Telemedicine: A cornerstone of healthcare assistance during the recent pandemic outbreak of COVID-19 but also a great opportunity for the future. A pilot experience in the largest Teaching Hospital in Southern Italy.

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Abstract

Background: At the end of 2019, Wuhan, China, experienced an outbreak of a novel coronavirus. The epidemiologic burden of COVID-19 is constantly evolving, with numbers of infected persons, hospital admissions and deaths growing near exponentially. The recent pandemic outbreak of COVID-19 worldwide caught the health care systems in every country around the world by storm and without a proper defense mechanism to cope and control such a pandemic. In fact, this outbreak is causing an overwhelming burden of illnesses that stresses health system capacity and adverse effects on healthcare workers including the risk of infection. In this context, telemedicine has been promoted and scaled up to reduce the risk of transmission. In this paper the Authors reports their own experience with Telemedicine.

Methods: During the “lockdown”, the AOU “Federico II” was forced to create peculiar pathways to ensure the safety of the patients and medical staff, and to keep an appropriate medical assistance, therefore it was introduced the telemedicine, wherever possible, by modifying the Information Technology (IT) related to the waiting times, rescheduling all booked visits and identifying several outpatient’s clinics suitable for telemedicine activities. Besides, safe pathways were properly studied to screening all patients who had a medical consult in person.

Results: Since the introduction of telemedicine service, 953 consultations were provided in this way, about 13 % of all medical consults delivered by AOU “Federico II” in this period; 97,38% of them were follow-up visits, that otherwise would have been missed during the current pandemic, so an economic loss has been avoided. In addition, it has been calculated that, using Telemedicine visits vs a face-to-face consultation, about 65-70% of direct costs were spared by our Healthcare Company.

Conclusions: Telemedicine has been the keystone that has allowed a rapid, appropriate response of whole overloaded healthcare systems to current Pandemic, and, as reported by Ohannessian et al., *all stakeholders are encouraged to address the challenges and collaborate to promote the safe and evidence-based use of telemedicine during the current pandemic and future outbreaks, and the COVID-19 pandemic is a call to adopt the necessary regulatory changes supporting wide adoption of telemedicine.*

Background

Coronaviruses are a group of related RNA viruses that cause diseases in mammals and birds. They are minute in size (about 65–125 nm) and contain a single-stranded RNA as nucleic material, size ranging from 26 to 32kbs in length, and categorized in five subgroups (alpha α , beta β , gamma γ and delta δ). Recently, at the end of 2019, Wuhan, an emerging business hub of China, experienced an outbreak of a novel coronavirus that killed more than 3000 and infected about 81000 individuals within the first fifty days of the epidemic (WHO Situation Report number 50).¹ This new virus, responsible for a new severe respiratory syndrome, was reported to be a member of the β group of coronaviruses² and it was defined

as “*Severe Acute Respiratory Syndrome Coronavirus 2*” (SARS-CoV-2) by the International Committee on Taxonomy of Viruses.³

As remarked by Lippi et al., the novel coronavirus disease (*COVID-19*) “*is the third coronavirus outbreak to have emerged in the past twenty years, after Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS)*”³.

Generally the human-to-human transmission occurs with close contact; in fact, the transmission primarily happen through the respiratory droplets production, just as influenza and other respiratory pathogens;² however transmission may also occur through fomites in the immediate environment by touching an infected surface or object.⁴ Airborne transmission may be possible in specific circumstances and settings in which procedures or support treatments that generate aerosols are performed. Other routes of transmission, such as fecal-oral and blood borne transmission, may be possible too.

Usually, SARS-CoV-2, like other respiratory viruses, is considered to be more contagious when people are symptomatic. However, it was also reported some cases in literature, in which several people were infected from asymptomatic subjects during the “prodrome period”.⁴

The estimated incubation period between infection and onset of symptoms is approximately 5 days (range: 2-14 days) but with a high variability (Possible outliers: 0 - 27 days).

Columbus et al reported that approximately 25% of patients had required intensive care and reporting a clinical deterioration at roughly day 8 of illness; besides, 10% of them required intubation and mechanical ventilation and approximately 3% required extracorporeal membrane oxygenation.⁶

Clinically, the immune responses induced by SARS-CoV-2 infection are two phased:

- The first phase occurs during the incubation period and it represents a “*non-severe stage*”; in this phase, a specific adaptive immune response is required to eliminate the virus and preclude the disease progression toward more severe stages.⁷
- The second phase occurs later, when the protective immune response is almost impaired; in this phase, the virus will propagate in host’s cells resulting in a massive destruction of the affected tissues, especially in organs that have high ACE2 expression.⁷ A cytokine release syndrome seems to affect patients with severe conditions associated to a genetic susceptibility.⁷

As reported by Yufang et al. in this phase, “*the innate immune response to tissue damage caused by the virus could lead to acute respiratory distress syndrome (ARDS), in which respiratory failure is characterized by the rapid onset of widespread inflammation in the lungs and subsequent fatality*”.⁷ Hence, the clinical features of COVID-19 are varied, ranging from asymptomatic state to acute respiratory distress syndrome and multi organ dysfunction.⁸

Due to the incontrovertible evidence demonstrating worldwide diffusion of SARS-CoV-2, COVID-19 has recently been declared a global pandemic disease by the World Health Organization (WHO);³ in that occasion, T.A. Ghebreyesus, the General Director of the Agency, warned the entire World on *“the alarming levels of spread and severity, and by the alarming levels of inaction”*.³

From then, The epidemiologic burden of COVID-19 is constantly evolving, with numbers of infected persons, hospital admissions and deaths growing near exponentially.³

The last Situation Report of the WHO attests that COVID-19 has already infected as many as 4993470 people up to May 22, 2020, from 213 countries and territories, causing 327738 deaths (WHO Situation Report number 123).¹ The current case fatality rate is calculated at approximately 6,5%.

The recent pandemic outbreak of COVID-19 worldwide caught the health care systems in every country around the world by storm and without a proper defense mechanism to cope and control such a pandemic.⁹

In fact, this outbreak is causing an overwhelming burden of illnesses that stresses health system capacity and adverse effects on healthcare workers including the risk of infection. The confinement of population and the outbreak impact on health care systems is disrupting routine care for non COVID-19 patients.¹⁰ The health care has undergone a progressive significant worsening for these patients over the last pandemic weeks. In this context, telemedicine, particularly video consultations, has been promoted and scaled up to reduce the risk of transmission;¹⁰ in fact, it is a versatile tool with a wide range of applications.

The framework included tele-expertise, remote patient monitoring of contact cases, and teleconsultation for triage and isolated cases.¹⁰ Telemedicine permits to non COVID-19 patients to get the necessary health care they need, while minimizing exposition to infection of themselves and medical staff. It is very important to remark that medical staff may become a potential and powerful vehicle for viral spread.¹¹

In this paper the Authors reports their own experience with Telemedicine.

Methods

The AOU “Federico II” is the largest teaching hospital in Southern Italy and a hospital center of high specialization. It is a health company with legal, financial and organizational autonomy and it is located in the city of Naples with over 1500000 inhabitants. It has one of the highest density of population area in Italy, with more than 2616.8 inhabitants per square kilometer, one of the highest in Europe. The facility covers all fields of medicine and has a very strong commitment in research and technology, hosting the biggest and the eldest school of medicine in the World. Its outpatient’s activity ranges from 180000 to 200000 visits per year, reaching peaks of 250000, with an average of 875 patients seen every day. During the “lockdown”, in order to ensure adequate medical assistance at COVID patients, the AOU “Federico II”

had to cancel or delay the usual medical assistance to non COVID patients, securing the latter just the essential services, such as urgencies, emergencies, time-related conditions (such as pregnancy, onco-haemathologic diseases, dialysis) and other rare conditions, exclusively followed by our facility, but not other medical services. These stronger criteria were dictated by National and Regional Guidelines in order to reduce the viral spread among people. In this time, there was a remarkable reduction of workloads, as reported in figure 1. We were forced to create peculiar routes (figure 2) to ensure, by one hand, the safety of the patients and medical staff (personal protective device Utilization, social distancing and protective behaviors), and, by other hand, to keep an appropriate medical assistance. To reach this goal and to serve the highest possible number of people at the same time, considering the mandatory limitations enforced by national and regional government, we first introduced the telemedicine, wherever possible. Since the main target of Telemedicine is the outpatient's clinical activity, and especially for follow up activities, we monitored and compared the volume of outpatient's clinics before and during the lockdown (in Italy March 9, 2020 – May 4, 2020).

To achieve this objective, we modified the Information Technology (IT) related to the waiting times and rescheduled all booked visits and identified several outpatient's clinics suitable for telemedicine activities. All the other patients had a medical consult in presence. Safe pathways were properly studied to screening them before their admission to outpatient's clinic (Figure 2).

Results

During the outbreak there was a drastic drop of admissions to outpatient's clinics compared to admissions in the same period of previous year (figure 1).

This drop has been rated to be from 875 to 200 patients seen daily (-77,14%).

As a consequence, this reduction also affected the ordinary activities of AOU "Federico II" with a dramatic abatement of hospitalizations (-58,14%) both in ordinary (-41,33%) and in Day Hospital/Surgery (-68,20%), inasmuch it was ensured just emergencies/urgencies and time-related or rare conditions.

In anticipation of phase 2, the Strategic Management of AOU "Federico II" of Naples (Italy) developed new strategies to implement the care services and minimize the risk factors for all stakeholders (patients and medical staff), diversifying the access mode to services; and Telemedicine played an important role in this strategy implementation.

Firstly, It was identified a group of outpatient's clinics (16) that took part in the pilot project; (table 1) these were 24.61 % of all active outpatient's clinics in AOU "Federico II".

Subsequently, the Health Management (HM) established a common protocol to define different patient pathways in which each patient is directed towards a consult via telemedicine or a medical consult in presence (Figure 2); in case of consult in presence, the patient is screened to check their coronavirus free condition before to be admitted to the outpatient's clinics by mean of medical History collection,

Table 1 - Outpatient's Clinics taking part in the Telemedicine project of AOU "Federico II"

1	Diabetology	9	Gastroenterology and Hepatology
2	Clinical Nutrition	10	Medical Genetics
3	Internal Medicine and Emo-Coagulation	11	Clinical Dermatology
4	Internal Medicine and Emergency medicine	12	Child Neuropsychiatry
5	Rheumatology	13	Pediatrics
6	Endocrinology	14	Hygiene and Preventive Medicine
7	Hypertension	15	Motor Rehabilitation
8	Allergology and Clinical Immunology	16	Neurology

epidemiological survey, body temperature measurement and COVID rapid test.

Since the introduction of telemedicine service, 953 consultations were provided in this way, about 13 % of all medical consults delivered by AOU "Federico II" in this period (3.69% of all consults in April and 16.34% in May). (figure 3); 97,38% of them were follow-up visits, that otherwise would have been missed during the current pandemic, so an economic loss has been avoided.

In addition, considering that the direct costs for a consult in person are to be attributed mainly to medical staff and secondly to triage, medical supplies and consumables, it has been calculated that, using Telemedicine visits vs a face-to-face consultation, about 65-70% of direct costs were spared by our Healthcare Company.

Discussion

Telemedicine, known also as "*remote medical care*", refers to providing clinical healthcare through electronic communication technologies rather than in presence. The initial form of telemedicine involved the use of a telephone but the use of video-calls and other telecommunication applications more recently has improved the service greatly,¹² though a phone call may be yet necessary as not all patients have the required device for a video consult.¹³

It was the first time that telemedicine was experienced on such a large scale not only at AOU "Federico II", but probably in the whole Southern Italy, also taking into account that traditionally such an approach is lacking, mainly due to poor compliance of end users. However, Telemedicine is particularly advantageous for densely populated areas, such as Naples, or for several specific subtypes of population such as geriatric patients, inhabitants located in areas far away from the outpatient's clinics, patients who have to be submitted to follow-up visits but, mostly, TM has showed all its potential to help in special situation such as the current Pandemic by permitting mildly ill patients to get the supportive care they need while minimizing their exposure to other acutely ill patients, in fact, as reported by Portnoy et al., "*...after all, the only infection that one can catch while use TM is a computer virus*".¹⁴

During the “Day after” lockdown, National and Local Regional Governments boosted new strategies to implement the care services and minimize the risk factors for all stakeholders (patients and medical staff), diversifying the access mode to Healthcare services and Telemedicine played an important role in this strategy implementation. The AOU “Federico II” of Naples adopted this solution to cope with healthcare needs of population; in fact Telemedicine allowed to recover a part of medical check-ups that had been put on standby, reducing the waiting times, and minimized drastically direct and indirect healthcare costs; indeed, telemedicine reduced consultation times, medical supplies and consumables, triage costs, and all indirect costs of health care (Patient and caregiver absenteeism, transport costs and risks ...).

We are aware that our results could suffer from a misclassification due to an initial misalignment of copayment data vs booking data so that the real proportion of volume of telemedicine may be underestimated. There is also a group of patients “*free of charge*” that could balance this misalignment, though.

Least but not last, as remarked by Moazzamia et al., *the Telemedicine has the ability to reinforce those health care workers that have been quarantined at home after exposure to COVID-19 and employ quarantined physicians to communicate with patients remotely via computer.*¹⁵

To achieve these goals our facility had to modify Information Technology (IT) related to the waiting times and rescheduled all booked visits, organize spaces and modality of video calling, using the smart work too, and readapt the terms of payment to the new needs, although some limitations including payment, credentialing, privacy, ethical consideration, loss of the patient medical relationship and staffing of specialists are exist too, and necessarily, they needs to be taken into account. Specially IT has been a cornerstone of organizational response to coordinating operational and clinical needs and must rapidly rearrange infrastructure, policies, and priorities to remain responsive.¹⁶

Certainly, telemedicine cannot replace in person patient care, and not all clinical situations are appropriate for video consultations,¹⁷ but could benefit other frontline physicians by reducing their workload and optimizing their time to attending to patients being in a critically-ill condition.¹⁵ However, as reported by Moazzamia et al., *creating telemedicine program takes time and does not happen overnight but it requires sources, funding and precise guidelines.*¹⁵ Besides, telemedicine requires a new dynamic approach to the patient, using a distinctive standard of care dedicate for telemedicine including rules about the physician-patient relationship, electronic prescribing and in-person follow-up.

The AOU “Federico II” had made stringent protocols and dedicate pathways to ensure safety and healthcare assistance to their patients. As reported by Ohannessian et al., *all stakeholders are encouraged to address the challenges and collaborate to promote the safe and evidence-based use of telemedicine during the current pandemic and future outbreaks, and the COVID-19 pandemic is a call to adopt the necessary regulatory changes supporting wide adoption of telemedicine.*¹⁰

Conclusion

Telemedicine has been the keystone that has allowed a rapid, appropriate response of whole overloaded healthcare systems to current Pandemic. Indeed, this crisis has presented dramatic events that have harshly stressed the health system capacity but also unprecedented opportunities that should not be ignored without making progress. TM has showed all its potential to relieve the work's burden of healthcare systems, though it will be necessary planning appropriate studies to clarify what telemedicine is best for as well as inappropriate; probably it will be necessary to improve the methodology and the approach to patients, proving them with opportune medical devices that allow an actual interaction between medical staff and patient. This will require heightened engagement to ensure that regulatory and policy gains are not rescinded. Telemedicine is central to care going forward, not just through this crisis. This way, future generations will derive benefits from our bitter experience.¹⁸

Abbreviations

WHO: *World Health Organization*

SARS : *Severe Acute Respiratory Syndrome*

MERS: *Middle East Respiratory Syndrome*

SARS-CoV-2: *Severe Acute Respiratory Syndrome Coronavirus 2*

COVID-19: *CoronaVirus Disease 19*

ACE2: *Angiotensin-converting enzyme*

CRS: *Cytokine release syndrome*

ARDS: *Acute respiratory distress syndrome*

AOU: *Azienda Ospedaliera Universitaria (Italian synonymous for: Teaching Hospital)*

IT: *Information Technology*

HM: *Health Management*

TM: *Telemedicine*

Declarations

Ethics approval and consent to participate

“Not applicable”

Consent for publication

"Not applicable"

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

"The authors declare that they have no competing interests"

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Authors' contributions

EAV conceived and revised the text. AI approved and supervised the project. ET and LI designed the paper, interpreted the data, made background literature revision, wrote and revised the text and designed the graphs. AP, GT and RT gave substantial support to creation of software and to modifying the Information Technology. FC collected and analyzed the data; VS: collected and analyzed the data, created and computerized the project, GB gave substantial contribution to writing the text; RE gave substantial contribution to writing and revising the text. PM acted as project facilitator and revised the text.

All authors have approved the submitted version (and any substantially modified version that involves the author's contribution to the study) and have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Figures

Figure 1

Reduction of workloads in AOU Federico II during lockdown (Compared periods 2019-2020)

Figure 2

Different patient pathways (Consult via telemedicine vs Medical Consult in presence)

Figure 3

Volume Reduction of Outpatient Clinics activity