessed and the trend of treatment was focus on the resolution of acute respiratory failure, but without real knowledge of the presentation of symptoms. The observation in the first days allowed to identify the common symptoms and signs of the infection, and starting from this observation the Director of the ED designed a model to effective triage of patient and rapid framing of the rate of respiratory failure and responsiveness of the patients to the oxygen treatment. From this point the director was able to redistribute the ED areas for the different types and needs of patients in scale model and at the same time to develop clinical documentation of rapid interpretation to evaluate the improvement or deterioration of the patients. All identifying the necessary devices to guarantee the treatment of symptoms.

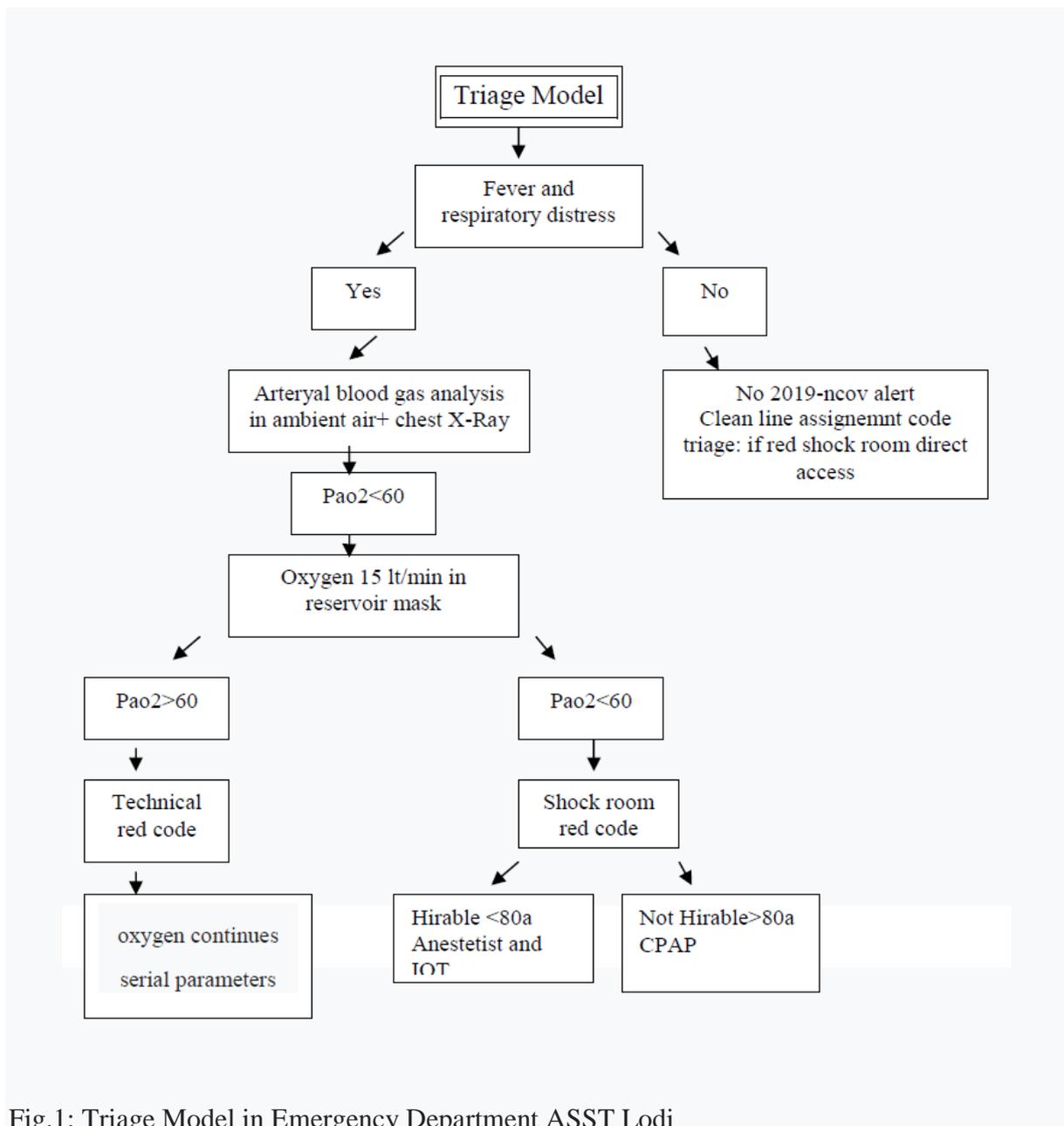


Fig.1: Triage Model in Emergency Department ASST Lodi

The evaluation of simplified parameters: temperature, oxygen saturation register in a nominal parameter sheet attached to the patient's stretcher and artery blood gas analysis (EGA). The schematization and optimization made it possible to identify necessary device and supplies: oxygen mask, continuous positive airway pressure (CPAP) and ventilation system, stretchers, syringes, personal protective equipment (PPE), antibiotics. The ED represented the key node for the remodeling of the hospital based on the accesses and the first epidemiological data collected. At the end of the first high flux of patients we had the necessity to have 5 intensive care unit (ICU) beds, 20 beds for patients in ventilation support (CPAP System), 40 beds for patients with pneumonia in oxygen support. It's not possible to attend the result of the test that consist in nasopharyngeal swab (collecting a sample from the back of the nose and throat), because the flux of patients had a 12 hours rate and the test result came in nearly 72 hours. The ED for not COVID patients has been opened with direct access after triage and dedicated diagnostics. In which 2 visiting rooms and a shock room for red codes been set up

### Hospital wards

The distribution of the hospital has been completely changed since the 3rd day of the emergency and with fluid progress on the basis of the needs.

The first measures covered critical areas. But as a first step it was necessary to stop all ordinary and non-urgent outpatient activity; to provide in the shortest time to discharge the patients in order to free up as many beds were possible in wards. After the recruitment of beds, it was necessary to change the wards destination and the structural creation of filter zones.

- ✓ Intensive care: from time zero all patients hospitalized in “sub-intensive” (pulmonary failure or cardiac failure) observation beds were sent to the ordinary ward and such beds were recovered as ICU beds. This allowed to increase the ICU capacity from 7 beds to 17 and predisposing in operating rooms intended for ordinary minor surgery with available ventilators, lifesaving places for non-viral patients.

- ✓ Wards: wards and beds have been created for patients with respiratory syndrome. As the first step, an area (at the previous neurology ward, where there were 4 beds monitored and potentially ventilator-equipped) of 18 beds became a critical pneumological area. It was possible to do this in 3 days with structural and logistical changes, creating filter zone, defining warehouse and sanitary areas. After these, two more 40-bed wards were set up for patients with oxygen needs without the need for intensive or sub-continuous monitoring. Again intervening on structure and logistics. At the end of the first week the hospital completely changed its face. This has also allowed a resumption of deferred urgent activities including surgical activity.

#### Service and management structure

- ✓ Radiology: ED radiology (CT scan, ultrasound and portable X-ray machine) and conventional X-Ray rooms were considered dirty; the x-ray rooms, the CT scan and the MRI scan site on the ground floor defined as clean and usable for non-covid patients.
- ✓ Service: clean service has redefined tools to use and the cycle of service, the kitchen prepared packages with disposable portions for dirty areas.
- ✓ Direction: permanent crisis unit with scheduled meetings (2 per day at 10 a.m. and 4 p.m.)

Press office planning and links with prefecture, region and external law enforcement agencies, . connection with Whuan and with international newspapers. Supplies on the basis of the need to renegotiate existing contracts to increase the amount of use of the supplies themselves.

- ✓ Pharmacy: sorting and controlling use drugs and DPI, connection with ethics committee for antiretroviral therapy in patients with Sars-cov2

The change was completed affecting the entire hospital on the 8th day. There was a need for a redistribution of medical and nursing staff to structural changes. Was necessary to redistribute the staff on duty (not quarantined). Driving permits from the red zone were given to the medical staff of every degree in order to ensure the assistance and the attainment of the workplace.

At the same time, the recruitment of external staff was necessary. Here has been voluntary recruitment both in other regional facilities and in the health sector of the Army. Holidays and temporary leave was suspended and the hospital has been staffed to provide day and night care in all wards. Surgery has at all times guaranteed emergencies with two operative theatres activated by day, one at night and guaranteed deferred urgency on shared operative theatre between general and specialist surgery.

## RESULTS

The literature data available at the time of the emergency were few and above all stemming from the only experience available on the outbreak from COVID 2019. The only country with published data and epidemiological or management studies was represented by the Chinese reality<sup>3,4,6</sup>. However, the health system and the Chinese government represent a very far model from the Italian reality where health is regional and where each ASST has significant autonomy such as the possibilities available to try to improve and optimize management and logistical choices. Applicable and effective models could result; major-emergency management and military management. Both systems ensure resource optimization in relation to large inflows<sup>7</sup>. Starting from the concept of advanced medical post and the use of the action plan for the major-emergency, we were able to organize the crisis unit as the hospital's operations center. At the same time, however, we were not certain about the number of infections or about the real needs of patients. This was the critical point for the

initial management. It was therefore necessary to initiate internal analyses that were possible thanks to the effort of the ED where epidemiological and health data are recorded up to the first access. After 72 hours it was therefore possible to have not only the pattern of inflows but also a realistic prediction of the necessary resources. Every effort was made to have a fluid model inside the Hospital. Prospectively patient management presents a linear management mode for patients who respond to only oxygen therapy: from ED to ward, circular one for the patient in need of ventilator support : from the ED will have to be allocated in one of the ventilated areas (depending on the need: ICU or sub-intensive) and then return to ward. The Hospital day by day thanks to the data collected and to the great structural and logistical effort was designed as a fluid and circular model. However, the confrontation with the regional government and its health facilities has become decisive and fundamental. In fact, the circular model provides for the need for the involvement of different structures. The first-line hospital in this case is represented by a provincial hospital with a capacity limited to 300 beds. The role of the first line hospital is to ensure framing and need of the patient, but large-scale management of the patients involved must be matched. This is why the regional network and transfers made it possible not to collapse at the first accesses of the frontline structure. These dynamics model was difficult to realize without reference models and without knowing the number of casualties and this was not possible to have it from the beginning; but the presence of all the representations in the management of the crisis has meant that, despite the low sensitivity of prospective data .The model has been applied allowing the management of the first phase of the emergency. In the same way, decentralized management of the First phase in the frontline hospital, has allowed other structures, albeit in different ways, to prepare suitable space and line of management for COVID patients.

While in the red zone the numbers began to grow new oil-spot infections that started to show up in the region, showing the same trend as the Chinese epidemic. At this point having a management model at its disposal could be the key to better addressing and optimizing the use of resources.

## CONCLUSION

The need for a quick response drove the hospital's choices of change. Centralizing and managing through the crisis unit has enabled and made change possible. At the end of the first week thanks to the restructuring and thanks to the triage and treatment guaranteed by the ED brought the ability of the hospital to manage in ED up to 100 patients without collapsing and at the same time to ensure the management of the patients and the capacity of the hospital according to need. Everything was possible thanks to the efforts of the medical and nursing staff, which has been redeployed to reinforce critical areas and replace quarantined operators ensuring maximum assistance. Coordination of the crisis unit with regional military and government authorities has enabled the centralization of the problem. It's necessary that from the moment that the biohazard emergency represents a certain epidemic, coordination should be increased to a higher level than ASST one and that the 'modular' structure can be coordinated at the regional level to ensure to increased effectiveness and availability of beds to guarantee the health of citizens.

The management on the front line also highlights the need to have a major emergency management plan that is diversified due to biohazard epidemic and in this case the plan should be regional and agreed in increasing stages of action with commitment of resources with a structured and centralized model. In this way, the account of both the structures and the work units (nurse, doctors and administrative or health support staff) will be managed as

the total account and with progressive commitment. This could also ensure that any infections between the staff are replaced.

Even for logistics, the ability to increase coordination on the basis of total resources would ensure adequate supply as needed and also cost would be able to preserve the right value. The conclusion of this first phase then creates talking points to improve and optimize the responsiveness of the NHS.

### ABBREVIATIONS

Severe acute respiratory Syndrome coronavirus 2 (SARS-CoV-2), 2019-ncov or COVID-19 (Novel Coronavirus 2019), Territorial social health company (ASST), Continuous Positive Airway Pressure (CPAP), Artery blood gas analysis (EGA), orotracheal intubation (IOT), Personal Protective Equipment (PPE), Intensive care unit (ICU), National health system (NHS)

## REFERENCES

1. World Health Organization Coronavirus disease (COVID-19) outbreak (<https://www.who.int>). Accessed on 22 February 2020;
2. National Health Commission of the People's Republic of China: update of Pneumonia of New Coronavirus Infection as of 21.00 on January 31. Available online:(<http://www.nch.gov.cn/xcs/yqtb/202002/84faf71e096446fdb1ae44939ba5c528.shtml>). Accessed on 22 February 2020;
3. Linton N.M, Kobayashi T., Yang y, et al. Incubation Period and Other Epidemiological Characteristic of 2019 Novel Coronavirus Infections with Right Truncation: A statistical Analysis of Publicly Available Case Data. *J.Clin.Med* 2020,9,538;
4. Habibzadeh P., Stoneman E.K., The Novel Coronavirus: A Bird's Eye View, *Ijoem*, 2020, 11, 65-71;
5. Guan W., Ni Z., Hu y., et al. Clinical Charateristic of coronavirus Disease 2019 in China. *N. Engl J Med*. 2020,28 Febraury, 1-13;
6. Wang D, Hu C., et al. Characteristic of 138 Hospitalized patients with 2019 novel coronavirus –iinfected pneumonia in Wuhan, China. *JAMA* 2020 Febraury 7 (Epub ahead of print);
7. Flohe S. Preclinical and intrahospital management of mass casulaties and terrorist incidents. *Der Chirurg*. 2017, 88, 830-840;

8. Porru S., Agresta A., Cimaglia C., et al. Management of biohazard in health Care System. *G. Ital Med Lav ergon*, 2012, 34(3 suppl.) 249-251;
9. Coronavirus disease (COVID-2019) situation reports (<https://www.who.int/emergencies/disease/novel-coronavirus-2019/situation-reports/>). Accessed on 22 February 2020;
10. World Health Organization. Coronavirus disease (COVID-19) technical guidance: laboratory testing for 2019-nCoV in humans (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance>). Accessed on 22 February 2020;
11. Barelli A., Biondi I., Soave M., et al. The comprehensive medical preparedness in chemical emergencies: “the chain of the chemical survival” *Europ J of Emer Med* 2008, 15, 110-118;
12. Burda P., Anand J.S., Chodorowski Z., et al. Logistic Preparedness of chosen urban agglomeration Hospitals to Act during Massive Chemical disaster. *Przegl Lek*, 2007, 64, 215-218;
13. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *Lancet* 2020 January 31 (Epub ahead of print).
14. Assiri A, McGeer A, Perl TM, et al. Hospital outbreak of Middle East respiratory syndrome coronavirus. *N Engl J Med* 2013; 369: 407-416;
15. Goyal SM, Chander Y, Yezli S, et al. Evaluating the virucidal efficacy of hydrogen peroxide vapour. *J Hosp Infect* 2014;86:255-259;

16. Alshammari M, Reynolds KA, Verhougstraete M, et al. Comparison of perceived and observed hand hygiene compliance in healthcare workers in MERS-CoV endemic regions. *Healthcare (Basel, Switzerland)* 2018;6:122;
17. Wong TW, Tam WW. Handwashing practice and the use of personal protective equipment among medical students after the SARS epidemic in Hong Kong. *Am J Infect Contr* 2005;33:580-586;
18. Zhao S, Lin Q, Ran J, et al. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: a data-driven analysis in the early phase of the outbreak. *Int J Infect Dis* 2020;92:214-217;
19. Ryu S, Chun BC. Epidemiological characteristics of 2019 novel coronavirus: an interim review. *Epidemiol Health* 2020;42:e2020-2016;
20. Biscayart C, Angeleri P, Lloveras S, et al. The next big threat to global health? 2019 novel coronavirus (2019-nCoV): What advice can we give to travellers? —Interim recommendations January 2020, from the Latin-American Society for Travel Medicine (SLAMVI). *Travel Med Infect Dis* 2020:10156;
21. Wang C, Horby PW, Hayden FG, et al. A novel coronavirus outbreak of global health concern. *Lancet* 2020;395:470-473;
22. Jung, S., Akhmetzhanov, A.R., Hayashi, et al. Real time estimation of the risk of death from novel coronavirus (2019-nCoV) infection: Inference using exported cases. *medrxiv* 2020;
23. Lessler, J., Reich, N.G., Brookmeyer, R., et al. Incubation periods of acute respiratory viral infections: A systematic review. *Lancet Infect. Dis.* 2009, 9, 291–300.