Physiotherapy 105 (2019) 321–327

Decline in functional status after intensive care unit discharge is associated with ICU readmission: a prospective cohort study

Leda Tomiko Yamada da Silveira [a,b], Janete Maria da Silva [c], Clarice Tanaka [a,d], Carolina Fu [a,*]

[a] Department of Physiotherapy, Communication Science & Disorders, Occupational Therapy—Medical School of University of São Paulo, Rua Cipotânea, 51, Cidade Universitária, 05360-000 São Paulo, SP, Brazil
[b] University Hospital, University of São Paulo, Av. Prof. Lineu Prestes, 2565, Cidade Universitária, 05508-000 Sao Paulo, SP, Brazil
[c] JMS Ciência e Saúde, Rua Manuel Augusto de Alvarenga 136, Vila Marari, 04402-050 São Paulo, SP, Brazil
[d] Clinical Hospital of Medical School of University of São Paulo, Av. Dr. Enéas de Carvalho Aguiar, 255, Cerqueira César, 05403-000 São Paulo, SP, Brazil

Abstract

Objectives To compare the functional status at intensive care unit (ICU) discharge of patients who were later readmitted to the ICU and patients discharged home and to verify whether a decline in functional status is associated with ICU readmission.
Design Prospective cohort study.
Setting ICU at a tertiary teaching hospital.
Participants Patients admitted to the ICU, ≥18 years old, submitted to invasive mechanical ventilation (IMV), and discharged to the ward.
Interventions Functional assessment at ICU discharge. Discharge Group (DG) (patients discharged home) and Readmission Group (RG) (patients who returned to the ICU) were compared with Mann–Whitney and Chi-square or Exact Fisher tests. Multiple logistic regression verified association.
Main outcome measures Barthel Index, key pinch strength, clinical and demographic data.
Results Patients in the readmission group presented lower Barthel Index [Median 40 (IQR 20–75) vs 60 (33–83), $P = 0.033$], greater relative variation (pre and post ICU) of the Barthel Index ($P = 0.04$), lower key pinch strength [3.4 (1.8–4.5) *vs* 4.5 (2.7–6.8) kg·f, $P = 0.006$] and higher APACHE II [18 (12–22) *vs* 15 (11–20), $P = 0.027$]. Multiple regression found that the relative variation of the Barthel Index was independently associated with ICU readmission ($P < 0.001$), as well as higher APACHE II ($P = 0.020$), shorter IMV duration ($P < 0.001$) and ICU admission without clear diagnosis ($P = 0.020$). The Hosmer–Lemeshow test indicated good adjustment of the model ($P = 0.99$).
Conclusion Readmitted patients presented poorer functional status and lower pinch strength. Relative variation of the Barthel Index was associated with ICU readmission despite other factors, as was higher APACHE II, shorter IMV duration and admission without clear diagnosis.

Trial registration number: Not applicable.

Keywords: Functional status; Critical care; Rehabilitation; Physical therapy modalities; Activities of daily living; Patient readmission

Introduction

Discharging a patient from intensive care unit (ICU) is a complex process and should involve multidisciplinary collaboration [1]. Although the status of the patients is not critical,

* Corresponding author.
E-mail addresses: lsilveir@usp.br (L.T.Y.d. Silveira), physiotherapy_janete@yahoo.com.br (J.M.d. Silva), cltanaka@usp.br (C. Tanaka), carolfu@usp.br (C. Fu).

https://doi.org/10.1016/j.physio.2018.07.010
0031-9406/

they may still be highly dependent. Frequently, general wards cannot count on having sufficient resources to provide an adequate level of care to highly dependent patients [2–4].

ICU readmission within the same hospital is one of the risks after ICU discharge [3]. Patients readmitted to the ICU tend to be older, have more comorbidities, non-surgical diagnosis, urgent surgery, and higher severity score [5,6]. Readmission rates and the outcome of readmitted patients have changed little in recent years, suggesting that ICU readmission is a chronic problem, which requires studies focusing on the identification of factors that can be modified.

The relationship between the severity of disease and workload in the care of ICU readmitted patients has been previously described; however, these findings are controversial [7,8] and the functional status itself has not been evaluated. Critically ill patients frequently have muscle weakness acquired in the ICU [9,10], physical deconditioning and deterioration of functional status, and physiotherapy is involved in the prevention and treatment of this condition [9]. A previous Brazilian study has shown that poor performance status is associated with prolonged ICU stay [11], but we did not find studies analysing its association with ICU readmission.

The aims of the study were to compare the functional status of patients who were readmitted to the ICU and patients who were discharged home after leaving the ICU and to verify whether functional status is associated with readmission to the ICU.

Methods

This was a prospective cohort study performed at a tertiary care university-affiliated hospital, with a total of 125 ICU beds. A convenience sample was used. The hospital's Ethics Committee for Analysis of Research Projects approved this study (approval number 1.593.307).

Inclusion criteria: patients admitted from the ward or emergency unit to the ICU, aged $\geq$18 years old, submitted to invasive mechanical ventilation (IMV) for at least 24 hours, discharged to the ward and who had their functional status assessed. The functional status assessment was not performed if the patient presented any condition that could directly compromise the functional status, such as neurologic disease, limb amputation or bed rest prescription, because we were interested in investigating the functional status impairment related only to the ICU stay. Patients with cognitive deficit, aphasia and tracheostomy were not included because they were unable to respond to the questionnaires.

We excluded patients with ICU length of stay (LOS) $\geq$90 days because we considered that it could cause bias. The functional status assessment had to be performed within 48 hours after ICU discharge. Patients who accepted participating in the study signed a consent form. All intensive care units were visited on a daily basis and eligible patients were followed until discharge to the ward.

Clinical and demographic variables that could be confounders were collected from patient records. They were: age; gender; body mass index (BMI); cause of hospital admission; cause of ICU admission; APACHE II (Acute Physiology and Chronic Health Evaluation) classification at the day of ICU admission; age-adjusted Charlson comorbidity index; cause of intubation; use of sedatives, neuromuscular blocking agents, vasoactive drugs, corticosteroids and antibiotics during ICU stay; complications during ICU stay; IMV duration; LOS in ICU, in general ward and in hospital; and outcome after discharge to the ward. APACHE II was collected for the first 24 hours of ICU admission. Charlson comorbidity index was assessed according to the patient's medical history.

The main predictive variable in the study was the functional status at ICU discharge. Functional status assessment was composed of the Barthel Index score [12] and key pinch strength.

The Barthel Index consists of ten activities of daily living (ADL) scored according to the level of dependence that the patient requires. The ADL are: feeding (score 0, 5 or 10); bathing self (score 0 or 5); personal hygiene (score 0 or 5); dressing (score 0, 5 or 10); bowel control (score 0, 5 or 10); bladder control (score 0, 5 or 10); toilet (score 0, 5 or 10); chair/bed transfer (score 0, 5, 10 or 15); ambulation (score 0, 5, 10 or 15) and stair climbing (score 0, 5 or 10). The sum of each ADL score is the total Barthel Index score, which may vary from 0 to 100. The higher the score, the more independent the patient.

The Barthel Index was assessed by interview post-ICU stay, i.e. 48 hours after being discharged from ICU to the ward, and pre-ICU stay. To assess the Barthel Index score pre-ICU the patient was asked about the ability in performing the ADL one month before being admitted to the hospital. We chose the interview format because it is an easier and faster method to assess the Barthel Index. Previous studies have shown good reliability in different ways of administration including self-report assessment [12]. Self-report should be used with care with patients with cognitive impairment or confusion, but those patients were excluded from our study. Each patient was interviewed by the same research member, to avoid bias caused by the way in which questions were asked [13].

The relative variation between post-ICU and pre-ICU scores was also calculated, as follows:

$$Relative\ variation\ \ for\ \ Barthel\ Index = \frac{Pre\ ICU\ score - Post\ ICU\ score}{Pre\ ICU\ score}$$

Key pinch strength was measured using a hydraulic pinch gauge (Saehan Corporation, 973, Yangdeok-Dong, Masan 630–728, Korea). The patient should be in sitting position with the shoulder in adducted and neutrally rotated position, elbow flexed at 90° and the forearm and wrist in neutral position [14]. Only the dominant member was tested and the best value of three attempts was elected.

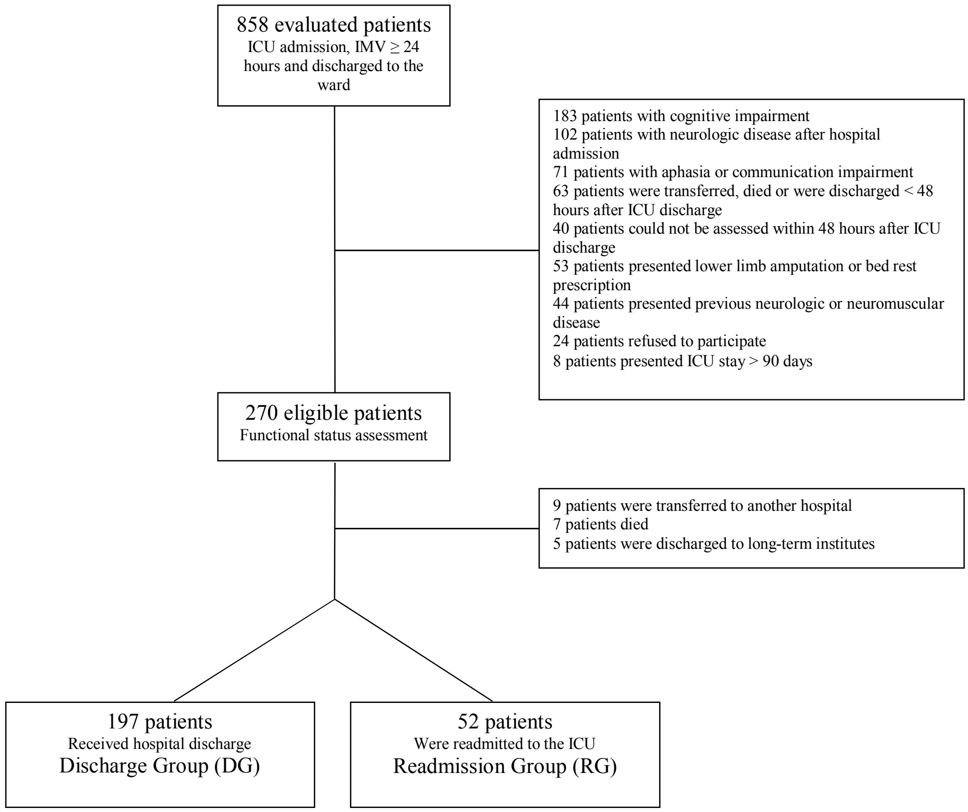

Fig. 1. Flowchart of patients included in the study.

Key pinch, performed between the pad of the thumb and radial face of the index finger, is considered the strongest pinch when compared to the tip-pinch and tripod pinch because it counts on the activation of adductor pollicis muscle and the flexor pollicis longus muscle. It is essential for the hand function, in activities such as grabbing and holding objects. It requires the movement of opposition between the thumb and the other fingers, coordination of fingers, adequate finger joint mobility and adequate strength of flexor muscles [15]. The impairment in the key pinch will certainly affect the performance of functional activities.

For the comparison of functional status, patients were analysed according to the outcome after discharge to the ward: patients who were discharged home were classified as the Discharge Group (DG) and patients who were readmitted to the ICU were named the Readmission Group (RG). Thus, the data of patients who died after ICU discharge were not analysed. Data of patients transferred to other hospitals were also not analysed, since we could not be informed of their outcome. For the RG, clinical and demographic data referred only to the first ICU stay. For this group, we also collected the cause of ICU readmission and APACHE II in the first 24 hours of readmission.

Data were analysed by descriptive one-dimensional analysis. Groups were compared using the Mann–Whitney test and Chi-square test or the Fisher Exact test. Multiple logistic regressions models were used to evaluate the association of functional status and ICU readmission. Statistical software R (version 3.1.3) and Minitab v.16 (Minitab Inc., Pennsylvania, USA) were used.

Results

Out of 270 eligible patients for the study, nine were transferred to other hospitals; seven died and five were discharged to long-term institutes. Therefore, the study population comprised 197 patients in DG and 52 patients in RG (Fig. 1). None of the patients included in the study were receiving palliative care.

Demographic data are presented in Table 1. Data regarding IMV duration and patients' length of stay are shown in Tables 2 and 3. Table 4 presents data concerning the second ICU stay for patients readmitted to the ICU (Readmission Group). About 15% of readmitted patients returned to the ICU within 48 hours after being discharged to the ward. The mortality rate for RG was 33%, while the mortality rate for all eligible patients was 10%.

There was no difference between groups for the Barthel Index score before hospital admission, but groups were different after ICU discharge for the Barthel Index score and for the Barthel Index score relative variation (Table 5).

To evaluate the association of functional status and ICU readmission, multiple logistic regression models were used.

Table 1
Clinical and demographic data for patients in both groups.

	Discharge Group $n = 197$	Readmission Group $n = 52$	P-value
Age, years old	51 (34–61)	56 (45–63)	0.148[a]
BMI, kg/cm^2	24 (21–27)	24 (20–26)	0.405[a]
Male gender, n (%)	111 (56)	22 (42)	0.071[b]
APACHE II at ICU admission	15 (11–20)	18 (12–22)	0.027[a]
Age-adjusted Charlson comorbidity index	3 (0–5)	4 (2–6)	0.055[a]
Type of hospital admission, n (%)			0.273[b]
Elective medical	71 (36)	23 (44)	
Elective surgical	30 (15)	12 (23)	
Emergency surgical	59 (30)	12 (23)	
Emergency medical	37 (19)	5 (10)	
Cause of hospital admission, n (%)			0.190[b]
Respiratory	38 (19)	2 (4)	
Cardiovascular	14 (7)	6 (11)	
Gastrointestinal	33 (17)	16 (31)	
Neurologic	11 (6)	3 (6)	
Trauma	22 (11)	1 (2)	
Pre-operative	30 (15)	12 (23)	
Infection	16 (8)	2 (4)	
Clinical investigation	7 (4)	3 (6)	
Others	26 (13)	7 (13)	
Cause of ICU admission, n (%)			0.008[b]
Shock	32 (16)	8 (15)	
Respiratory failure	60 (30)	4 (8)	
Renal failure	9 (5)	2 (4)	
Coma	11 (6)	6 (11)	
Post-operative	79 (40)	27 (52)	
Cardiac arrest	2 (1)	1 (2)	
Monitoring	2 (1)	3 (6)	
Liver failure	2 (1)	1 (2)	

BMI: body mass index; APACHE II: Acute Physiology and Chronic Health Evaluation; ICU: intensive care unit. Others: refers to other causes of hospital admission, including renal/metabolic, haematological, exogenous poisoning, bleeding, skin disease, tetanus. Values are expressed as median (1st–3rd quartile) unless otherwise noted.
[a] Mann–Whitney test.
[b] Chi-square or Fisher Exact test.

Table 2
Medication use during ICU stay for both groups.

	Discharge Group $n = 197$	Readmission Group $n = 52$	P-value
Medication use, n (%)			
Antibiotics	193 (98)	52 (100)	0.583[a]
Sedatives	181 (92)	47 (90)	0.779[a]
Vasoactive drugs	149 (76)	50 (96)	<0.00[a]
Corticosteroids	99 (50)	25 (48)	0.876[a]
Neuromuscular blockers	14 (7)	1 (2)	0.206[a]
Duration of medication use, days			
Antibiotics	11 (7–19)	11 (6–14)	0.180[b]
Sedatives	4 (2–7)	3 (2–4)	0.019[b]
Vasoactive drugs	4 (2–6)	4 (3–6)	0.550[b]
Corticosteroids	7 (4–13)	7 (5–12)	0.978[b]
Neuromuscular blockers	2 (1–2)	1 (1–1)	0.123[b]

ICU: intensive care unit. Values are expressed as median (1st–3rd quartile) unless otherwise noted.
[a] Chi-square or Fisher Exact test.
[b] Mann–Whitney test.

For the selection of the group of explanatory variables, the following procedure was adopted: first, simple logistic regression models were adjusted using variables that could influence the readmission to the ICU, based on the literature and clinical experience. The variables whose test presented $P < 0.05$ were included in the multiple logistic regression analysis.

After the multiple regression model had been adjusted, the variable with the greatest P-value among those with $P > 0.05$ was withdrawn and the model was readjusted for the remain-

Table 3
Duration of invasive mechanical ventilation and ICU, ward and hospital length of stay for both groups.

	Discharge Group $n = 197$	Readmission Group $n = 52$	*P*-value
Duration of IMV in the first ICU stay, days	5 (3–10)	4 (2–6)	0.017
Length of stay, days			
At the ward before the first ICU admission	1 (0–7)	2 (1–8)	0.246
First ICU stay	11 (6–22)	11 (6–15)	0.152
At the ward after ICU discharge	10 (5–19)	8 (4–15)	0.043
Second ICU stay after readmission	–	4 (2–9)	–
Total ICU stay	–	15 (10–23)	–
Total hospital stay	30 (18–50)	45 (33–68)	<0.001

IMV: invasive mechanical ventilation; ICU: intensive care unit. Values are expressed as median (1st–3rd quartile). The Mann–Whitney test was used to compare groups.

Table 4
Data specific for patients readmitted to the ICU.

	Readmission Group $n = 52$
APACHE II at ICU readmission	14 (11–20)
Cause of ICU readmission, *n* (%) (n = 49)	
Shock	16 (31)
Respiratory failure	6 (12)
Renal failure	0
Coma	0
Post-operative	19 (37)
Cardiac arrest	3 (6)
Monitoring	5 (10)
Liver failure	0
Cause of readmission different from first ICU admission, n (%)	31 (63)
In-hospital death, n (%)	17 (33)
ICU readmission within 48 hours after ICU discharge, n (%)	8 (15)

APACHE II: Acute Physiology and Chronic Health Evaluation; ICU: intensive care unit. Values are expressed as median (1st–3rd quartile) unless otherwise noted.

ing variables. This procedure was repeated until only the variables with $P \leq 0.05$ remained in the model. Afterwards, the variables that presented $0.05 \leq P \leq 0.10$ in the simple regression model were included, one at each time, in the multiple model in order to verify its significance at the level of 0.1 in the presence of the other significant variables.

The variables included in the multiple analysis were the relative variation of the Barthel Index score, key pinch strength, gender, cause of hospital and ICU admission, ICU length of stay, age-adjusted Charlson comorbidity index, APACHE II, IMV duration, and duration of sedatives use. Since only one cause of ICU admission – 'monitoring' – was significant ($P = 0.02$) compared with 'shock', which was used as the reference, the other causes of ICU admission were grouped and the model was readjusted. 'Monitoring' was significant for both adjustments; however, the variable 'gender' was no longer significant ($P = 0.11$). The cause of ICU admission 'monitoring' was used when patients were admitted to the ICU with clinical and vital sign deterioration but without a clear diagnosis.

Finally, after multiple logistic regression analyses, the variables associated with ICU readmission were: cause of admission to the ICU 'monitoring' ($P = 0.020$), APACHE II ($P = 0.020$), length of IMV ($P < 0.001$) and relative variation of the Barthel Index score ($P < 0.001$).

To verify whether the final model was well adjusted, the Hosmer–Lemeshow test was applied and it was found to be $P = 0.99$, which indicates good adjustment. Residual graphics indicated good behaviour, with some atypical patients, but the removal of those observations did not change the conclusions.

Discussion

This study investigated the relationship of the functional status at ICU discharge with readmission to the ICU and showed that a decline in functional status after ICU stay is associated with ICU readmission. To the best of our knowledge, this result has not been previously described. Other factors also shown to be related to ICU readmission were:

Table 5
The Barthel Index score and key pinch strength group comparison.

	Discharge Group $n = 197$	Readmission Group $n = 52$	*P*-value
Barthel Index score before ICU admission	100 (100–100)	100 (100–100)	0.390
Barthel Index score after ICU discharge	60 (33–83)	40 (20–75)	0.033
Relative variation in the Barthel Index score	0.4 (0.2–0.7)	0.6 (0.3–0.8)	0.040
Key pinch strength, kilogram-force	4.5 (2.7–6.8)	3.4 (1.8–4.5)	0.006

ICU: intensive care unit; $Relative\ variation\ for\ Barthel\ Index = \frac{Pre\ ICU\ score - Post\ ICU\ score}{Pre\ ICU\ score}$.
Values are expressed as median (1st–3rd quartile). The Mann–Whitney test was used to compare groups.

ICU admission for monitoring purpose without a clear diagnosis, shorter IMV duration, and higher APACHE II score.

ICU admission due to ‘monitoring’ was associated with ICU readmission after multivariate analysis that also included other factors. This motive was attributed when clinicians could not establish a clear diagnosis, although patients presented severe clinical deterioration and required vigorous monitoring provided in the ICU. Since the diagnosis was not clear, perhaps those patients did not receive assertive treatment and clinical stabilisation was not definitive. Consequently, patients’ clinical condition might easily deteriorate after being discharged from ICU.

Similar to previous studies, patients from RG presented higher APACHE II [5]. However, there was no statistical significance for the age-adjusted Charlson comorbidity index or the median age of DG and RG, although previous studies have observed that older patients are more likely to be readmitted to the ICU [5]. This may have been influenced by the fact that the subjects in our population were not old.

Groups differed regarding cause of ICU admission; the most expressive difference was that there was a larger percentage of patients admitted to the ICU because of respiratory failure in the DG, while the Readmission Group presented a larger percentage of patients admitted to the ICU due to coma and in the post-operative period.

A larger percentage of patients in RG used vasoactive drugs, but the duration of use was not different between groups. The duration of use of sedatives was greater for DG, which can be related to the fact that more patients in this group were admitted to the ICU because of respiratory failure, which often requires IMV and sedation.

Length of IMV at first ICU stay was shorter for RG than DG. This was an unexpected finding. A possible explanation could be the cause of ICU admission of the study population. The Discharge Group presented a higher proportion of patients admitted to hospital due to respiratory issues and admitted to ICU due to respiratory failure. This could justify the fact that this group presented higher IMV duration. Another possible explanation for this unexpected finding could be the premature IMV weaning in the RG group, although the design of our study did not include weaning protocols since this was not an objective of this study.

As expected, patients from the DG stayed longer at the ward after ICU discharge, probably related to the fact that they needed final adjustments in clinical course before being discharged home. However, also as expected, the length of hospital stay was greater for the RG.

The Readmission Group presented lower Barthel Index score at ICU discharge and higher relative variation of the Barthel Index score than the discharged patients did, although groups were not different before hospital admission: both groups presented a maximum score for the Barthel Index before hospital admission. Some authors suggest a classification of patients according to the Barthel Index score stratification as follows: zero to 20 points: full dependence; 21–60 points: severe dependence; 61–90 points: moderate dependence; 91–99 points: mild dependence; 100: full independence [16]. According to this stratification, our study population can be considered severely dependent after ICU discharge.

The objective of this study was to verify whether there was an association between functional status and ICU readmission. According to the multiple regression analysis, the results corroborate the initial hypothesis and patients who were readmitted to the ICU presented greater functional status impairment caused by the ICU stay.

We do not intend to claim that functional status impairment is the only factor associated with ICU readmission; in fact, our study’s results show that other factors are also important. However, some of the factors may not be changed, such as the cause of ICU admission or APACHE II, while functional status can be modified. Reducing the impact of ICU stay in functional status and improving functional status after ICU discharge should both be emphasised in this population. Functional status depends on factors such as muscle strength, postural balance, and physical conditioning, which may be stimulated during physiotherapy, whether in the ICU or on the ward [9].

Detecting physiological deterioration on the ward at an early stage reduces the rate of ICU readmission [17]. Some authors suggest that the level of care provided at the ward may influence ICU readmission and in-hospital death [6,18]. Therefore, the identification of patients who present a higher probability of being readmitted to the ICU could help in the definition of ICU discharge itself. It may also help with the definition of the level of care required by the patient at the ward and the need for more intense follow-up, since health interventions are frequently more beneficial for patients with worse prognoses. Besides, human resources are scarce in health systems [19] especially in developing countries and in the public health system.

Individualised rehabilitation, including physiotherapy, has been recommended following ICU stay until after hospital discharge [9,10,20]. The multi-professional team should be able to act not only during the acute phase but also during persisting deficits and functional status impairment [9,18].

Among the limitations of this study, we point out that this was an observational, single centre study. Besides that, many patients were excluded from the analysis because of the possibility of bias regarding the evaluation of the Barthel Index score. We did not include patients with neurological impairment because we were interested in the effect of ICU on the functional status. Thus, the generalisation of the results should be undertaken carefully. The design of the study did not allow the follow-up of patients at the ward or in longer outcomes.

In conclusion, for the type of population included in this study, readmitted patients presented poorer functional status at ICU discharge than patients who were discharged home. Deterioration of the Barthel Index score was associated with ICU readmission even in the presence of other factors. Readmitted patients’ key pinch strength was smaller but not associated with ICU readmission. Other factors associated with ICU readmission in the multivariate regression analysis were admission with no clear diagnosis, higher APACHE II score and shorter IMV duration.

Key messages

- At ICU discharge, functional status of patients who were later readmitted to the ICU was worse than patients who were later discharged home.
- Decline in functional status presented independent association with ICU readmission.
- Other factors with independent association with ICU readmission were: admission with no clear diagnosis, higher APACHE II score and shorter IMV duration.

Acknowledgements

We thank Mr. Cauê Padovani, Mrs. Bruna Peruzzo Rotta, Mr. José Marcelo Mafra and Mrs. Michele de Cássia Santos Ramos for helping with the data collection. We also thank Mrs. Júlia Maria Pavan Soler and Miss Carolina Yea Ling Sun for the statistical support.

Ethical approval: The Clinical Hospital, School of Medicine, University of São Paulo Ethics Committee approved this study (approval number 1.593.307). All participants gave written informed consent.

Conflict of interest: None declared.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.physio.2018.07.010.

References

[1] Lin F, Chaboyer W, Wallis M. A literature review of organisational, individual and teamwork factors contributing to the ICU discharge process. Aust Crit Care 2009;22(1):29–43, http://dx.doi.org/10.1016/j.aucc.2008.11.001.
[2] Elliott M. Readmission to intensive care: a review of the literature. Aust Crit Care 2006;19(3):96–8, 100–4.
[3] Araujo TG, Rieder MM, Kutchak FM, Franco-Filho JW. Readmissões e óbitos após a alta da UTI –um desafio da terapia intensiva. Rev Bras Ter Intensiva 2013;25(1):32–8.
[4] Stelfox HT, Lane D, Boyd JM, Taylor S, Perrier L, Straus S, *et al.* A scoping review of patient discharge from intensive care: opportunities and tools to improve care. Chest 2015;147(2):317–27, http://dx.doi.org/10.1378/chest.13-2965.
[5] Elliott M, Worrall-Carter L, Page K. Intensive care readmission: a contemporary review of the literature. Intensive Crit Care Nurs 2014;30(3):121–37, http://dx.doi.org/10.1016/j.iccn.2013.10.005.
[6] Frost SA, Alexandrou E, Bogdanovski T, Salamonson Y, Davidson PM, Parr MJ, *et al.* Severity of illness and risk of readmission to intensive care: a meta-analysis. Resuscitation 2009;80(5):505–10, http://dx.doi.org/10.1016/j.resuscitation.2009.02.015.
[7] Campbell AJ, Cook JA, Adey G, Cuthbertson BH. Predicting death and readmission after intensive care discharge. Br J Anaesth 2008;100(5):656–62, http://dx.doi.org/10.1093/bja/aen069.
[8] Silva MCM, Sousa RMC, Padilha KG. Patient destination after discharge from intensive care units: wards or intermediate care units? Rev Latino-Am Enfermagem 2010;18(2):224–32.
[9] Hodgson CL, Tipping CJ. Physiotherapy management of intensive careunit-acquired weakness. J Physiother 2017;63(1):4–10, http://dx.doi.org/10.1016/j.jphys.2016.10.011.
[10] Hashem MD, Parker AM, Needham DM. Early mobilization and rehabilitation of patients who are critically ill. Chest 2016;150(3):722–31.
[11] Zampieri FG, Ladeira JP, Park M, Haib D, Pastore CL, Santoro CM, *et al.* Admission factors associated with prolonged (>14 days) intensive care unit stay. J Crit Care 2014;29(1):60–5.
[12] Collin C, Wade DT, Davies S, Horne V. The Barthel ADL index: a reliability study. Int Disabil Stud 1988;10(2):61–3.
[13] Roedl KJ, Wilson LS, Fine J. A systematic review and comparison of functional assessments of community-dwelling elderly patients. J Am Assoc Nurse Pract 2016;28(3):160–9.
[14] Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil 1985;66(2):69–74.
[15] Araújo MP, Araújo PMP, Caporrino FA, Faloppa F, Albertoni WM. Estudo populacional das forças das pinçaspolpa-a-polpa, trípode e lateral. Rev Bras Ortop 2002;37(11/12):496–504.
[16] Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel index for stroke rehabilitation. J Clin Epidemiol 1989;42(8):703–9.
[17] Johnson AE, Burgess J, Pimentel MA, Clifton DA, Young JD, Watkinson PJ, *et al.* Physiological trajectory of patients pre and post-ICU discharge. Conf Proc IEEE Eng Med Biol Soc. 2014 2014:3160–3, http://dx.doi.org/10.1109/EMBC.2014.6944293.
[18] Niven DJ, Bastos JF, Stelfox HT. Critical care transition programs and the risk of readmission or death after discharge from an ICU: a systematic review and meta-analysis. Crit Care Med 2014;42(1):179–87, http://dx.doi.org/10.1097/CCM.0b013e3182a272c0.
[19] Bemis-Dougherty AR, Smith JM. What follows survival of critical illness? Physical therapists' management of patients with post-intensive care syndrome. Phys Ther 2013;93(2):179–85, http://dx.doi.org/10.2522/ptj.20110429.
[20] Walsh TS, Salisbury LG, Merriweather JL, Boyd JA, Griffith DM, Huby G, *et al.* Increased hospital-based physical rehabilitation and information provision after intensive care unit discharge: the RECOVER randomized clinical trial. JAMA Intern Med 2015;175(6):901–10.