pagepress

How the COVID-19 infection tsunami revolutionized the work of respiratory physiotherapists: an experience from Northern Italy

Carla Simonelli[1], Mara Paneroni[2]*, Aubin Georges Fokom[1], Manuela Saleri[1], Ilaria Speltoni[2], Irene Favero[2], Francesca Garofali[2], Simonetta Scalvini[2], Michele Vitacca[1]

[1]Cardiac Rehabilitation, ICS Maugeri IRCCS, Institute of Lumezzane (BS); [2]Pulmonary Rehabilitation, ICS Maugeri IRCCS, Institute of Lumezzane (BS), Italy

Abstract

Due to COVID-19 outbreak, to lighten the burden of acute and critical care hospitals, some respiratory rehabilitation departments have been used to host patients with COVID-19 in the post-acute phase. This new and unexpected situation required a change of roles and scheduling of the rehabilitation teams. In this manuscript we describe the unexpected and urgent organizational change of the Cardio-Pulmonary Rehabilitation (CPR) service during the COVID-19 emergency in a Northern Italian rehabilitation hospital, focusing on the Respiratory Physiotherapists' (RPTs) role. A quick three-days complete reorganization of the entire hospital was needed. A COVID-19 care team including a multidisciplinary panel of physicians, nurses, and RPTs was quickly performed to manage 90 beds for post acute patients with COVID-19. Within the team, the RPTs changed their shifts, so as to be available 16h per day, 7 days out of 7. Remodelled tasks in charge of RPTs were: oxygen therapy daily monitoring, non invasive ventilation (NIV) and continuous positive airways pressure (CPAP) delivery, pronation and postural changes to improve oxygenation, reconditioning with leg/arm cranking and exercises, initial and final patients' functional assessment by short-physical performance battery (SPPB) and 1-minute sit-to-stand test (1-STS) to evaluate motor conditions and exercise-induced oxygen desaturation. Three "what-to-do" algorithms were developed to guide: i) oxygen de-escalation by reducing inhaled fraction of oxygen (FiO_2); ii) oxygenation improvement through the use of Venturi mask; iii) reconditioning and physical activity. One-hundred seventy patients were treated in one month. As main topics, RPTs have been involved in oxygen therapy management in almost a third of the admitted patients, reconditioning exercises in 60% of the cases, and initial and final functional motor capacity assessment in all patients. Details of activities performed by the RPT in one typical working day are also shown. Our reorganization has exploited the professional skills and clinical expertise of the RPTs. This reorganization can provide practical insights to other facilities that are facing this crisis, and may be a starting point for implementing post-COVID-19 rehabilitation. Future studies will have to improve and review this organization.

Correspondence: Mara Paneroni, ICS Maugeri IRCCS, Via Salvatore Maugeri 4, 27100 Pavia, Italy.
E-mail: mara.paneroni@icsmaugeri.it

Key words: COVID; physiotherapist; respiratory physiotherapist; organization; rehabilitation outcome.

Contributions: SC has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. MP, as corresponding author, has been identified as guarantor of the paper, taking responsibility for the integrity of the work as a whole, from inception to published article. All the Authors contributed substantially to data analysis and interpretation, and the writing of the manuscript. All the Authors approved the final version of the manuscript and declare that questions related to the accuracy or integrity of any part of it have been appropriately investigated and resolved

Conflict of interest: MV has no conflict of interest related to the current manuscript; MV has perceived grants for intellectual consultations from Chiesi, Boehringer Ingelheim, Glaxo, Menarini, Vivisol, Sapio Life, Philips, Fisher and Paykel. The other authors have no perceived financial or have no personal conflicts of interest that might bias the content of this manuscript.

Funding: This work was supported by the "Ricerca Corrente" funding scheme of the Italian Ministry of Health.

Patient's consent for publication: Obtained.

Acknowledgment: We thank Laura Comini for technical assistance and editing.

Received for publication: 6 May 2020.
Accepted for publication: 15 May 2020.

Licensee PAGEPress, Italy
Monaldi Archives for Chest Disease 2020; 90:1085
doi: 10.4081/monaldi.2020.1085

Introduction

The global outbreak of coronavirus disease (COVID-19) is having a widespread diffusion throughout the world [1,2]. Italy, and particularly the northern region of Lombardy [3], have been affected by an exponential growth of cases, which made necessary, for national and regional authorities, to implement extraordinary measures to contain the spread of the virus very quickly. The COVID-19 disease may cause massive diffuse alveolar damage resulting in acute respiratory failure (ARF) that requires, in a high

percentage of cases, mechanical ventilation [4]. In order to lighten the burden on acute care hospitals, certain rehabilitation facilities have been used to host COVID-19 patients in the post-acute phase of the disease, in particular involving respiratory rehabilitation departments with expertise in the management of lung diseases. This reorganization has showed up with the need to modify tasks, roles, and scheduling of the rehabilitation teams, albeit in the absence of indications and guidelines on the management of patients in the post-acute phase, and data on their characteristics and rehabilitation needs.

The aim of this study was to describe the unexpected and urgent organizational change of the Cardio-Pulmonary Rehabilitation (CPR) Service during the COVID-19 emergency in an Italian rehabilitation hospital, with focus on the Respiratory Physiotherapist Therapists' (RPTs) role.

Materials and Methods

This was an organizational and observational (STROBE statement) study performed at the Istituti Clinici Scientifici Maugeri IRCCS, Institute of Lumezzane, Brescia, Italy, starting from March 10th 2020 to the present day. All data presented in this study referred to the period between March 14th and April 14th, 2020. Due to the descriptive nature of the article no ethical approval was necessary.

Pre-COVID-19 organization at the CPR service

The CPR service is composed by 8 RPTs (6 full time, 2 part-time) and 1 senior RPT's coordinator, all experienced in pulmonary and cardiac rehabilitation. Until March 10th 2020, the CPR service worked in a unique daily shift, starting at 8.00 am until 4.00 pm, 7 days out of 7. The RPTs managed the rehabilitation needs of 56 inpatients and 14 outpatients with chronic cardiac and pulmonary conditions (Figure 1). The routine activities performed by RPTs before the health crisis were exercise training, following the current best practices [5,6]; patients' devices adaptation, education and follow-up of domiciliary non invasive ventilation (NIV) or continuous positive airways pressure (CPAP) for chronic respiratory failure and sleep related breathing disorders; bronchial secretion clearance techniques; oxygen therapy management during exercise; patients' education on chronic diseases management and healthy lifestyle; training of students and other professionals (*e.g.*, lectures) and research activities.

All rehabilitation activities were monthly planned and organizational plan was provided by the 20th day of each month by the coordinator. The management of the evaluation of oxygen at rest and during the night and the mechanical ventilation adaptation in acute patients were managed directly by the pulmonologist.

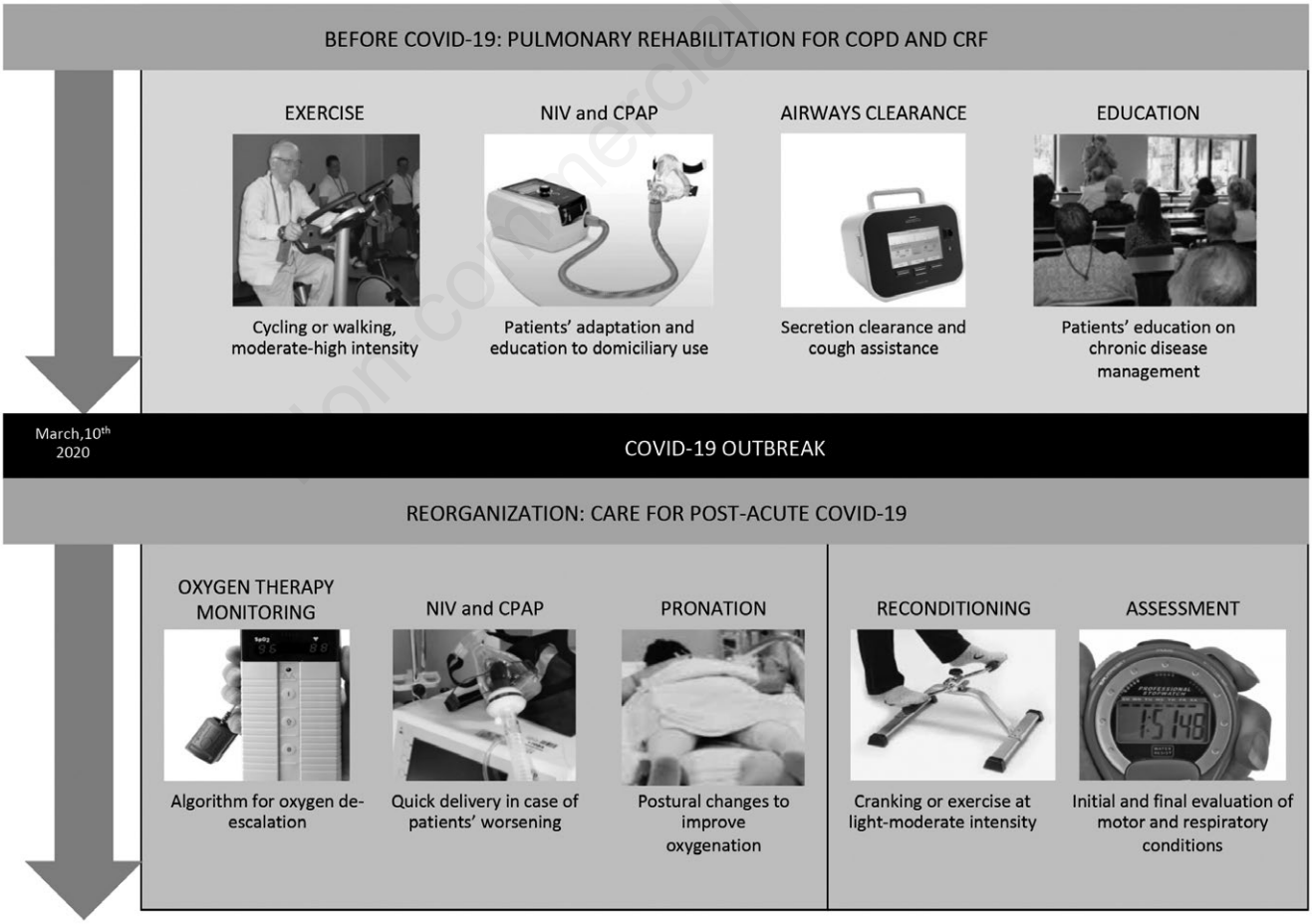

Figure 1. Respiratory physiotherapist's activities in post-acute COVID-19. COPD, chronic obstructive pulmonary disease; CRF, chronic respiratory failure; NIV, non invasive ventilation; CPAP, continuous positive airways pressure.

Organizational changes due to COVID-19 outbreak

During the dramatic emergency period, our medical centre was selected from the Regional Health authorities to hospitalize patients with COVID-19 and interstitial pneumonia. The patients were immediately transferred to our COVID-19 unit as soon as they were discharged from ICU and non-ICU units in the post-acute phase with more stable clinical conditions.

Even if at the arrival to our hospital, the patients have already passed the critical period, they were still too unstable to be discharged home, and needed continuous sub-acute care. Within three days, a hospital crisis unit including the health authorities, physicians, nurses, RPTs, and physiotherapists of the neuromuscular rehabilitation service (PTs) was created in our Institute with the purpose of reorganizing the hospital and its activities. A COVID-19 care team was selected including a multidisciplinary panel: physicians (pulmonologists, internists, neurologists, geriatricians, physiatrists and cardiologists), nurses, RPTs and PTs.

In this context, the role of the RPTs within the COVID-19 care team was reformulated. Together with pulmonologists and nurses, the RTs of the CPR service set up the new organization, as described below.

Protocol description and measures

In order to show the new organization, we have described:

1) **Organizational plan:** general new hospital organization, role of RPTs, the number of all tasks performed by the RPTs during a typical working day, as well as the percentage of patients who needed a specific performance.
2) **Patients' characteristics:** Number and characteristics of patients admitted during the study period were presented. Dead, discharged patients and currently number of hospitalized patients were collected.

Statistics

Given the nature of this study, only descriptive statistics was performed. All data were presented as number, percentage, or median (interquartile range) unless otherwise specified.

Results

Organizational plan

Our Rehabilitative Hospital reorganized completely its tasks, shifts and roles, in a short period of time. All rehabilitative activities non related to COVID-19 were completely stopped after the beginning of COVID-19 crisis.

Physicians in charge of the patients, alternated themselves in the role of case-manager (*e.g.*, drug therapy management, decisions on diagnostic-therapeutic procedures and on discharge, *etc.*). Within the team, a pulmonologist consultant was available 24 h a day (on duty during the day and available by telephone during the night). All physicians remained outside the COVID-19 area, and communications were allowed through dedicated technological strategies, as described below. Inside the COVID-19 area, a doctor on call was always present and available.

As far as the nurses' team is concerned, it was responsible for all nursing evaluations and treatments, drugs administration, monitoring of oxygen and NIV/CPAP especially during the night shift. Moreover, the nurses managed communications with relatives and family members about the patients' clinical conditions by periodical phone calls. Furthermore, since many patients arrived at our Institute from other hospitals without personal effects and no visits were allowed, the nurses were responsible of favouring communications between patients and relatives/families by technology such as tablets for on-demand video calls to be used in the COVID area; and of managing the delivery of patient's spare clothes, objects and personal belongings by relatives (*i.e.*, patient bags and baggage were left at the reception and brought in the COVID-19 area by the nurses). In the most chaotic days, as many patients lacked, for example, of pyjamas and linen, nurses also organized charity collections of clothes, bath items, books and magazines.

Because of the infectious risk, the patients were not allowed to leave their "reserved" rooms. They had to wear a surgical mask, even over oxygen goggles and treatment masks, if tolerated. No object could leave out from the reserved area if not through dedicated dirty paths. Periodic sanitisations of the lung disease department were carried out by the cleaning staff. Special precautions were taken to contain the spread of infected micro-particles: the use of Venturi masks for oxygen therapy was preferred, as it was less dispersive [7]; non invasive mechanical ventilation was carried out on a closed mask and positioning an antiviral filter before the expiratory valves.

The role of RPTs

Due to extreme paucity of protective personal equipment (PPE), it was not possible to get more than one/two RPTs in the ward per work-shift. Therefore, the workload was in the ratio of 1 RPT/ 90 patients in comparison to 1RPT/12 patients as in the normal hospital routine. This condition manifested the need for an extremely efficient and rational organization. With a great staff flexibility, new RPTs work-shifts were arranged: in a first phase, a daily shift with one RPT available in the COVID-19 ward from 7.00 am to 3.00 pm was established; however, with a complete Covid-hospital unit of 90 beds two shifts were needed with one RPT available from 6.00 am to 2:00 pm, and another one from 2:00 pm to10.00 pm, 7 days out of 7.

Considering the specific expertise and education background of the RPTs on duties (particularly in the management of chronic respiratory failure and non invasive ventilation), the tasks that could be managed by the CPR service were selected, with the monitoring and care for NIV/CPAP and oxygen therapy shared by RPTs and nurses. Figure 1 shows the variation of RPTs tasks before and after the COVID-19 pandemic.

RPTs were also in charge of managing all the materials needed to deliver oxygen therapy, CPAP and NIV, which were prompted and organized in a dedicated storage room inside the COVID-19 ward, separated from the materials of non COVID patients.

New dedicated "what-to-do" algorithms were developed by the COVID-19 care team to guide the RPTs' clinical activity in the ward. In details, they were:

1. **Algorithm for oxygen de-escalation** (Figure 2): the RPTs were instructed to follow the algorithm to monitor daily SpO_2 and manage the reduction of the oxygen therapy. One or two daily phone-meetings with a pulmonologist were held in order to check and confirm any change of oxygen therapy and in order to take decisions of complex cases. The phone-call between the RPTs and pulmonologists served as a prescription from the physician, exceptionally exempting the need for a written document. RTs collected all measured data and oxygen therapy changes in a dedicated computerized table, which was automatically shared with the nurses for the final application.
2. **Algorithm for oxygenation improvement** (Figure 3): in case of SpO_2 worsening, the algorithm provided indication on increasing levels of intervention to be applied. Venturi masks,

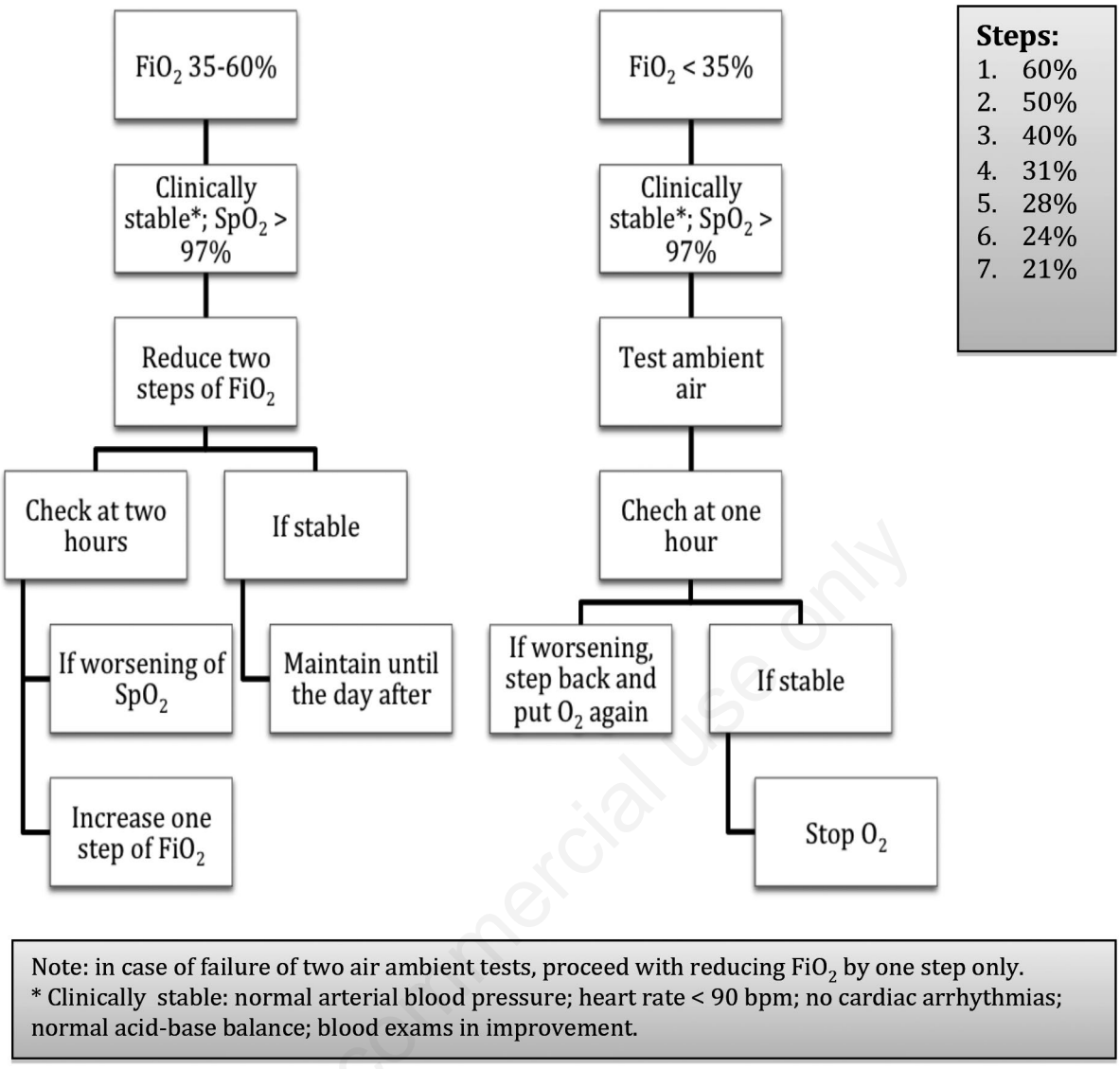

Figure 2. Algorithm for oxygen de-escalation. FiO_2, inhaled fraction of oxygen; SpO_2, peripheral oxygen saturation.

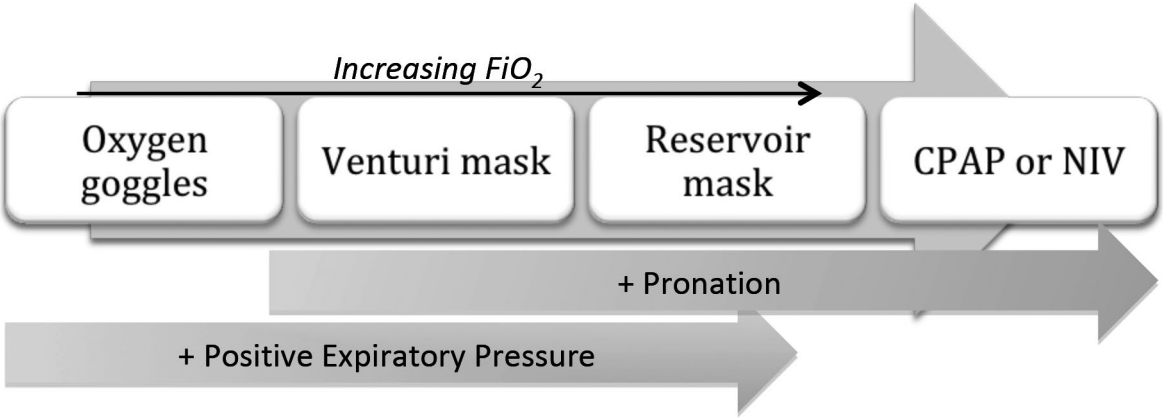

Figure 3. Algorithm to improve oxygenation. FiO_2, inhaled fraction of oxygen; CPAP, continuous positive airways pressure; NIV, non invasive ventilation.

reservoir masks, CPAP or NIV were prescribed during the phone-meeting by the pulmonologist, and were provided to patients by RPTs. The same dedicated computerized table described in the previous paragraph served as data collection which was shared between nurses and RPTs. Pronation (or postural changes if prone position was not possible) and positive expiratory pressure (PEP) were delivered by RPTs as add-on therapeutic strategies to improve SpO_2, on individual basis when oxygen/NIV support were not sufficient to reach adequate SpO_2. Therapeutic interventions as devices and materials were selected on patient's clinical characteristics, compliance, available materials, result of blood gases analysis and radiological patterns [8]. A trial session in order to observe the improvement in SpO_2 was performed before implementation. The RPTs were in charge of postural changes of body position as to set the level of PEP imposed. The need for palliation or quick transfer to an acute care hospital was decided on a case-by-case basis when treatments failed to improve SpO_2.

3. **Decisional algorithm on reconditioning and physical activity:** RPTs developed an assessment chart for motor and respiratory function, using the Short Physical Performance Battery (SPPB) at admission [9], as a screening to identify the subjects who needed physical reconditioning. Disabled or partially disabled patients were managed by PTs when actions concerned mobilization and recovery of physical autonomy were needed. The rehabilitation of this patients' population consisted of arm and or leg cranks, low intensity aerobic exercises, walking at light-to-moderate intensity at least 30 min a day. Given the limited time available for each patient, RPTs educated patients to perform their exercises independently. A close monitoring of oxygen desaturation during the exercise sessions was performed in order to maintain an appropriate oxygen saturation during the rehabilitation sessions (target SpO_2 above of 92%). At patient's discharge, the 1-minute step test (1-STS) [10] with SpO_2 monitoring in order to assess exercise-induced desaturation was used as an outcome index. SPPB and 1-STS tests were selected because they were considered simple and easy to use. Figure 4 shows a RPT, with a proper PPE, and a patient inside the ward carrying on the 1-STS. On selected cases, other tests such as the Six-Minute Walk test [11], hand-held dynamometry [12] and the Single-Breath Count Test [13] were performed under experimental conditions, with the aim to identify their feasibility and possible clinical indications in these patients population.

A PPE kit was available to the pulmonologist to enter the COVID-19 ward under urgent request. Arterial Blood Gases analysis, even if not used routinely, were always available at pulmonologist's request. An ultrasound machine was also available in the ward and could be used by doctors and RPTs for chest ultrasound, if needed.

Figure 4. RPT with proper PPE controls a patient inside the ward carrying on the 1-STS.

Organization of communications and logistics

As no paper documents could be brought out of the COVID-19 ward due to infectious risk, an online communications system had to be organized. The RPTs on duty were connected by mobile phone with earphone to the outside. The phone was used for daily briefings with the pulmonologist, as well as for any other communication. Personal Computer (PC) stations connected to the Internet were set and all members of the COVID-19 care team were enabled to access the network. Documents and forms needed for carrying out the clinical activity were sent by email and printed directly in the COVID-19 ward. It was not allowed to pass paper documents between the COVID-19 Unit and the outside. All measures, tests and therapeutic variations were collected on dedicated Excel (Microsoft, Redmond, USA) charts. An *ad hoc* created mailing list was used to share these Excel documents with the whole COVID-19 Care Team. As regards to the materials needed in the ward, in order to limit contamination, a filter area was created to share objects positioned from the outside of the ward to be recovered by the staff on duty in the COVID-19 ward.

Table 1 described the time sheet of the RPT in two duties in a typical working day with 90 hospitalized patients.

Table 1. Time sheet of the RPT in two duties in a typical working day with 90 hospitalized patients.

Task	N. of performances
SpO_2 monitoring	89
Oxygen de-escalation	7
Oxygen increase	5
CPAP or NIV application and monitoring	4
Pronation exercises	2
PEP prescription and monitoring	5
Reconditioning exercises	29
Short Physical Performance Battle test	6
1 minute Sit-to-Stand test	5

SpO_2, peripheral oxygen saturation; CPAP, continuous positive airways pressure; NIV, non invasive ventilation; PEP, positive expiratory pressure.

Patients characteristics

A total of 170 inpatients were treated during the study period (first 32 days since the COVID-19 ward opening). Among these, 11 died (6.5%), 78 were discharged (45.9%), and the remaining were still hospitalized at the study completion. Patients aged 70 (59-76) years had a moderate/severe impairment of motor functional capacity with a SPPB 3 (0-7) points out of 12. Fiftyfive % of patients were totally disabled (SPPB=0 points) at admission, being 41.7% already disabled before COVID-19 disease. Forty three % of patients were on oxygen therapy. In these last patients, overall mean FiO_2 was 27.5 (10.6%) and mean SpO_2 was 95.0 (2.6%). Considering all 170 patients, oxygen de-escalation was required in 63 (37.1%) of them, while increase in oxygen therapy was needed in 17 (10.0%), CPAP in 8 (4.7%), NIV in 1 (0.6%). Pronation or change in posture was performed in 18 (10.6%) patients. Leg/arm crank or exercises were performed by 101 (59.4%) patients, while 166 (97.6%) underwent SPPB (including patients who scored zero) and 61 (35.9%) performed the 1-STS test.

Discussion

This study describes the possibility to enhance skills and clinical experience prioritizing tasks of a Respiratory Physiotherapists' team employed in a rehabilitation hospital during the unexpected, urgent and dramatic emergency related to the COVID-19 outbreak in Northern Italy. The main topics in which RPTs have been involved were oxygen therapy management in almost a third of the admitted patients, reconditioning exercises in sixty percent of them, and CPAP administration and change of posture, to a lesser extent. RPTs were in charge of initial and final functional motor capacity assessment in almost all cases, as well.

This study describes an organizational change similar to that occurred in case of other epidemic events (*e.g.*, Ebola) [14]. COVID-19 caused a crisis of standard of care requiring significant changes on staff members and in resources [15]. This health crisis with a large number of critically ill patients [16] overwhelmed hospitals and critical care resources [17]. The reorganization of our service and hospital, therefore, was part of a larger reorganization extended to the entire national, regional and local health service to face the emergency.

During the pre-crisis phase and in the first few weeks of COVID-19 outbreak, the selection of guidelines on emergency management and acute response was of global priority in Italy [15]. Standard operating procedures to reorganize hospitals and activities referred to acute and intensive care or to low-income countries were reviewed [14,15].

Reasonably, all guidelines on physiotherapy management were issued firstly for facing up the acute phase [18] and indications on the post-acute and rehabilitation phase were addressed later. Therefore, in the few weeks described in the present study, the need for reorganization took place based on existing literature and previous experiences, in the absence of dedicated indications and guidelines. The re-organization included the creation of three decision algorithms, two dedicated to oxygen and ventilation therapy, and one for the assessment and administration of physical activity. In the context of a crisis and on large numbers of patients, the precise selection of the cure and the accurate assessment of the individual's needs were not possible. Considering the need for an extremely efficient organization, the short time and the psychological and stressful conditions to which the staff was subjected, generation of easy and repeatable algorithms providing standard answers were formulated.

Many decision-making algorithms that had previoulsy been proposed successfully for weaning of ventilation in ICU [19] or for prescription of rehabilitative programs [20] were used as examples. We believe that our unit reorganization based on simple algorithms allowed: i) to bring together the whole staff in duties, from the most to the least expert RPT, harmonizing the differences between individuals; ii) to manage quickly and efficiently a large number of patients in a stressful context; and iii) to have a "minimum" basis of tasks and organized performances, to implement a more precise organization even in a post crisis event. As already described in case of other epidemics such as SARS [21], team building and professionals' empowerment are strategies that allow the management of work-related stress. In a staff that is facing fear of contagion, concern for relatives, possibility of seeing colleagues get infected and sick, and at high risk of burnout [22], professional recognition and a sense of responsibility are tools that can motivate staff to endure stress. Furthermore, these skills, refined during the emergency, can easily be exploited once the peak of the crisis is over, in order to continue managing subjects with COVID-19-related disabilities, after prolonged ICU hospitalizations or with persistent lung impairment.

RPTs' skills in Italy include noninvasive ventilation and CPAP management [23], oxygen therapy assessment and management during exercise, recovery of functional autonomy after bed resting, exercise testing and training [24], and it is in line with what the scientific community has previously defined [25]. These skills have been quickly converted to manage post-acute COVID-19 patients needing oxygen therapy and/or CPAP, with functional weakness, exercise-induced dyspnea, fatigue and desaturation [26]. Italian RPTs network has made it possible enhancing professional skills of others RPTs and of all care teams. The optimal use of resources, education background of the RPTs on duties and high level of motivation have contributed to positively share knowledge, expertise and practical experiences. Again, the re-organization made easy the integration between the pulmonologists and the other physicians: various specialists played a role as case-manager, each carrying out his own professional expertise, and a single consultant pulmonologist was able to manage a large number of patients with respiratory problems from the outside of the COVID-19 ward, by communicating with an expert RPT. RPTs also relieved part of the workload on the nursing staff, dealing with the monitoring of respiratory conditions and managing the changes in oxygen therapy that would otherwise have remained in charge of the nurse. Furthermore, this organization allowed to experiment the feasibility of treating this kind of patients by RPT with "remote" consultation of pulmonologists.

The validity of this study is limited by its descriptive nature. Our goal is not to share quantitative data (postponing these data to further studies), but to describe the urgent response of our CPR service to the COVID-19 pandemic. In different context, countries, habits, and in the presence of staff with different skills, we are aware that this organization may not be applicable. However, we believe that useful ideas can arise from any experience, to help and overcome the present moment and set a new beginning.

In conclusion, this study describes the unexpected and urgent organizational change of the Cardio-Pulmonary Rehabilitation Service during the COVID-19 emergency in our Italian rehabilitation hospital, exploiting the professional skills and clinical expertise of the RPT.

References

1. Worldometer [Internet]. COVID-19 coronavirus pandemic. Accessed on: 10 April 2020. Available at: https://www.worldometers.info/coronavirus/
2. WHO [Internet]. Global surveillance for human infection with coronavirus disease (COVID-2019). Accessed on: 10 April 2020. Available at: https://www.who.int/publications-detail/global-surveillance-for-human-infection-with-novel-coronavirus-(2019-ncov)
3. Istituto Superiore di Sanità. Accessed on: 10 April 2020. Available at: https://www.epicentro.iss.it/coronavirus5.
4. Vitacca M, Nava S, Santus P, Harari S. Early consensus management for non-ICU ARF SARS-CoV-2 emergency in Italy: from ward to trenches. Eur Respir J 2020. pii: 2000632. doi: 10.1183/13993003.00632-2020.
5. Spruit MA, Singh SJ, Garvey C, et al. An official American thoracic society/European respiratory society statement: Key concepts and advances in pulmonary rehabilitation. Am J Respir Criti Care Med 2013;188:e13-e64.
6. Piepoli MF, Corrà U, Benzer W, et al. Secondary prevention through cardiac rehabilitation: from knowledge to implementation. A position paper from the Cardiac Rehabilitation Section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil 2010;17:1–17.
7. Thomas P, Baldwin C, Bissett B, et al. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. J Physiother 2020. doi: 10.1016/j.jphys.2020.03.011.
8. Winck JC, Ambrosino N. COVID-19 pandemic and non invasive respiratory management: Every Goliath needs a David. An evidence based evaluation of problems. Pulmonology 2020. pii: S2531-0437(20)30093-3. doi: 10.1016/j.pulmoe.2020.04.013.
9. Larsson P, Borge CR, Nygren-Bonnier M, et al. An evaluation of short physical performance battery following pulmonary rehabilitation in patients with chronic obstructive pulmonary disease. BMC Res Notes 2018;11:348.
10. Bohannon RW, Crouch R. 1-Minute Sit-to-Stand Test: systematic review of procedures, performance, and clinimetric properties. J Cardiopulm Rehabil Prev 2019;39:2-8.
11. Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J 2014; 44:1428-46.
12. Andrews AW, Thomas MW, Bohannon RW. Normative values for isometric muscle force measurements obtained with hand-held dynamometers. Phys Ther 1996;76:248-59.
13. Rega PP, Bork CE, Burkholder-Allen K, et al. Single-Breath-Count Test: an important adjunct in the triaging of patients in a mass-casualty incident due to botulism. Prehosp Disaster Med 2010;25:219-22.
14. Cancedda C, Davis SM, Dierberg KL, et al. Strengthening health systems while responding to a health crisis: Lessons Learned by a nongovernmental organization during the Ebola virus disease epidemic in Sierra Leone. J Infect Dis 2016;214: S153-63.
15. Hick JL, Christian MD, Sprung CL. Surge capacity and infrastructure considerations for mass critical care. Intensive Care Med 2010;36:S11-20.
16. Joynt GM, Loo S, Taylor BL, et al. Coordination and collaboration with interface units. Intensive Care Med. 2010;36:S21-31.
17. Buoro S, Di Marco F, Rizzi M, et al. Papa Giovanni XXIII Bergamo Hospital at the time of the COVID-19 outbreak: letter from the warfront. Int J Lab Hematol 2020. doi: 10.1111/ijlh.13207.
18. Lazzeri M, Lanza A, Bellini R, et al. Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR). Monaldi Arch Chest Dis 2020;90:1285. doi: 10.4081/monaldi.2020.1285.
19. Ely E, Bennett PA, Bowton DL, et al. Large scale implementation of a respiratory therapist-driven protocol ventilator weaning. Am J Respir Crit Care Med 1999;159:439-46.
20. Simonelli C, Vitacca M, Ambrosino M, et al. Therapist driven rehabilitation protocol for patients with chronic heart and lung diseases: a real-life study. Int J Environ Res Public Health 2020;17:pii: E1016. doi: 10.3390/ijerph17031016.
21. Lau PY, Chan CWH. SARS (Severe Acute Respiratory Syndrome): reflective practice of a nurse manager. J Clin Nursing 2005;14:28-34.
22. Dewey C, Hingle S, Goelz E, Linzer M. Supporting clinicians during the COVID-19 pandemic. Ann Intern Med 2020;M20-1033.
23. Simonelli C, Paneroni M, Vitacca M. An implementation protocol for noninvasive ventilation prescription: the physiotherapist's role in an Italian hospital. Respir Care 2013;58:662-8.
24. Cooper BG, Troosters T, Burge G, et al. Allied respiratory professionals. Eur Respir J 2010;36:701-3.
25. Troosters T, Tabin N, Langer D, et al. Introduction of the harmonised respiratory physiotherapy curriculum. Breathe (Sheff) 2019;15:110-5. doi: 10.1183/20734735.0124-2019.
26. Yi Y, Lagniton PNP, Ye S, et al. COVID-19: what has been learned and to be learned about the novel coronavirus disease. Int J Biol Sci 2020;16:1753-66.