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Rehabilitation of intubated COVID-19 patients in a Singapore regional hospital with early intensive care unit and sustained post-intensive care unit rehabilitation

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Abstract

Background: A proportion of patients with COVID-19 become critically ill, but few studies describe the functional outcomes and rehabilitation process of these patients.
Objective: To describe the complications encountered and functional outcomes of critically ill COVID-19 patients requiring intubation and subsequent intensive care unit (ICU) management and rehabilitation.
Methods: Retrospective case note review was conducted on all patients requiring intubation and ICU admission and subsequently discharged from our hospital from February 15, 2020 to May 1, 2020. Demographics, preexisting medical conditions, complications encountered in ICU, ICU and General Ward Length of Stay, number of therapy sessions delivered, nutritional data, and functional outcomes on discharge were collected from electronic medical records and entered in a deidentified database.
Results: Most patients developed significant breathlessness affecting post-ICU rehabilitation, a few patients developed ICU associated delirium while no patient developed ICU-associated weakness. All patients survived and could walk 20 m within 12 days post-extubation.
Conclusion: Early ICU and sustained post-ICU rehabilitation of critically ill, intubated COVID-19 patients is feasible. Further studies could look into the outcomes of this group of patients, in particular the effect of nutrition and pulmonary training on functional outcomes. We strongly recommend an interdisciplinary rehabilitation team approach in managing critically ill COVID-19 patients.

Keywords

Intensive care unit rehabilitation, COVID-19, multidisciplinary rehabilitation

Introduction

The COVID 19 pandemic has seen close to 84 million infections and over 1.8 million deaths as of January 4, 2021.[1] Locally, over 58 000 cases were diagnosed, of which there were 29 deaths recorded as of January 4, 2021.[2]

It is widely recognized that intensive care unit (ICU) survivors can develop post-intensive care syndrome and hence they would benefit from early ICU rehabilitation as well as sustained post-ICU rehabilitation.

A local, single center study looking at a case series of 22 patients admitted to the ICU for respiratory failure reported that 13 out of these 22 patients required mechanical ventilation, and the overall mortality rate was 9.1%. In this study,

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the length of invasive mechanical ventilation and overall ICU stay were 11 days and 16 days, respectively.[3]

In this article, we aim to describe the rehabilitation process and functional outcomes of a case series of COVID-19 patients who were intubated and mechanically ventilated for severe COVID-19 pneumonia in our hospital.

Methods

Our hospital is a 500-bed general hospital with 15 ICU beds. COVID-19 patients requiring intubation and ICU admission were admitted to a combined intensive care unit and managed by a medical team led by an intensivist. Once determined to be suitable for rehabilitation, the intensive care medical team refers the patient to a multidisciplinary ICU rehabilitation team consisting of a rehabilitation physician, physiotherapist, occupational therapist, dietitian, respiratory therapist, and speech therapist. The ICU rehabilitation team will discuss which team members would attend to the patient on any given day, minimizing the number of rehabilitation personnel going in and out of the rooms housing intubated COVID-19 patients. If patients were still intubated, then rehabilitation will proceed with lightened sedation or on sedation breaks. These patients will be mobilized by physiotherapist with respiratory therapist support while the occupational therapist will do reality orientation for the patient and start off the process of upper limb and activities of daily living (ADL) retraining. The speech therapists will commence swallow assessments and swallow rehabilitation post-extubation. The dietitian will conduct ongoing nutritional status assessments and titrate the nutritional interventions as appropriate. Patients were subsequently followed up for rehabilitation post-ICU till discharge from the acute hospital. All patients with COVID-19 infection requiring intubation and ICU admission and subsequently discharged from our hospital from February 15, 2020 to May 1, 2020 were included in the study. Patients with COVID-19 who were admitted to ICU but not intubated were excluded from the study. All patients received early ICU rehabilitation and sustained post-ICU rehabilitation conducted by a multidisciplinary rehabilitation team. Baseline demographic data, number of therapy sessions, rehabilitation outcomes, and medical information were reviewed retrospectively and data were collected. Informed consent was not obtained as this was a retrospective medical records review and approved by our Centralized Institution Review Board.

Results

A total of eight patients were included in the study. Patient demographics and comorbidities are shown in Table 1. All patients were community independent before admission. Their initial APACHE 2 scores were between 9 and 32. They stayed between 5 and 19 days in the ICU and were mechanically ventilated from 3 to 17 days. Seven out of eight patients required neuromuscular paralysis, and three out of eight patients required proning. Two out of eight patients developed ICU delirium, and one out of eight patients required CRRT. No patients developed ICU-associated weakness. Subsequently, patients stayed in the Isolation General Ward between 4 and 13 days. Five out of eight patients had significant breathlessness or desaturations affecting their post-ICU rehabilitation.

The number of physiotherapy and occupational therapy sessions in the ICU and General Ward are delineated in Table 2. Patients took between 1 and 12 days post-extubation to ambulate 20 m and all were at least home independent without walking aid on discharge from our hospital.

Table 3 shows the number of speech therapy (ST) sessions received by patients in ICU and General Ward, duration of nasogastric tube (NGT) feeding, and progress of feeding based on their functional oral intake scale (FOIS). All patients were fed via NGT at ICU and were all deemed safe to commence oral diet following an initial speech therapy review. At the point of discharge, all patients had their NGT removed and were recommended regular diet texture or diet with minimal modifications. Most patients had dysphonia, with them exhibiting characteristics of moderate breathiness as defined as by Consensual Auditory-Perceptual Evaluation of Voice scale[4] and a GRBAS (Grade, Breathlessness, Roughness, Asthenia, Strain)[5] score of G1R0A1B2S0.

Table 4 shows the summary of dietetic intervention and nutritional data from ICU to the General Ward. All patients were started on enteral feeding within 48 h of ICU admission (6 patients within 24 h). Accumulated caloric adequacy in ICU and General Ward was 52–91.5% and 56.9–104.9%, respectively. Accumulated protein adequacy based on estimated minimum requirement in ICU and general ward was 55–97.4% and 55.7–134.4%, respectively. The average protein intake in ICU was 0.7–1.1 g/kg/day.

Discussion

We believe that our case series is the first study to look at multidisciplinary rehabilitation in and out of ICU for intubated COVID-19 patients locally. While there are position papers articulating the suggested rehabilitation management of critically ill COVID-19 patients, there is a paucity of studies to guide the rehabilitation assessments and prognostication of intubated COVID-19 patients. We hope to shed light on future directions in refining the rehabilitation strategies for future intubated COVID-19 patients.

Impairments affecting rehabilitation progress

All patients were community independent without walking aid prior to admission. During their ICU stay, a significant number of patients developed ICU delirium. These patients were reorientated by the occupational therapists as part of the occupational therapy consult, from the ICU to the General Ward and recovered from delirium prior to discharge from the hospital. Most of the patients underwent neuromuscular paralysis, but none of them developed neuromuscular weakness. Most of the patients developed significant breathlessness affecting therapy in the post-ICU rehabilitation phase. They required oxygen support during post-ICU physiotherapy as well as pulmonary-specific training including dyspnea management and were discharged from the hospital without oxygen support. All patients were discharged 2 weeks post-ICU stay This suggests that for COVID-ICU patients, the rehabilitation program should

Table 1. Demographics and ICU admission details.

Subject	Age	Comorbidities	Gender	Community independent before admission?	No. of days in ICU	No. of days on mechanical ventilation	No. of days of neuromuscular paralysis	Days off paralysis till extubation	No. of days of proning in ICU	No. of days in general ward	APACHE 2 score on admission	Presence of ICU delirium?	Antipsychotics prescribed?	ICU-acquired weakness?	No. of days on dialysis	Breathlessness or desaturation on room air affecting therapy post-ICU
1	54	Hypertension, hyperlipidemia, and chronic kidney disease	Male	Yes	17	9	3	5	0	13	24	No	No	No	0	Yes
2	51	Hypertension, hyperlipidemia, and diabetes mellitus	Female	Yes	19	17	11	4	2	8	13	No	No	No	0	Yes
3	47	Hypertension	Female	Yes	5	3	0	NA	0	4	11	No	No	No	0	No
4	62	Diabetes mellitus	Female	Yes	8	7	1	4	0	10	9	No	No	No	0	Yes
5	58	Nil	Female	Yes	19	16	8	4	8	6	20	Yes	No	No	0	Yes
6	61	Nil	Male	Yes	13	10	0	NA	0	5	27	No	No	No	0	Yes
7	46	Hypertension	Male	Yes	9	6	1	3	0	6	32	No	No	No	0	No
8	39	Nil	Female	Yes	7	6	1	5	0	6	21	yes	No	No	7	No

ICU: Intensive care unit.

Table 2. Functional progress across ICU-GW rehabilitation.

	Subjects							
	1	2	3	4	5	6	7	8
No. of PT sessions in ICU (non-chest PT)	11	3	1	3	6	1	2	4
No. of OT sessions in ICU	0	2	0	0	1	0	1	0
If neuromuscular paralysis was done, days to non-chest PT referral after removal of paralysis	1	2	NA, not paralysed	4	1	NA. not paralysed	0	1
No. of PT sessions in GW	9	5	0	2	4	3	1	2
No. of OT sessions in GW	7	4	0	2	3	2	1	1
Number of days patient is able to sit over bed edge (days from extubation)	6	−1	−1	0	−2	0	−1	−2
Number of days patient is able to stand up (days from extubation)	8	0	−1	0	1	4	1	−1
Nunmber of days patient is able to ambulate 20 m (post-extubation)	12	7	3	1	5	4	3	1
Presence of ICU delirium? Y/N	N	N	N	N	Y	N	N	Y
Home ADL_S independent on discharge? Y/N	Y	Y	Y	Y	Y	Y	Y	Y

N = no, Y = yes, NA = not applicable
ICU: Intensive care unit; ADL: activities of daily living; PT: physiotherapist.

Table 3. Changes to patient oral intake function with speech therapy intervention and presence/absence of dysphonia post-intubation.

No.	Total ST sessions	No. of days on NGT before ST Ax	No. of days on NGT removal after ST Ax	FOIS at initial ST	FOIS at last ST	Dysphonia post-intubation
1	2	17	0	6	7	N
2	3	21	4	3	6	Y
3	0	3	−2	6	7	N
4	2	7	6	3	7	Y
5	4	15	2	3	7	Y
6	2	13	2	6	7	Y
7	2	7	−1	4	7	Y
8	1	7	−2	7	7	N

ST: speech therapy; NGT: nasogastric tube; FOIS: functional oral intake scale.

place more emphasis on pulmonary-specific training rather than general reconditioning.

Physiotherapy and occupational therapy interventions

More than half of the patients were mobilized prior to extubation. We attribute this to close communication between the medical and allied health teams, allowing for titration of ventilator settings and sedation breaks to encourage early mobilization of intubated COVID-19 patients. Collaborative sessions involving physiotherapist (PT) and occupational therapist (OT) at the early stage of rehabilitation also reduced overall exposure time in terms of man-hours to the COVID-19 environment for both PT and OT. In addition, patients were frequently prescribed theraband exercises, and nurses were educated on how to perform exercises with patients during their routine nursing sessions.

Despite long sedation periods and infection control measures limiting presence of familiar objects, faces, and activities, only 25% of patients had ICU delirium. This is similar to local rates and remains relatively low when compared with global incidence.[6] This may be largely attributed to reality orientation efforts and early mobilization during therapy sessions.[7] Education of energy conservation strategies were taught by OTs as a key intervention, as a significant number of patients were impacted by breathlessness post-extubation. Although no measures of well-being or anxiety were implemented, psychoemotional support and validation were provided during OT sessions.

Speech therapy interventions

From a service delivery standpoint, Marvin et al.[8] suggest bedside swallowing assessments conducted 24 h post-extubation as the standard of care. However, this may be insufficient given the complexity of care required. Specific to the patient population, the increased breath-swallow coordination needs and reduced tolerance for "normal" swallowing apnea as a result of their compromised lung function are critical in determining their swallow safety when commencing oral trials. Hence, it may be worthwhile to consider also the patients' physical performance during physiotherapy as a guide when considering when to refer to the ST for a swallowing assessment.

Most patients in this case series developed dysphonia which resolved on discharge from hospital; this would suggest the need for the speech therapist to be more involved in terms of dysphonia management to improve the communication aspect of these patients. A European study on COVID-19 patients reported that 27% of mild to moderate COVID-19 patients had mild dysphonia.[9] Future studies could look into the role of greater speech therapist involvement in critically ill COVID-19 patients not only for

Table 4. Nutrition data of intubated COVID-19 patients.

		ICU								General ward					
No.	BMI	No. of days post-ICU admission/ intubation to initiation of feeding	No. of days post-ICU admission to first DIT review	No. of dietitian reviews	Estimated caloric requirement (kcal/d)[a]	Calories adequacy (%)	Estimated minimum protein requirement (g/d)[b]	Protein average intake (g/ kg/day)	Protein-adequacy (%)[c]	No. of dietitian reviews in GW	Estimated caloric requirement (kcal/d)[d]	Calories adequacy (%)	Estimated minimum protein requirement (g/d)[b]	Protein-average intake (g/ kg/day)	Protein adequacy (%)[c]
1	31.4	1	1	7	1232.5 ± 147.5	91.5	78.0	1.0	97.4	2	1875.0	104.9	62.0	1.1	134.4
2	25.5	1	1	5	1388.8 ± 121.3	90.6	74.5	1.1	90.9	3	1557.6	98.8	74.5	1.3	110.6
3	31.4	1	2	1	1762.5 ± 112.5	52.0	98.0	0.7	55.0	1	1812.0	61.0	82.0	0.4	73.0
4	24.7	2	2	2	1787.3 ± 18.2	56.1	91.0	0.7	57.7	2	2208.0	70.2	75.5	0.9	90.7
5	25	1	1	5	1503.7 ± 116.0	72.6	72.0	0.9	71.1	2	1598.0	56.9	72.0	0.7	55.7
6	23.4	1	1	4	1745.3 ± 67.1	68.9	84.0	0.9	73.1	2	1955.0	104.1	84.0	1.4	119.9
7	29.4	2	1	3	1692.0 ± 108.0	73.6	92.2	0.9	73.0	2	1763.0	72.3	92.2	0.6	54.9
8	26.5	1	1	3	1481.9 ± 80.0	75.3	78.0	0.7	62.4	2	1690.0	69.6	78.0	1.0	84.0

ICU: intensive care unit.

[a]Estimated caloric requirements in ICU was calculated based on Penn-state equation for patient with BMI <30 kg/m2 and American Society of Parenteral and Enteral Nutrition (ASPEN) guidelines, that is, 22–25 kcal/kg ideal weight or 11–14 kcal/kg actual weight for patients with BMI 30–40 kg/m2, the.

[b]Estimated protein requirements in both ICU and general ward were based on actual body weight if BMI <27.5 kg/m2 and adjusted body weight if BMI ≥27.5 kg/m2.

[c]The protein adequacy is based on the estimated minimum requirement calculated by dietitian.

[d]Estimated caloric requirements in general ward was calculated based on Mifflin–St Jeor equation for all patients.

swallowing rehabilitation but also in terms of improving communication and voicing in these patients as well.

Dietetics interventions

Dietitians screen all ICU cases daily and work closely with ICU physicians to optimize the nutrition care of ICU patients. All COVID-19 patients in this study were assessed by a dietitian within 24–48 h post-ICU admission (Table 4).

Accumulated energy adequacy of this group of COVID-19 patients in ICU (72.6%) is higher than those of ICU patients reported internationally (60%).[10,11] This optimal energy adequacy is likely attributed by early initiation of enteral feeding; 75% of patients were fed on the first day of ICU admission as compared to less than 60% reported internationally.[10] Accumulated protein adequacy in ICU of 72.6% is also higher than 58% reported in international ICU studies.[11,12] The average protein intake during ICU stay was 0.9 g/kg/day, which is still lower than 1.2 g protein/kg/day based on international guidelines.[13,14] This may be attributed by the reduction in enteral feeding after accounting for non-nutritional calories from propofol to prevent overfeeding.

Overall, nutrition support delivery may also be disrupted by prone position for acute respiratory distress syndrome due to COVID-19, nil by mouth orders for spontaneous breathing trials.

After ICU discharge, our dietitians continue to monitor this group of COVID-19 patients and adjust nutrition interventions accordingly. As a result, both accumulated caloric and protein adequacy improved to 79.7% and 90.4%, respectively (Table 4). The relationship between optimal nutrition therapy for post-ICU survivor and their eventual functional outcomes remains largely uninvestigated.[14] Further research for formal recommendations and study into this relationship is needed.

Interdisciplinary training

A practical consideration for carrying out rehabilitation in the COVID-ICU and COVID General Ward environment is the consideration to minimize human traffic flow into the room. This highlights the need for interdisciplinary training and close communication among rehabilitation team members to minimize number of rehabilitation clinicians going to attend individual COVID-19 patients, yet deliver as many aspects of rehabilitation training and service to the patient as possible. We are able to execute early and sustained post-ICU Rehabilitation due to the presence of a highly committed allied health team with weekly in reach rehabilitation physician reviews in the ICU to assess impairments in ICU patients and coordinate interdisciplinary rehabilitation in the ICU and post-ICU.

Strengths and limitations

We acknowledge that the sample size of our study is too small to conclude the efficacy of any one intervention. We also did not do any holistic functional scoring like Functional Independence Measure (FIM) or Barthel's Index and neither we were able to do measures like gait speed due to the limitations of human traffic into the room limiting the rehabilitation team members' interaction time with the patient to do these measures and the lack of space in the isolation ICU and General Ward rooms.

We believe, however, that the results reflect the effect of multidisciplinary, coordinated, sustained rehabilitation efforts on intubated COVID-19 patients and that this is one of the few studies describing the service provision of rehabilitation in intubated COVID-19 patients in the clinical isolation environment. We await the publication of more studies examining the effect of multidisciplinary rehabilitation or specific rehabilitation interventions in improving the functional outcomes of intubated COVID-19 patients.

Conclusion

Early ICU and sustained post-ICU rehabilitation of critically ill, intubated COVID-19 patients is feasible. Further studies could look into the outcomes of this group of patients, in particular the effect of nutrition and pulmonary training on functional outcomes. We strongly recommend an interdisciplinary rehabilitation team working closely with the ICU medical team to optimize functional outcomes of these patients.

Authors' contributions

First author was responsible for the conceptualizing and design of the study as well as drafting the manuscript while the rest of the authors contributed to the data acquisition and analysis as well as editing the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical approval

SingHealth Centralised Institution Review Board reference no 2020/2499.

Informed consent

Not applicable (waiver of consent approved by Singhealth Centralised Institution Review Board)

Availability of data and materials

Available

Trial Registration

Not applicable

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