Original Article

Protein, caloric and anthropometric analysis of patients submitted to conventional physiotherapy and cycle ergometer of inferior members in ICU: a pilot study

Análise proteica, calórica e antropométrica de pacientes submetidos à fisioterapia convencional e cicloergômetro de membros inferiores em UTI: estudo piloto

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ABSTRACT | INTRODUCTION: Protein-energy malnutrition is defined by caloric and/or protein deficiency, which can cause changes in body composition such as sarcopenia, mental status, functionality and consequently impair the clinical outcome. **OBJECTIVE:** To assess the energy and protein supply of critically ill patients undergoing conventional physical therapy associated with an active cycle ergometer (or only conventional physical therapy) and correlate with anthropometric data and the MRC scale and PERME score. **MATERIALS AND METHODS:** A pilot study with critically ill patients admitted to the ICU, divided into a control (CG) and experimental (EG) group. All were evaluated by the MRC scale and PERME score and submitted to anthropometric measurements. After eight days of conventional physical therapy intervention (CG) or active ergometer associated with the conventional approach (GE), they were reassessed. The protein and caloric intake of all were evaluated every day. **RESULTS:** There was a significant reduction in calf circumference measurements in the CG and a non-significant loss of measurements in the EG (p=0.001). The caloric and protein adequacy level was 73.9% and 69.5%, respectively. There was no significant difference between the groups. **CONCLUSION:** Mobilization with a cycle ergometer seems to positively affect the preservation of muscle mass in lower limbs in critically ill patients.

KEYWORDS: Body composition. Malnutrition. Enteral nutrition. Nutrition therapy. Intensive Care Units.

RESUMO | INTRODUÇÃO: A desnutrição proteico-energética é definida como resultado da deficiência calórica e/ou proteica, podendo causar alterações na composição corporal como a sarcopenia, no estado mental, na funcionalidade e consequentemente prejudicar o desfecho clínico. **OBJETIVO:** Avaliar oferta energética e proteica de pacientes críticos, submetidos à fisioterapia convencional associada ao cicloergômetro ativo (ou unicamente a fisioterapia convencional) e correlacionar com os dados antropométricos, e a escala MRC e Perme Escore. **MATERIAL E MÉTODOS:** estudo piloto com pacientes críticos internados na UTI, divididos entre grupo controle (GC) e experimental (GE). Todos foram avaliados pela escala MRC e PERME escore e submetidos a medidas antropométricas. Após 8 dias de intervenção fisioterapêutica convencional (GC), ou clicoergômetro ativo associado a abordagem convencional (GE), eles foram reavaliados. O aporte proteico e calórico de todos foram avaliados todos os dias. **RESULTADOS:** Houve redução significativa de medidas de circunferência de panturrilha no GC e perda não significativa de medidas no GE (p=0,001). O nível de adequação calórico e proteico foi de 73,9% e 69,5% respectivamente. Não houve diferença significativa entre os grupos. **CONCLUSÃO:** A mobilização com o cicloergômetro parece exercer efeito positivo na preservação da massa muscular em membros inferiores de pacientes críticos. No entanto, estudos que avaliam a medida de massa muscular em membros inferiores de modo mais controlado são necessários para comprovar essa hipótese.

PALAVRAS-CHAVE: Composição corporal. Desnutrição. Nutrição enteral. Terapia nutricional. Unidade de Terapia Intensiva.

Submitted 05/18/2021, Accepted 10/20/2021, Published 11/08/2021
J. Physiother. Res., Salvador, 2021 November;11(4):631-639
http://dx.doi.org/10.17267/2238-2704rpf.v11i4.3839 | ISSN: 2238-2704
Assigned editors: Cristiane Dias, Giuliano Gardenghi

How to cite this article: Souza RCD, Andrade NP, Carvalho EM, Melo FG. Protein, caloric and anthropometric analysis of patients submitted to conventional physiotherapy and cycle ergometer of inferior members in ICU: a pilot study. J Physiother Res. 2021;11(4):631-639. http://dx.doi.org/10.17267/2238-2704rpf.v11i4.3839

Introduction

Protein-energy malnutrition is defined as a result of caloric and/or protein deficiency, which can cause changes in body composition such as sarcopenia, mental status, functionality and impair the clinical outcome. It is caused by multiple factors, such as food deprivation, diseases, and/or old age.[1] It is a condition commonly found in the hospital environment that leads to an increased risk of surgical and infectious complications, development of pressure injuries, mortality, length of stay, and hospital expenses.[2] In intensive care units (ICU), the prevalence of malnutrition varies between 43 and 88%.[3]

In critically ill patients, there is a great loss of muscle mass, and the causes are multifactorial, including reduced contractility of muscle fibers, disuse, and muscle degradation, while protein anabolism is insufficient to compensate for these losses.[4,5] Furthermore, it has been demonstrated that this hypermetabolic state can persist for up to two years after hospital discharge, prolonging patients' full recovery, highlighting the difficulty in recovering lean mass and its functionality.[6]

Almost half of the patients do not return to work in the first year after admission, and mortality is still high. Therefore, in addition to the aforementioned in-hospital consequences, the post-discharge period has also been receiving special attention. At the same rate that mortality in the ICU has been declining, the number of patients who do not return to functional life post-ICU and depend on post-discharge rehabilitation environments has grown. This "event" has been called post-intensive care syndrome. Thus, studies seeking to measure the quality of life after admission to the ICU, especially physical functionality, have gained space in the literature.[6] For Wischmeyer et al., nutrition and physical activity offered during hospitalization are essential factors in this process, as they show individual's metabolic reserve.[6]

The multidisciplinary team must develop strategies to minimize the loss of muscle function and functional capacity of patients hospitalized in ICUs, aiming to increase nutritional and physical rehabilitation, allowing these individuals to be reintroduced into society with functional independence and quality of life. This study aimed to evaluate the energy and protein supply of critically ill patients undergoing conventional physical therapy associated with an active lower limb cycle ergometer, or only conventional physical therapy, correlating anthropometric data with the Medical research council (MRC) scale and the Perme Intensive Care Unit Mobility Score (PERME score), seeking to confirm the benefit and importance of adequate nutritional intake and active exercises to maintain muscle mass in critically ill patients.

Material and methods

A pilot study with critically ill patients admitted to the adult ICU of a public university hospital. Data collection took place from February to November 2018. The study was approved by the local research ethics committee (CAAE: 82259317.9.0000.5152) and by the Brazilian Registry of Clinical Trials (U1111-1215-1362)

Patients over 18 years of age participated in the study; without distinction of sex and cause of admission to the ICU; that presented a lower limb MRC equal to 3, being able to perform an active lower limb cycle ergometer; dependent on mechanical ventilation for more than 48 hours; able to follow simple commands; and hemodynamically stable. The criteria of hemodynamic stability and safety of active mobilization proposed by Bradley et al.[7] was respected. Patients who were not able to follow the commands to perform the cycle ergometer were excluded.

The MRC scale consists of the assessment of muscle strength through six movements tested bilaterally. The degree of muscle strength for each movement varies between 0 (complete paralysis) and 5 (normal muscle strength). Thus, the total score ranges from 0 (complete tetraparesis) to 60 (normal muscle strength).[8]

All were evaluated by the Perme score, which was developed to assess the mobility status of patients admitted to the ICU. The Perme Score assesses the mobility status of critically ill patients through fifteen items. They were divided into seven categories: mental status, potential barriers to mobility, functional strength, bed mobility, transfers, endurance, and distance covered. The score ranges from 0 to 32 points, where a low score reflects less mobility and greater need for assistance, and the opposite is true.[9] A physical therapist applied both scales.

The sample calculation was performed using the G*Power 3.1.2.9 software. To determine the sample size, we used the calculation for two means between dependent samples. The parameters used were: two tails, large effect size (0.50); default significance level (α=0.05); test power (1-β=0.80), resulting in 34 patients.

After being eligible, patients were randomized into two groups, with sealed envelopes, per person not involved in the study and classified as: Control group (CG): received only the standard sector intervention consisting of active-assisted or active exercises in the upper limb bed and lower limbs without using the cycle ergometer, lasting 15 minutes, twice a day for eight consecutive days. The experimental group (EG): submitted to conventional physiotherapy and active cycle ergometry of the lower limbs once a day (Minibike for Exercises Acte Sports ®) in dorsal decubitus and head elevated at 45 degrees. The patient actively pedaled the cycle ergometer for 15 minutes without additional load. The 6-hour interval between the conventional intervention and the cycle ergometer was respected.

On the first day, all were evaluated by the MRC scale and Perme score and submitted to anthropometric measurements more sensitive to muscle quantity and functionality[10], in addition to being mobilized limbs: calf circumference (CP) and arm circumference (AC). On the ninth day, after eight days of intervention, the participants underwent the same assessments as the first day. Anthropometric measurements were taken in the upper (CB) and lower (CP) limbs that presented better conditions for measurement (mobility, without dressings), without investigating limb dominance, but in the same limb on the first and ninth day. To obtain the CP, the measurement was performed with an inelastic measuring tape. The leg is bent at a 90-degree angle to the knee, and the measurement is taken from the most protruding part of the calf. For the BC, it was first flexed at an angle of 90 degrees, then we located the midpoint between the ends of the prominences of the olecranon and the ulna, then, with the arm extended, we contoured with an inelastic measuring tape the height of the midpoint so that the tape adhered to the skin but did not press it.[11]

Data regarding energy needs and supply (in kilocalories) and protein (in grams) were collected daily as well as the value of the Simplified Acute Physiology Score (SAPS), which estimates the patient's mortality risk.[12]

Data were analyzed using SPSS version 22.0. Quantitative variables are presented as means and standard deviations, and qualitative variables are presented as frequencies and percentages. A t-test for independent samples was performed to assess differences between groups in the MRC scale, Perme score, CP, CB, and the need and supply of kilocalories and grams of protein. Associations of qualitative variables were analyzed using Fisher's exact test and Pearson's correlation analysis between anthropometric data, caloric and protein supply, between anthropometry and values of the MRC scale and Perme final score. Adopted significance level: 95%.

Results

A total of 33 patients were included, of which ten died or were discharged from the ICU before completing the eight days of intervention. The final sample consisted of 23 patients, 11 in (EG) and 12 in (CG).

Figure 1. Patient selection flow diagram

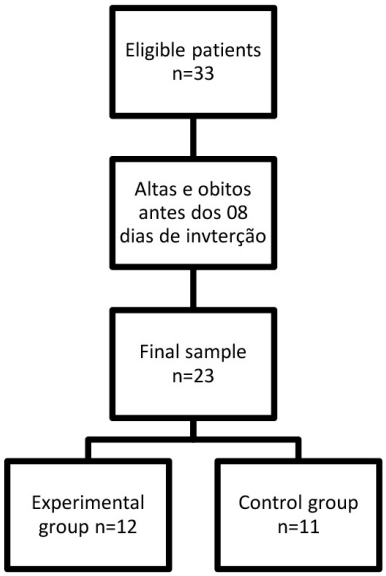


Table 1 shows the characterization of the groups with sociodemographic and anthropometric data, routes and types of feeding, and clinical outcome where most participants used enteral diets via a nasoenteral tube. There was no significant difference between the analyzed groups, and in Figure 1, we present the clinical characterization of the groups.

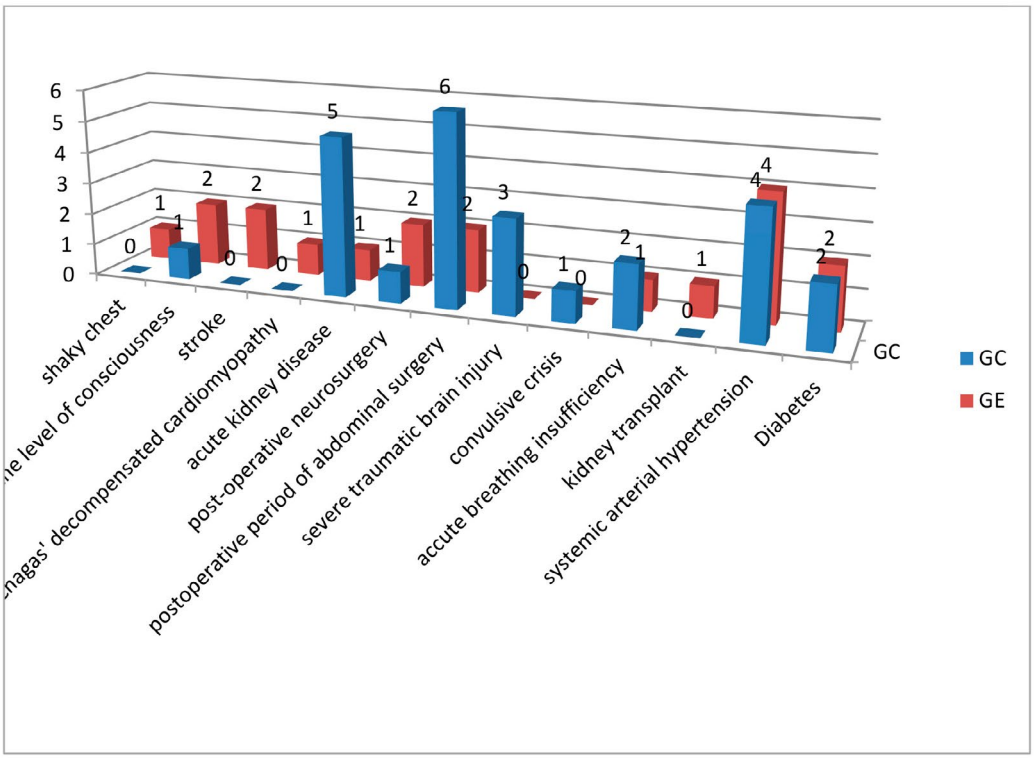
Although most patients received average amounts of energy and proteins close to their needs Table 2, the energy and protein deficit found for some patients was expressive, CG-5.45± 5352.43 and -339± 294.85 and EG -3.467 ± 4817.28 and -232.55 ± 290.20, values for energy and protein respectively.

Table 3 shows the mean percentages of energy and protein adequacy received concerning the needs of patients by group, without statistical significance.

Table 4 shows the anthropometric variables analyzed before and after physical therapy intervention. When analyzing the initial calf circumference (CPI) and on the 9th day to the end (CPF), we observed a significant reduction ($p = 0.001$). In the CG, there was no difference in the EG ($p = 0.053$). Comparing the initial arm circumference measurement (CBI) with the 9th day to the end (CBF), we observed a significant decrease in both groups (CG $p = 0.038$ and GE $p = 0.041$).

When analyzing the correlation between energy and protein output (difference between need and supply) and the reduction in anthropometric measurements in both groups, there were no significant correlations. Finally, we performed correlation analyzes between energy and protein output and the final values of the MRC scale and Perme score; we observed a significant, moderate, and inverse correlation between energy output and the final Perme score in the CG, showing that the more calories the patient did not receive, the higher was his score on the Perme score. The other correlations were not significant, Table 5.

Figure 2. Clinical characterization of critically ill patients, N=23



N: study population
CG: control group
GE: experimental group

Table 1. Characterization of critically ill patients and feeding routes, N=23

	CG(n=12)	EG(n=11)	P
Men/Women	8/4	6/5	
Age (years)	55,2 ± 20,6	49,5 ± 17,1	0,491
Length of stay when entering the survey (days)	15,75 ± 13,2	11,91 ± 6,3	0,402
Total length of stay (days)	25,4 ± 13,9	24,9 ± 10,3	0,922
SAPS points	66,4 ± 17,5	63,0 ± 20,4	0,671
Average height (meters)	1,71 ± 0,63	1,66± 0,09	0,318
Average weight (kilograms)	71,7 ± 5,73	65,8 ± 8,12	0,214
IMC (kg/m²)	24,4 ± 1,18	23,8 ± 1,67	0,419
Food route*			
SNE diet (n/%)	5(41,6)	7(63,6)	
SNE diet e VO(n/%)	3(25)	3(27,2)	
NP(n/%)	2(16,6)	1(9,0)	
SNE diet e NP(n/%)	2(16,6)	0(0)	0,230
Clinical outcome**			
hospital discharges (n/%)	8(74,9)	8(64,4)	
Deaths (n/%)	4(36,6)	3(25,1)	0,554

N = study population
Fisher's Test*
Student t test **
SAPS: SimplifiedAcutePhysiology Score, SNE: nasoenteric probe, VO: orally, NP: Parenteral nutrition

http://dx.doi.org/10.17267/2238-2704rpf.v11i4.3839 | ISSN: 2238-2704

Table 2. Presentation of the values in kilocalories and grams that each critical patient did not receive in the nine days of follow-up.N=23

Energy (kcal)		Proteins (g)	
Patient	**Difference between need and supply**	**Patient**	**Difference between need and supply**
	CG		
CG11	-17.547	GC11	-911
CG01	-11.075	GC01	-767
CG18	-10.689	GC18	-588
CG13	-8.574	GC13	-480
CG12	-4.515	GC12	-411
CG06	-3.900	GC06	-273
CG02	-2.460	GC08	-230
CG08	-2.192	GC02	-131
CG10	-2.043	GC10	-118
CG09	-1.653	GC09	-101
CG17	-825	GC17	-58
CG07	0	GC07	0
Mean and standard deviation	-5,45± 5352,43		-339± 294,85
	EG		
EG05	-15.750	GE05	-945
EG15	-9.114	GE15	-569
EG10	-4.256	GE09	-293
EG01	-2.133	GE10	-222
EG13	-1.968	GE01	-156
EG11	-1.964	GE04	-146
EG09	-1.224	GE11	-112
EGO2	-864	GE13	-84
EG07	-700	GEO2	-78
EG04	-164	GE12	-56
EG12	0	GE07	103
Mean and standard deviation	-3,467 ± 4817,28		-232,55 ± 290,20

CG: control group, EG: experimental group

Table 3. Percentage of energy and protein adequacy in relation to the needs of the critically ill patient. N=23

	CG		**EG**		**Geral**	
	Energy(n/%)	Protein(n/%)	Energy(n/%)	Protein(n/%)	Energy(n/%)	Protein(n/%)
0 a 32,9%	2(16,6)	3(25,0)	1(9,0)	2(18,1)	3(13,0)	5(21.7)
33 a 65,9%	2(16,6)	2(16,6)	1(9,0)	0(0)	3(13,0)	2(8,6)
66 a 100%	8(66,6)	7(58,3)	9(81,8)	9(81,8)	17(73,9)	16(69,5)

Table 4. Association between anthropometric variables in critically ill patients, N=23

	Calf Circumference (cm)			**Arm Circumference (cm)**		
	Initial	**End**	**p[a]**	**Initial**	**End**	**p[a]**
CG	33,3± 3,8	31,1± 3,4	0,001	29,6± 3,9	27,9± 3,7	0,038
EG	33,0± 3,3	31,8± 3,6	0,053	30,0± 3,6	29,0± 3,7	0,041
p[b]	0,873	0,643		0,836	0,474	

Student T test
[a]p value between initial and final measurement
[b]p value between GC and GE

Table 5. Correlation of energy and protein output and the reduction in anthropometric measures and between energy and protein output and the final values of the MRC scale and PERME score. N=23

	CG		EG	
	r	p	r	p
Kcal vs CP	0,2	0,52	0,45	0,15
Kcal VS CB	0,36	0,23	0,49	0,11
Protein vs CP	0,24	0,43	0,33	0,3
Protein vs CB	0,37	0,22	0,36	0,26
Kcal vs PERME end	0,59	0,03	0,31	0,35
Kcal vs MRC end	0,29	0,35	-0,01	0,96
Protein vs PERME end	0,52	0,08	0,43	0,17
Protein vs MRC end	0,2	0,52	0,05	0,87

Source: Own elaboration.
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Kcal = kilocalories
CP= calf circumference
CB = arm circumference

Discussion

The objective of this study was to confirm the benefit and importance of adequate nutritional intake and active exercises for mass muscle maintenance in critically ill patients.

Although most patients are close to the protein and caloric goals, the level of adequacy is still low, with 73.9% and 69.5% of caloric and protein adequacy, respectively, being below 80%, as demonstrated by Ribeiro.[13] Similar results were found by Menezes et al., where caloric and protein adequacy levels were 77.2% and 73.8%.[14] At the same time, Nunes et al. obtained caloric adequacy of 64.6% and protein of 66.7%.[15] Researches point out that one of the justifications for these results is due to the number of breaks made for procedures (30.0%) and failures in administration (42.9%).[16] In this study, these data were not analyzed, characterizing a research bias.

The high deficit of calories and proteins is a worrying factor, especially due to the severity of the patients who have marked protein catabolism and increased resting energy expenditure.[17] However, the supply of nutrients cannot reverse the associated proteolysis, gluconeogenesis, and lipolysis to stress. They can reduce the consequences of exacerbated catabolism, with better results when associated with effective early mobilization.[18]

Regarding anthropometric data, we identified significant decreases in PC and BC measurements in the CG, and a non-significant decrease in PC in the EG, demonstrating positive effects for maintaining muscle mass when using the cycle ergometer. However, it cannot be said that mobilization alone is sufficient to maintain measurements since the importance of nutrition in maintaining muscle fibers is well established.6 Studies that more accurately assess the characteristics of musculoskeletal mass are needed to confirm this hypothesis.

There were no significant correlations between anthropometric measurements and caloric or protein deficit or between caloric or protein deficit and scales. The correlation found was between the deficit of kilocalories and the final Perme score in the CG, suggesting the opposite of what was expected. The absence of correlations between the analyzed variables may have been generated because n was not reached, and therefore the sociodemographic and clinical characterization was not homogeneous, which can be considered one of the study's limitations.

Clinical studies with a more robust sample, longer follow-up time, and more reliable muscle mass analysis such as ultrasound, or tomography, for example, would be of great importance to prove what this pilot study suggests.

As a limitation of the study, the number of patients did not reach the sample size, possibly due to the profile of patients where few had a level of awareness for inclusion and the lack of similar studies for discussion.

Conclusion

Mobilization with a cycle ergometer seems to positively affect the preservation of muscle mass in lower limbs in critically ill patients.

Acknowledgments

Article from the work of completion of residency by the Residency Program in the Professional Area of Health, Faculty of Medicine, Universidade Federal de Uberlândia, based on the dissertation "Analysis of the mobility of critically ill patients undergoing Physiotherapeutic Intervention in relation to the Perme Score."

Authors' contributions

Souza RCD was responsible for data collection and manuscript construction. Andrade NP was responsible for data collection and manuscript review. Carvalho EM and Melo FG guided the research and revised the final version of the text.

Conflicts of interest

No financial, legal, or political conflicts involving third parties (government, corporations and private foundations, etc.) have been declared for any aspect of the submitted work (including, but not limited to grants and funding, advisory board participation, study design, preparation manuscript, statistical analysis, etc.).

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