Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Letter to the Editor

Usefulness of step down units to manage survivors of critical Covid-19 patients

Dear Editor

The Coronavirus 2 (Covid-19) associated severe acute respiratory failure (ARF) has led to a huge number of admissions to intensive care units (ICU) with high fatality rates and shortage of beds. We had previously reported management and outcomes of patients with nasal/throat swabs still positive for SARSCoV-2 by polymerase chain reaction, transferred from acute care hospitals to rehabilitation facilities of northern Italy [1]. The present letter (Ethics committee approval: 2440, May 26th 2020, informed consent by patients) reports the outcome of survived critical patients undergone invasive mechanical ventilation and transferred, from March to June 2020, from ICU of Italian Regions Lombardia and Piemonte directly to step down units of three centers (Lumezzane, Pavia, Veruno) of Istituti Clinici Scientifici (ICS) Maugeri IRCCS network, referral Institutions for prolonged weaning, pulmonary rehabilitation and chronic care. Our step-down units consist of fully monitored beds, equipped for both non-invasive and invasive ventilatory support located within rehabilitative respiratory wards of multidisciplinary rehabilitation hospitals. A 24-h on-duty doctor is available, the nurse-to-patient ratio is 1:4 to 1.6 during daytime and 1:7 to 1: 10 during night-time, a respiratory physiotherapist cares for seven patients 8/24, 6/7 [2]. Effective protective personal equipment was provided to all professionals [3].

In addition to weaning strategies and management of underlying comorbidities, treatment of viral infection was continued or started, including one or more drugs among those proposed (chloroquine, antivirals, steroids, and anticoagulants) according to the evolving research at the time. Daily sessions of physiotherapy with type, intensity, timing and modality of intervention tailored to the individual patient's needs were also performed [4]. Non-invasive ventilation (6% of patients) and high flow oxygen (6%) were also used.

At admission and in the case also at discharge the following data were recorded: demographics, anthropometrics, comorbidities, need of mechanical ventilation, and/or oxygen, presence of tracheostomy, dysphagia with need of artificial enteral nutrition, delirium, acute hospital length of stay (LOS), step down LOS, arterial oxygen tension to inspiratory oxygen fraction (PaO_2/FiO_2) ratio; motor and functional disabilities by the Barthel index; arm strength by the Medical Research Council scale, (MRC), and final destination at discharge.

Data were collected in each unit according to shared criteria, and recorded in a single database. The main outcome was the rate of discharge home

Table 1
Demographic, anthropometric, clinical characteristics at admission, at discharge and final destination of patients in study. Data as mean ± Standard Deviation or numbers (%).

	Admission	Discharge	P
Number of patients	89		
Age, years	61.9 ±11.3		
Male, n (%)	63 (70.8)		
BMI, Kg/m^2	26.5 ± 5.4		
CIRS	1.7 ±1.2		
Acute Hospital LOS, days	35.6 ±26.2		
Step down LOS, days		19.1±11.0	
PaO_2/FiO_2	317.0 ±90.9	400.3 ±65.4	0.0000
FiO_2	0.30 ±0.87	0.25 ±14.5	0.0129
Barthel Index, score (N=79)	27.7 ±31.0	56.6 ±34.5	0.0000
MRC Quadriceps Force, (N=63)	2.5 ±0.9	3.5 ±1.4	0.0000
MRC Biceps Force (N= 63)	2.9 ±0.9	3.6 ±1.3	0.0000
Delirium, n (%)	19 (21.3)	0 (0)	0.0001
CPAP or NIV, n (%)	4 (4.4)	0 (0)	0.0001
Tracheostomised in SB	18 (20.22)	2 (2.2)	0.0002
Tracheostomised in MV	22 (24.7)	2 (2.2)	0.0003
Dysphagia n (%)	25 (28.1)	6 (6.7)	0.0000
Oxygen need, n (%)	66 (74.2)	22 (24.7)	0.0001
Died patients, n (%)		1 (1.1)	
Discharged to rehab units, n (%)		40 (44.9)	
Discharged home, n (%)		44 (49,5)	
Transferred to acute hospitals, n (%)		4 (4.5)	

Abbreviations. BMI: Body Mass Index; CIRS: Cumulative Illness Rating Scale; CPAP: Continuous Positive Airway Pressure; PaO_2/FiO_2: Arterial Oxygen Tension to Inspiratory Oxygen Fraction ratio; LOS: Length of Stay; MRC: Medical Research Council; MV: Mechanical ventilation; NIV: Non Invasive ventilation; SB: Spontaneous breathing

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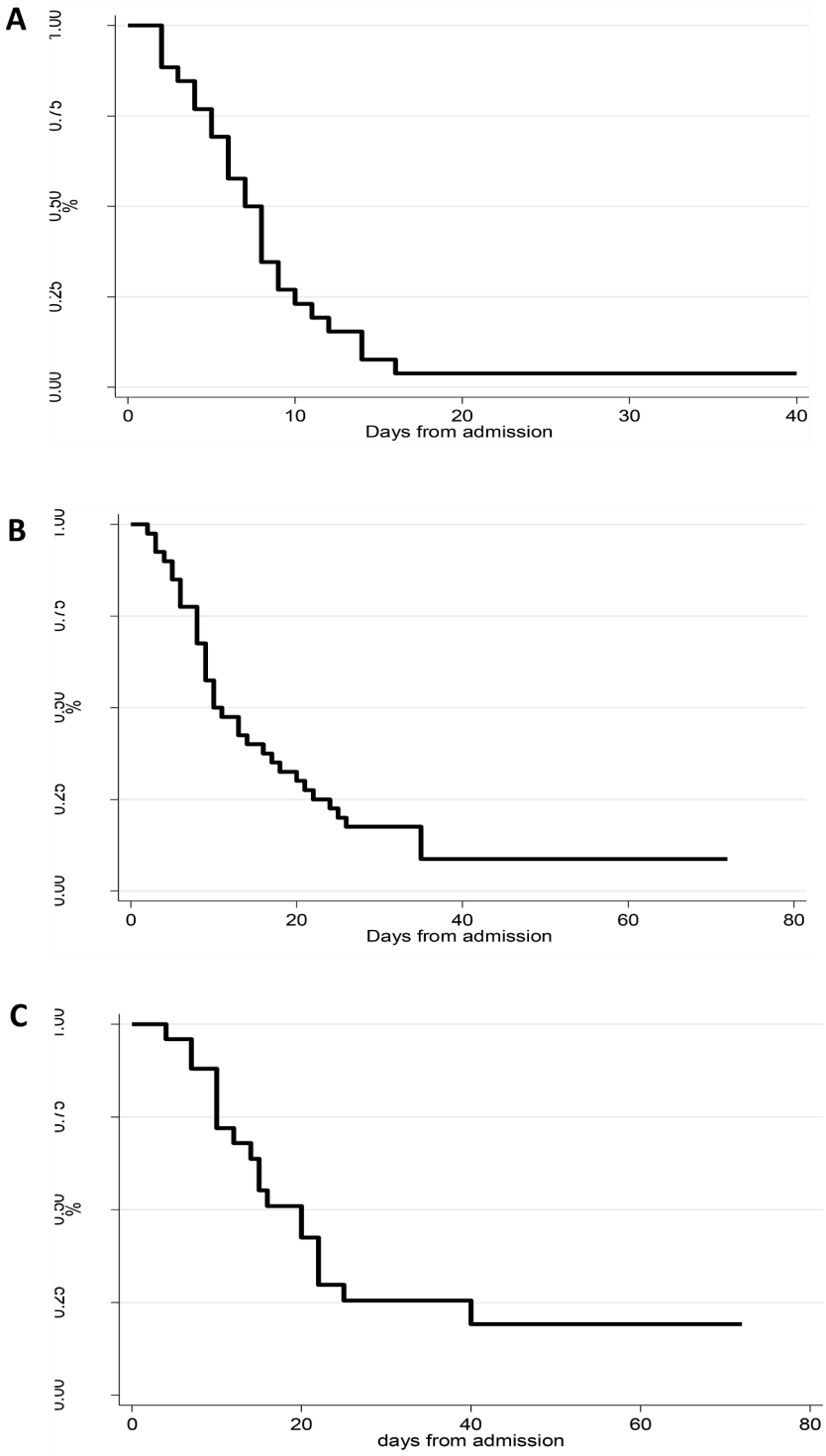

Figure 1. Kaplan Mayer curves of probability to remain under mechanical ventilation (panel A), tracheostomy (panel B), and artificial enteral nutrition (panel C).

or to rehabilitation units. As secondary end-points we assessed the changes in motor and functional disabilities, changes in arm strength, rate of weaning from mechanical ventilation, tracheostomy and artificial enteral nutrition. Mean ± Standard Deviation and numbers (%) were used as descriptive statistics. Post-to-pre comparisons were performed by paired t-test for continuous variables and by chi-square test for binary variables. The probability to remain under mechanical ventilation, tracheostomy and artificial enteral nutrition was assessed by means of Kaplan-Meier estimator for a survivor function, and a log-rank test was used to define differences between groups. Significant differences were defined by $P < 0.05$.

During the period of study, 89 patients were admitted (Pavia 32, Lumezzane 25, Veruno 32). Demographics, anthropometrics, clinical characteristics at admission, at discharge and final destination of patients are shown in Table 1. One patient died and four required readmission to acute care hospitals, the vast majority of patients were either discharged home or transferred to rehab units. Fig. 1 shows the probability to remain under mechanical ventilation, tracheostomy, or artificial enteral nutrition respectively. The mean times (50% of patients free) of weaning from mechanical ventilation and decannulation were 8.7 ± 7.4 (median 7) and 17.4 ± 13.5 (median 13) days respectively. Oral feeding started after 21.3 ± 15.2

(median 20) days. Age or CIRS did not influence the times to wean, decannulation, or start of oral feeding. There was no difference in results among centers.

Our data indicate that patients surviving Covid-19 associated ARF requiring ICU admission, transferred to step down units may show significant improvements in physiological and clinical conditions and can be discharged home or to rehabilitation facilities in the vast majority. Patients at admission needed a mean FiO_2 <30, with oxygenation rather preserved (mean PaO_2/FiO_2 317).

On admission both indexes of muscle strength and functional independence were severely compromised; at discharge, they improved but still showed residual severe deficits in peripheral muscle strength and physical disability as assessed by the Barthel Index with incomplete recovery within 19 days of step-down unit stay. This result justifies the decision to transfer 44% of patients to a rehab unit for a dedicated and specialized program. A recent study has reported that such disabilities may persist up to six months [5].

It is rather interesting to compare the characteristics and outcome of these Covid-19 patients with those needing prolonged weaning admitted to our step-down units before the Covid-19 pandemic and published elsewhere [6-7]. Earlier patients were older (mean age: 71 vs 62 years), with a higher prevalence of tracheostomy (81% of cases vs 45%), longer mean step-down unit LOS (30 vs 19 days), and lower weaning rate from mechanical ventilation (62% vs 90%) as compared to Covid-19 patients. The prevalence of delirium and dysphagia of historical controls were similar to those of Covid patients (18% vs 21% and 33% vs 28%, respectively) [8-9].

In conclusion, admission of Covid-19 patients who survived ICUs to dedicated step-down units resulted in good physiological and clinical outcomes. Whether step down units promotes better patient recovery, saving ICU beds due to early discharge from ICU needs further research.

Declaration of competing interest

The Authors declare absence of any conflict of interest related to the data presented in the paper.

References

[1] Vitacca M, Migliori GB, Spanevello A, Melazzini MG, Ambrosino N, , COVID-19 ICS Maugeri IRCCS network, Ceriana P, Fanfulla F, Braghiroli A, Fracchia C, Balbi B. Management and outcomes of post-acute COVID-19 patients in Northern Italy. Eur J Intern Med 2020;78:159–60. https://doi.org/10.1016/j.ejim.2020.06.005.
[2] Ceriana P, Nava S, Vitacca M, Carlucci A, Paneroni M, Schreiber A, Pisani L, Ambrosino N. Noninvasive ventilation during weaning from prolonged mechanical ventilation. Pulmonology 2019;25(6):328–33. https://doi.org/10.1016/j.pulmoe.2019.07.00.
[3] Ippolito M, Vitale F, Accurso G, Iozzo P, Gregoretti C, Giarratano A, Cortegiani A. Medical masks and Respirators for the Protection of Healthcare Workers from SARS-CoV-2 and other viruses. Pulmonology 2020;26(4):204–12. https://doi.org/10.1016/j.pulmoe.2020.04.009.
[4] Vitacca M, Carone M, Clini EM, Paneroni M, Lazzeri M, Lanza A, Privitera E, Pasqua F, Gigliotti F, Castellana G, Banfi P, Guffanti E, Santus P, Ambrosino N. ITS - AIPO, the ARIR and the SIP/IRS. Joint Statement on the Role of Respiratory Rehabilitation in the COVID-19 Crisis: The Italian Position Paper. Respiration 2020;99(6):493–9. https://doi.org/10.1159/000508399.
[5] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan China. Lancet 2020;395(10223):497–506. https://doi.org/10.1016/S0140-6736(20)30183-5.
[6] Schreiber AF, Ceriana P, Ambrosino N, Malovini A, Nava S. Physiotherapy and weaning from prolonged mechanical ventilation. Respir Care 2019;64(1):17–25.
[7] Ceriana P, Delmastro M, Rampulla C, Nava S. Demographics and clinical outcomes of patients admitted to a respiratory intensive care unit located in a rehabilitation center. Respir Care 2003;48(7):670–6.
[8] Ceriana P, Fanfulla F, Mazzacane F, Santoro C, Nava S. Delirium in patients admitted to a step-down unit: analysis of incidence and risk factors. J Crit Care 2010;25(1):136–43.
[9] Ceriana P, Carlucci A, Schreiber A, Fracchia C, Cazzani C, Dichiarante M, Cattani B, Fassio C, Segagni D, Nava S. Changes of swallowing function after tracheostomy: a video-fluoroscopy study. Minerva Anestesiol 2015;81(4):389–97.

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