An Italian Neurorehabilitation Hospital Facing the SARS-CoV-2 Pandemic: Data From 1207 Patients and Workers

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Objective: The aim of the present observational study is to report on the data from a large sample of inpatients, clinical staff and other workers at an Italian neurorehabilitation hospital dealing with SARS-CoV-2 infections, in order to analyze how it might have affected the management and the effectiveness of neurorehabilitation.

Methods: The data on infection monitoring, obtained by 2,192 swabs, were reported and compared among 253 patients, 722 clinical professionals and 232 other hospital workers. The number of admissions and neurorehabilitation sessions performed in the period from March-May 2020 was compared with those of the same period in 2019.

Results: Four patients and three clinical professionals were positive for COVID-19 infection. Six out of these seven people were from the same ward. Several measures were taken to handle the infection, putting in place many restrictions, with a significant reduction in new admissions to the hospital \( p < 0.001 \). However, neither the amount of neurorehabilitation for inpatients \( p = 0.681 \) nor the effectiveness of treatments \( p = 0.464 \) were reduced when compared to the data from 2019.

Conclusions: Our data show that the number of infections was contained in our hospital, probably thanks to the protocols adopted for reducing contagion and the environmental features of our wards. This allowed inpatients to continue to safely spend more than 3 hours per day in neurorehabilitation, effectively improving their independence in the activities of daily living.

Keywords: coronavirus, COVID-19, rehabilitation, molecular test, swab, SARS-CoV-2, hospital design and construction

INTRODUCTION

The World Health Organization (WHO) characterized the novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) outbreak as a pandemic on March 11th 2020 (1). In response to this, many governments implemented a series of emergency containment measures, including social restrictions and the quarantine of positive and suspect cases. Italy was the first Western country with a wide diffusion of coronavirus disease (COVID-19), so it could be important for other countries to analyze in depth the Italian case-study (2). In April, Iosa and coworkers suggested...
a dynamic analysis of the Italian case-fatality ratio to gain deeper insight into the course of the COVID-19 pandemic, and we anticipated the need to prepare rehabilitation units. Both people with COVID-19 sequelae related to motor and respiratory functions and patients with neurological disorders (3), not infected but needing neurorehabilitation in the time of this pandemic, could not wait to be treated (4–6). Several measures, including those imposed by the Decrees of the Italian President of the Council of Ministers, were taken to tackle the infection in rehabilitation hospitals with the aim of monitoring the insurgence of epidemic outbreaks (4). As nosocomial transmission is a severe problem in relation to the condition of inpatients, any action should be taken to minimize the risk of transmission among patients and clinical staff (7). However, an analysis of the impact of these measures is lacking in the literature. A recent study analyzed the outcomes of outpatients with pre-existing neurological disorders reporting the prevalence of symptoms of COVID-19 infection (8). The authors found that the presence of neurological chronic diseases did not increase the prevalence of COVID-19 infection, but the burden of neurological disorders was worsened by the lockdown. These problems could be even more dramatic for inpatients. Indeed, hospital access to people with neurologiological impairments due to brain or spinal cord injury in the subacute phase was often postponed as a consequence of infection. However, the neurorehabilitation of these patients is time-dependent and cannot be delayed, nor can it be reduced in intensity (9, 10). Furthermore, in Italy, there was an increased pressure on high specialty neurorehabilitation wards to admit patients with severe neurological disabilities (sometimes even with unstable vital functions and a high risk of medical complications) due to the sudden need for intensive care units to free up beds for COVID-19 positive patients with respiratory insufficiency. Other countries are now facing the same problem. In this scenario, there is a need for a quantitative analysis of the impact of the adopted restriction measures on inpatients needing neurorehabilitation, especially in hospitals exposed to the risk of COVID-19 infection.

The aim of the present observational study is to report on the data regarding COVID-19 infection monitoring in a large sample of inpatients needing neurorehabilitation, clinical staff and other hospital workers, analyzing how it might have affected the management and the efficacy of neurorehabilitation.

**MATERIALS AND METHODS**

This was an observational study performed on data collected during the monitoring of hospitalized inpatients and people working in our hospital from April 30th to May 26th 2020. People were classified into three categories: inpatients, clinical staff (medical doctors, psychologists, nurses, therapists, health care assistants, etc.) and other hospital workers (administrative staff, cleaners, etc.). They underwent repetitive series of swabs related to the program monitoring at out hospital during the COVID-19 pandemic.

**Protocols**

During the SARS-CoV-2 pandemic, the Italian Society of Neurological Rehabilitation indications were followed for the reorganization of neuro-rehabilitation activities (4). Moreover, we also changed our protocols in the following aspects:

- Our neurorehabilitation units admitted patients with subacute neurologiological impairments due to severe acquired brain lesions or stroke coming from an acute unit only if they were not affected or suspected to be infected with COVID-19 (with two negative nasal swabs performed within the last 48 h before discharge from acute wards).
- Our hospital is formed by six identical wards for inpatients, with 26 bedrooms having only two beds each (each room was 46 square meters with a bathroom inside), according to the requirements defined by Italian law, plus one room with negative pressure, and the availability of a gym in each ward (as shown in **Figure 1**). We planned three different pathways for human traffic within each ward: one for entering, one for exit, and one specific for isolated patient with different elevators just used for them, as shown in **Figure 1**. This figure also shows that each ward has a gym in which there were two rooms for speech therapy. The detail of one bed-room and of the isolation room with negative pressure were also shown in that figure.
- Healthy people, such as workers and allowed visitors, could enter into the hospital only if their body temperature was lower than 37.5°C (if higher, home isolation was suggested). Employees commute from home, no specific restrictions to social activities were required by the hospital direction, but they were required to strictly follow the restrictions of the lockdown programmed by Italian government for all the citizens (for example, in the study period, in Italy most of the shops were closed, restaurants were closed, religious meetings were forbidden).
- Posters with behavioral/health general rules (such as about social distancing in rooms, maximum number of people allowed into elevators at the same time, hand hygiene recommendations, use of protective devices, and so on) were positioned at each entrance and within all the complex operative units and the number of hand-sanitizing gel dispensers in the whole hospital was increased.
- A specific guideline has been drawn up describing prevention and control measures during the management of suspected and confirmed cases of COVID-19 in our facility, and several training sessions have been held with the health care professionals for the correct use of SARS-CoV-2 personal protective equipment (PPE) such as surgical masks, whereas suspected cases were cared by clinical staff using medical cap, eye-visor, face shield, N95 respiratory mask, double disposable gloves, medical protecting coverall, leg cover waterproof boots.
- Reorganization of work shifts (medical and non-medical staff) with a reduction in some activities in order to reduce contact and movements (for example, encouraging staff to work from home for administrative activities).
- After the first case of a positive swab in our hospital (April 30th), neither new admissions (up to May 21st) nor visitors...
In our hospital, a total of 2,192 nasal swabs were performed in <1 month: 13 swabs on April 30th finding one nurse positive; 62 swabs on May 2nd finding another nurse and two stroke patients positive (these patients came from the same ward as the first positive case); 1,093 swabs on May 4th and 5th with positive findings in other two stroke patients (from the same ward) and one therapist (from another ward); no more positive cases were found in the subsequent analysis of 31 swabs on May 7th, 151 swabs between 11th and 12th, 738 between 18th and 19th, 104 swabs on 26th May. All seven positive cases (corresponding to a prevalence of 0.6%) were asymptomatic. Familiars were advised. According to the regional guidelines, positive patients were immediately isolated in the special room with negative pressure and transferred within 6 h to a regional dedicated Covid-hospital (during this short time, the patients did not receive any rehabilitation session). After the recovery in that hospital and the following negativization of two consecutive swabs, two out of the four patients were discharged at home and the other two were re-admitted to our hospital to continue the neurorehabilitation. The cases of positive employers were notified to the competent authorities, and these subjects were quarantined at home for 14 days in charge to family physician, and they were allowed to return to work after 2 negative nasal swabs performed within the last 48 h.

The cumulative data are reported in Table 1. The odds ratio of being infected by SARS-CoV2 was not statistically different between patients and clinical staff, although it was close to the significance threshold (OR = 3.85; 95% CI: 0.86–17.3; p = 0.058). Conversely, an odds ratio of 64.8 (95% CI: 7.7–545; p < 0.001) was found in favor of being hospitalized or working in the same ward. For a comparison with the data of the outbreak during the study period, in Italy there were 104,664 new contagions in March, 99,671 in April and 27,534 in May. In Lazio (the Italian region of our hospital and in which resided our employees) the number of contagions were 3,092 in March, 3,521 in April and 1,112 in May.

Number of Treated Patients

The admission of patients to the hospital was stopped immediately after the first positive swab. This measure implies a reduction in inpatients, as shown in Figure 2. During the period from March to May 2020, 89 patients were admitted (median BI-score = 12, IQR = 26). In the same period of 2019 the number of admissions were 180; however, the median BI-score was not significantly different (BI-score = 13, IQR = 30, p = 0.468).

The hospital bed occupancy was significantly different in the entire period from March to May 2020 with respect to the same period in 2019 (p < 0.001), especially after the first positive case, when the temporary halt to new admissions occurred, as shown in Figure 2. The rehabilitation of outpatients (day hospital) was even more significantly decreased: it was 36% of planned occupancy in March, 3.8% in April and 8.6% in May, whereas the matching percentages in 2019 were 106, 102.1, and 103.6%, respectively (p = 0.010).

From an economic point of view, the amount of loss of income related to the reduction of Day Hospital was 64% in March, 96% in April, and 92% in May; whereas that of inpatients was 5, 6,
FIGURE 1 | The planimetry of one of the six identical wards of our hospital. In details are also shown the planimetry of one of the twenty-seven standard patient's rooms of the ward (in yellow) and the special isolation room with negative pressure. In blue the rooms of doctors and in pink the gym. Stairs and elevators are located in proximity to each gate. The dotted rows show the pathway defined for human traffic during the analyzed period: the blue pathway is that for entering into the ward, the red one for exit from the ward, and the green one that related to a patient isolated in the special room. All the measures are expressed in meters.

TABLE 1 | Data on subjects classified as patients, clinical staff or other hospital workers.

| Categories of people | Age (years old) | Sample N | Gender (female %) | Number of tests | Positive swab |
|----------------------|-----------------|-----------|-------------------|-----------------|--------------|
| Patients             | 66.3 ± 16.2     | 253       | 35%               | 560             | 4            |
| Clinical staff       | 44.0 ± 11.8     | 722       | 64%               | 1,361           | 3            |
| Other workers        | 47.6 ± 12.4     | 232       | 59%               | 271             | 0            |
| Total                | 50.7 ± 16.4     | 1207      | 57%               | 2,192           | 7            |

15%, respectively. The loss related to other outpatient hospital services were 73, 81, and 61%, respectively.

Number of Treatments and Their Effectiveness in Inpatients
The mean time spent by each patient in neurorehabilitation activities was not reduced in the period from March to May 2020 (global mean: 213 ± 15 min) with respect to the same period in 2019 (211 ± 10 min, \( p = 0.558 \)), nor in the period after the first positive cases with the temporary halt to new admissions (211 ± 11 vs. 215 ± 10 min, \( p = 0.681 \)). The number of patients discharged in the period from March to May 2020 was 71; their median BI-score was 69 (IQR = 50) with a treatment effectiveness of 48 ± 40% and a median length of stay of 49 days (IQR = 42). In the same period in 2019, the number of discharged patients was much higher at 233, with a median BI-score of 54 (IQR = 67, \( p = 0.049 \)), an effectiveness of 47 ± 36% (\( p = 0.464 \)) and a median length of stay of 63 days (IQR = 52, \( p = 0.001 \)), as shown in Figure 3.

DISCUSSION
The aim of the present observational study was to report on how COVID-19 infections were monitored and contained in a large sample of inpatients and workers, and how infection management might have affected neurorehabilitation activities. Our results highlight three important findings about the management of the COVID-19 outbreak in neurorehabilitation.

First of all, the safety protocol and continuous monitoring performed with nasal swabs allowed us to identify 7 cases in 1,207 screened people. All the positive cases were asymptomatic, and only the planned monitoring allowed us to discover the presence.
FIGURE 2 | Hospital bed occupancy in 2019 (blue line) and in 2020 (red line) for the period from March to May. The vertical red line represents the day of the first positive case in our hospital, corresponding to the beginning of the temporary halt to new admissions. The green line represents the last day of this period of halted admissions.

FIGURE 3 | Mean time spent by patients in neurorehabilitation activities (in minutes), averaged by week in 2019 (blue line) and 2020 (red line). The vertical red line represents the day of the first positive case in our hospital, corresponding to the beginning of the temporary halt to new admissions. The green line represents the last day of this period of halted admissions.
of positive cases in the hospital. The prevalence of COVID-19 on
the screened population in our hospital (0.6%) was slightly higher
than that of the Italian population at 0.2% (11), but this was due
to the fact that our sample was related to a hospital population.

The second finding is related to the clusterization of positive
cases, with 6 out of 7 coming from the same ward. The odds ratio
related to the environmental factor was 64.8 vs. an odds ratio
of 3.85 for the category of persons (patients vs. clinical staff).
This effect was already well-known and at the basis of social
distancing and isolation of infected patients (12). Furthermore,
this odds ratio may suggest the need to isolate the different wards
of a hospital, reducing possible contacts among patients and/or
workers in different wards. The protocols related to internal
transfers, inspired by the Decrees of the Italian President of
the Council of Ministers together with the scientific literature
(4, 10), adopted severe measures and allowed us to counteract
the pandemic. Among the adjunctive measures, it is important
to mention the requirement of two negative nasal swabs within the
last 48 h before discharge from acute wards for being admitted in
our hospital, even if this was not required by the World Health
Organization guidelines.

Moreover, the prompt interdiction of visitor entry, although this rule enormously overwhelmed nursing staff and
neurorehabilitation professionals regarding the management of
daily activities and the psychological isolation of inpatients with
severe neurological disabilities and common neuropsychological
disorders. Another factor that may have contributed to
containing the outbreak could be the architectural structure of
our wards, with wide bedrooms having only two beds
each and the availability of a wide gym in each ward. Before
COVID-19, some authors (13) reported that the architecture of hospital facilities does not influence nosocomial infection
rates, concluding that there is a lack of stringent evidence to
link hospital design and construction with the prevention of
nosocomial infection. However, further studies (14–16) support
the opposite idea, i.e., that the design of the physical environment
influences nosocomial infection rates. The safety protocols, the
large rooms and the presence of a gym in each ward, together
with the presence of six isolation rooms with negative pressure,
could be the key factors that limited the outbreak of SARS-CoV-2
in our hospital.

Finally, the third main finding of our study was that,
during the containment of the pandemic in our hospital, the
admissions were significantly reduced due to the temporary
halt on admissions, but the mean time spent by inpatients in
rehabilitation was not reduced by the emergency. It allowed
us to provide the same level of treatment effectiveness.
Despite many difficulties in discharging patients from our
neurorehabilitation hospital due to the problems with managing
the chronic phase of neurological diseases, the length of
stay was shorter than that in 2019, according to a general
process of reduction of length of stay already occurring before
pandemic. The main problem was the dramatic reduction
in amount of care reserved to outpatients, as also observed
elsewhere (8).

Our study has some limits, the main of which is that
the present study is an observational study based only
on one hospital, without a population-based analysis and
with some populations (i.e., stroke patients) that could be
overrepresented. However, our study is similar to a previous
one analyzing rehabilitation of outpatients, although ours
is more focused on inpatients. The presence of COVID-
19, its management and the contemporary management of
neurorehabilitation makes this study important for other
similar hospitals.

In conclusion, the prevalence of COVID-19 infection in
our inpatient neurorehabilitation hospital was effectively
managed, affecting the number of admissions and the
rehabilitation of outpatients, but not that of inpatients,
who achieved a good level of independence in the activities
of daily living, similar to that of hospitalized patients in
the same period in 2019. Six out of seven positive cases
of SARS-CoV-2 were recorded in the same ward, and
wide screening allowed us to contain the infection by
isolating and transferring positive professionals and patients,
respectively. These results suggest the need for repetitive
and systematic screening of patients and clinical staff in
neurorehabilitation hospitals to prevent outbreaks and to
maintain a high amount of effective neurorehabilitation
for inpatients.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included
in the article/supplementary material, further inquiries can be
directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and
approved by Fondazione Santa Lucia ethics committee. The
patients/participants provided their written informed consent to
participate in this study. Written informed consent was obtained
from the individual(s) for the publication of any potentially
identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

GM and MI wrote the first draft of this manuscript. MI and SP
performed all the data analysis. CC, AS, and AR conceptualized
and supervised the study. SP, MG, MT, UN, RF, and MM revised
the manuscript and provided important contributions. MB was
responsible of all the swab analysis. All authors contributed to
the article and approved the submitted version.

FUNDING

This study has been performed in the framework of Current
Research of our Foundation, financed by Italian Ministry
of Health.
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