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Impact of hospitalization in an intensive care unit on range of motion of critically ill patients: a pilot study

Impacto do internamento em unidade de cuidados intensivos na amplitude de movimento de pacientes graves: estudo piloto

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ABSTRACT

Objective: To evaluate the joint range of motion of critically ill patients during hospitalization in the intensive care unit.

Methods: This work was a prospective longitudinal study conducted in a critical care unit of a public hospital in the city of Salvador (BA) from September to November 2010. The main variable evaluated was the passive joint range of motion. A goniometer was used to measure the elbows, knees and ankles at the time of admission and at discharge. All patients admitted in the period were included other than patients with length of stay <72 hours and patients with reduced joint range of motion on admission.

Results: The sample consisted of 22 subjects with a mean age of 53.5±17.6 years, duration of stay in the intensive care unit of 13.0±6.0 days and time on mechanical ventilation of 12.0±6.3 days. The APACHE II score was 28.5±7.3, and the majority of patients had functional independence at admission with a prior Barthel index of 88.8±19. The losses of joint range of motion were 11.1±2.1°, 11.0±2.2°, 8.4±1.7°, 9.2±1.6°, 5.8±0.9° and 5.1±1.0°, for the right and left elbows, knees and ankles, respectively ($p<0.001$).

Conclusion: There was a tendency towards decreased range of motion of large joints such as the ankle, knee and elbow during hospitalization in the intensive care unit.

Keywords: Range of motion, articular; Inpatients; Intensive care units

INTRODUCTION

Changes in joint flexibility and the consequent decreased range of motion (ROM) may be related to decreased mobility or bed rest, factors common to patients admitted to intensive care units (ICU).[1] Flexibility is directly linked with the ability to perform Activities of Daily Living (ADLs), and its reduction can promote functional decline and worsening of quality of life.[1-3]

Functional decline, characterized by the loss of ability to perform ADLs, has already been found to occur during ICU internment and has multiple causes.[3] The physical therapist is a professional with a role in minimizing functional decline through therapeutic movement and positioning, as reported in a recent Brazilian recommendation.[4]

Compromised ROMs can have a direct impact on the quantity and quality of daily tasks performed by the impaired body region. In a normal individual, the lack of freedom of movement requires compensations that hinder the execution

of these activities. However, for the bedridden individual during the course of acute illness, such adjustments do not occur, causing dependency and the habit of non-use, which perpetuate functional losses.[2,5]

ROM behavior during the ICU stay is still not clearly defined. It is known that a loss of flexibility occurs after admission, but there is no knowledge regarding how it varies during the course of this period. Currently, this gap in knowledge leads to health professionals overlooking the joint component, which can be a potential factor in the functional decline of this population.[5-9] This pilot study therefore aimed to evaluate the variation in the ROM of large joints during ICU internment.

METHODS

This work was a prospective study of a longitudinal cohort, carried out in the ICU of a public hospital of the city of Salvador (BA), Brazil. The unit consists of 22 beds serving clinical and surgical patients. A sample of consecutive patients admitted to the unit during the period between September and November 2010 was used.

Adult subjects (>18 years) were included who were admitted to the unit during the study period on a consecutive basis and who consented to participation. The following were considered to be exclusion criteria: admission to ICU <72 hours; presence of functional contracture, as proposed by Clavet et al.[2], on admission (elbow <90°, knee <90°, ankle <0°);[2] individuals with unhealthy limbs and individuals with periarticular cutaneous tissue with continuity lesions, such as burns, ankylosis, deformities and amputations. The study was approved by the Ethics Committee of the hospital where the study was conducted under protocol number CEP 22/10, and all patients or their guardians signed the terms of a free and informed consent form.

All individuals in the sample had the following evaluated variables: passive ROM in degrees of elbow flexion, knee flexion and ankle dorsiflexion; admission disease and comorbidities; Acute Physiology And Chronic Health Evaluation II (APACHE) II; Glasgow scale for patients without sedation and Richmond Agitation-Sedation Scale (RASS) for those who were sedated; age in years; gender; length of stay in days; Barthel Index on admission (by consultation with family members); duration of ventilation and sedation during hospitalization.

A preliminary evaluation was conducted to standardize the collection method and to evaluate the reliability of goniometry in patients in the ICU (Table 1) in addition to estimating the average length of stay in the unit.

Table 1 - Goniometry reliability data for the sample

Reliability of universal goniometry	ICC
Intraexaminer	
Elbow	0.96
Knee	0.94
Ankle	0.76
Interexaminer	
Elbow	0.96
Knee	0.92
Ankle	0.72

ICC - intraclass correlation coefficient.

For the measurement of ROM, a previously validated method was used[10] with a universal goniometer (*Carci Indústria e Comércio de Aparelhos Cirúrgico e Ortopédicos*) to evaluate the passive range in each instance. For greater reliability, a dermographic pen was used to maintain the anatomical reference measurement points. All measurements were performed by the same previously trained examiner.

The first ROM measurements were performed within the first 24 hours of admission to the unit and the second set of measurements on the day of discharge from the ICU to ascertain the ROM behavior of the ankle, knee and elbow joints throughout the hospital internment.

In all measurements, the patients were positioned in dorsal decubitus of 0°, without the trunk being inclined. To measure the range of elbow flexion, the fulcrum was aligned at the lateral epicondyle, with the arm fixed perpendicular to the humerus, performing passive flexion of the elbow to the maximum range. To measure the range of knee flexion, the fulcrum was positioned at the level of the lateral femoral condyle, and maximum flexion was performed. Ankle dorsiflexion was performed by positioning the fulcrum two fingers below the lateral malleolus, with the fixed arm perpendicular to the fibula and the moving one passing through the fifth metatarsal tubercle, with maximum dorsiflexion being performed from the neutral position of the ankle. All measurements were performed three times, and the highest value was used.

All patients included in the study received the conventional physical therapy employed routinely in the unit. The attending physical therapists were not informed of the progress of the variable of interest.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for Windows program, version 16.0. The demographic and clinical characteristics

of the patients were described as frequencies and percentages for categorical variables, and continuous data were presented as measures of central tendency and dispersion. The level of statistical significance adopted was 5%. The paired *t* test was used to evaluate the change in ROMs studied at discharge compared to the ROMs at admission.

RESULTS

The number of patients admitted to the ICU during the study period was 51 patients, of whom 5.8% and 9.8% were excluded due to the presence of contractures and periarticular lesion or limb amputation, respectively. Nine other individuals were excluded for not consenting to participate in the study. Twelve patients were excluded after the start of data collection due to their short length of stay in the unit, <72 hours (Figure 1).

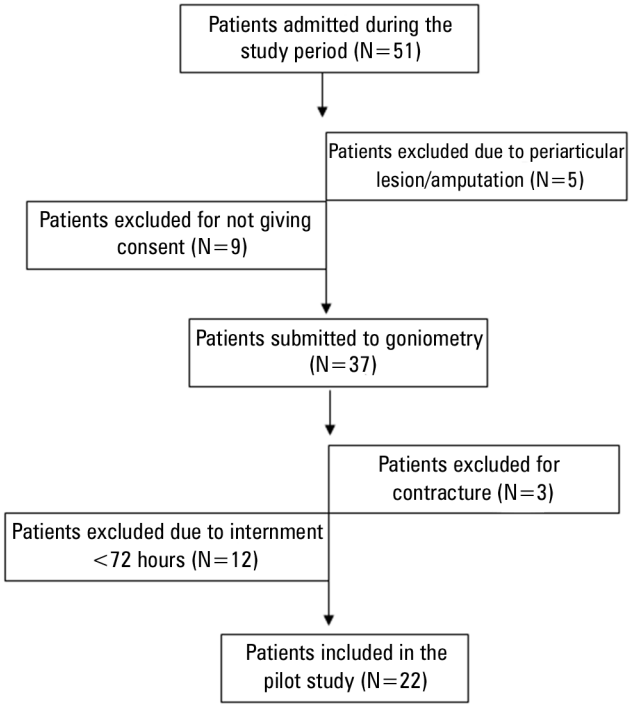

Figure 1 - Flow diagram of patients included in the study.

The final sample consisted of 22 individuals with a predominance of males (59.1%) and a mean age of 53.5±17.6 years. Almost half of the patients (45.5%) came from the emergency unit to the ICU. Most individuals had functional independence prior to admission, with a prior Barthel index of 88.8±19 points. The APACHE II at admission had a mean value of 28.5±7.3 points (Table 2).

Table 2 - General characteristics of the population

Sample characterization	Variable	Mean±SD
Gender		
Male	13 (59.1)	
Female	9 (40.9)	
Original unit		
Emergency	10 (45.5)	
Operating room	6 (27.3)	
Hospitalization unit	6 (27.3)	
Ages (years)	53.5±17.6	
APACHE II	28.5±7.3	
Glasgow	11.0±2.3	
RASS	-3.4±1.1	
Reason for admission		
Neurological	9 (40.9)	
Gastro-hepatic	5 (22.7)	
Cardiologic	3 (13.6)	
Nephrologic	3 (13.6)	
Others	2 (9.0)	
Comorbidities		
SH	10 (45.5)	
Respiratory tract infection	6 (27.3)	
Kidney failure	2 (9.1)	
Arrhythmia	2 (9.1)	
Others	2 (9.1)	
Type of sedation		
Sedation	15 (68.2)	
None	5 (22.7)	
Analgesia	2 (9.1)	
Neuromuscular blocker	0 (0.0)	
Sedation time (days)		6.2±2.1
ICU internment time (days)		13.0±6.0
Hospitalization time (days)		28.9±2.1
Mechanical ventilation time (days)		12.0±6.3

SD - standard deviation; APACHE II - Acute Physiology And Chronic Health Evaluation II; RASS - Richmond Agitation-Sedation Scale; SH - systemic hypertension; ICU - intensive care unit. Results expressed as a number (percentage) or mean±standard deviation.

During the preliminary study, intra-and inter examiner goniometry reliability was evaluated for the joints studied, and high reliability was observed under both conditions. The intraclass correlation coefficient values are shown in table 1.

Regarding the reasons for admission, 40.9% were admitted due for neurological disorders, followed by gastro-hepatic (22.7%) and cardiac (13.6%) diseases. The most prevalent comorbidity was systemic arterial hypertension (45.5%), followed by respiratory tract infection (23.7%).

Approximately 68% of patients in the sample received some sedation during their hospitalization, with a mean time of 6.2±2.1 days. The mean duration of mechanical ventilation (MV) was 12.0±6.3 days, with a similar mean ICU stay of 13.0±6.0 days (Table 2).

Regarding ROM behavior from admission to discharge, a bilateral reduction was observed in the ROM of the elbow, knee and ankle, with testing performed in an isolated manner (p<0.001) (Table 3).

Table 3 - Joint range of movement on admission and at discharge from intensive care unit for the sample

Joint	Admission	Discharge	ROM variation
R Elbow	139.6±2.0	128.5±2.2	11.1±2.1*
L Elbow	138.7±1.9	127.7±2.4	11.0±2.2*
R Knee	149.0±1.6	140.6±1.9	8.4±1.7*
L Knee	149.2±1.3	140.0±1.9	9.2±1.6*
R Ankle	9.3±0.8	3.5±1.1	5.8±0.9*
L Ankle	7.4±1.1	2.3±1.0	5.1±1.0*

ROM - joint range of movement; R - right side; L - left side; Range of movement in degrees (°). Results expressed as the mean±standard deviation. * p<0.001.

DISCUSSION

This study revealed that over the period of the ICU stay, there was a tendency toward decreased ROM of the elbow, knee and ankle. This finding is in agreement with previous studies.[2,3,7] This loss, according to Dittmer and Teasell,[11] could be caused by a shortening of the connective tissue, which in turn is caused by immobility, disuse and hypomobility. These factors also contribute to a possible increase in muscle contraction, which could further affect the loss of ROM.

In a recent retrospective study, Clavet et al.[2] also evaluated changes in the ROM of the five major joints of the body after 2 weeks of ICU stay, but they did not use goniometry on admission. They demonstrated that 39% of individuals had some type of contracture at discharge, and 34% were functionally significant contractures. This study used a goniometer to ensure greater reliability of ROM measurement, and conducted ROM measurement at both admission and discharge, unlike the aforementioned study.

The elbow was the joint most affected in the study by Clavet et al.,[2] followed by the knee and the ankle. In this study, however, the ankle was the joint that suffered the greatest loss, followed by the elbow and knee. The joint changes observed may limit performance in work activities and even basic ADLs. The aforementioned study, in turn, identified factors associated with reduced ROM.

Regarding the length of hospitalization, this study had a mean duration of 13.0±6.0 days, which is considered an average time in relation to previous studies,[2,3] which included hospital stays of up to 3.1 weeks. Despite the large sample size, a limitation of the study cited above was that individuals were not evaluated upon admission, but only at discharge from the ICU and from the hospital, which prevented the comparison of functional loss between the studies. However, the aforementioned study found that a quarter of patients continued to suffer from joint contractures that limited ADLs at home, demonstrating a persistent condition of reduced mobility even after discharge. This study evaluated ROM only during ICU stay and did not propose to evaluate it after hospital discharge.

The reduction of ROM in these 22 patients was approximately 62% and 69% in the ankles, 5.4% and 6.1% in the knees, and 8% and 7.9% in the elbows, on the right and left sides, respectively. This loss should be noted by health professionals due to the possible risk of functional decline emanating from the stability of mobility reduction or from further deterioration. This risk is associated with other risk factors previously described, such as length of stay >8 days; duration of MV >10 days; neurological and vascular based diseases; use of neuromuscular blockers and APACHE II >15.[2]

Studies suggest that athletes who lose flexibility of a few degrees of ROM suffer from impaired physical performance.[12,13] No correlation was found in the literature between ROM loss of this magnitude and loss of functionality in hospitalized or sedentary individuals; however, it is clear that the decline in biological structures over even a short period is a preponderant factor for further follow-up of this variable.

Reduced mobility has many causes, including edema, the use of catheters and venous access and hemodynamic and neurological changes.[3,7] The impact of immobility at the intra-articular level was demonstrated in a study with rats that identified changes in fibrosis, tendon shortening and reduction of synovial fluid production after 2 weeks of immobility, with such changes persisting for more than 30 weeks even with interrupted immobility.[14] In this study, all patients underwent daily physical therapy during hospitalization in the ICU, in line with RDC. 7 of the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária* - ANVISA).[15] During physical therapy, the patients received respiratory care in addition to therapeutic movement and positioning to preserve the complete mobility of joints, but nonetheless, there was a loss in ROM.

The impact of specific treatment aimed at maintaining the ROM in this profile of critically ill patients is scarce, and the majority of early mobilization protocols [4,7,16-19] do not prioritize stretching, maximum range of movement and stretched positioning. Such a macroscopic view cannot take into account the demands and basic principles for maintaining musculoskeletal integrity and may explain the loss in the patients studied despite the use of conventional physical therapy.

Neurological patients comprised 40.9% of the sample, with a Glasgow mean of 11.0±2.3. During the study period, the unit in question had no sedation interruption protocol. No neuromuscular blocking agents were used; however, 68.2% of the sample were given some sedative substance, with a mean of 6.2±2.1 days and a daily RASS scale of -3.4±1.1, in keeping with the modality of "moderate sedation." Such findings may be related to the loss of ROM, as reported in previous studies.[2,20,21]

The APACHE II score for the population in question was 28.5±7.3, characterizing the sample as critically ill patients with high mortality in 24 hours. This factor is important for most cases of immobility and prolonged hospitalization. Another aspect to be considered is that the population had a mean age of 53.5±17.6 years, which is considered low. Such an economically active age group of individuals reinforces Herridge et al.'s work,[18] which showed that in 33% of cases, the critically ill patient suffered a decline in physical function related to an inability to carry out her/his original work activities even after 5 years of internment. This parallel is applicable to this research, as the population had previous functional independence as measured by the Barthel Index (88.8±19.0).

Neurological conditions were the main reason for admission in 40.9% of patients selected for the study. This result may be an influencing factor in the resulting loss of ROM, as already noted by Clavet et al.[2] Furthermore, the use of sedation in 68.2% of the population and the use of MV for an average of 12.0±6.3 days may contribute to the loss found.[19,22]

This study had the advantage of using an evaluation method that was easy to manage, had low cost and was minimally invasive, rendering it feasible in clinical practice. The findings should alert health professionals to a field of biomechanics that has been little noticed until this pilot study. The main limitation of this study was the small sample size, which limits conclusions as to whether hospitalization was the causative factor and also extrapolation of the results to other populations. The facts that the study focused only on the period within the intensive care unit and that it examined a cross-sectional cohort in the acute phase may have led to a possible recovery of the variable of interest. However, the results generated were objective and should serve as a starting point for the development of new follow-up studies that could elucidate the behavior of this variable of interest in larger populations and over longer time intervals. Only then would it be possible to correlate the results to risks and loss of functionality.

CONCLUSION

There was a tendency toward decreased joint range of movement of large joints such as the ankle, knee and elbow during hospitalization in the intensive care unit. The small sample size limits conclusions about possible causal factors but highlights the importance of measuring this variable in the intensive care unit.

RESUMO

Objetivo: Aferir a amplitude de movimento articular de pacientes graves durante o internamento numa unidade de cuidados intensivos.

Métodos: Estudo prospectivo e longitudinal, realizado em uma unidade de cuidados intensivos de um hospital público da cidade de Salvador (BA), no período de setembro a novembro de 2010. A principal variável avaliada foi a amplitude de movimento articular passiva, por meio da goniometria dos cotovelos, joelhos e tornozelos, no momento da admissão e na alta. Todos os pacientes internados no período foram incluídos, sendo excluídos aqueles com tempo de internamento <72 horas e com reduções da amplitude de movimento articular na admissão.

Resultados: A amostra foi composta por 22 indivíduos, com idade média de 53,5±17,6 anos, tempo de internamento na unidade de cuidados intensivos de 13,0±6,0 e de ventilação mecânica de 12,0±6,3 dias. O APACHE II foi 28,5±7,3, sendo que a maioria dos pacientes era independente funcional previamente ao internamento, com índice de Barthel prévio de 88,8±19. As perdas de amplitude de movimento articular foram 11,1±2,1°; 11,0±2,2°; 8,4±1,7°; 9,2±1,6°; 5,8±0,9° e 5,1±1,0°; para cotovelos, joelhos e tornozelos, respectivamente do lado direito e esquerdo (p<0,001).

Conclusão: Houve uma tendência de decréscimo nas amplitudes de movimento de grandes articulações, como tornozelo, joelho e cotovelo, durante o internamento em unidade de cuidados intensivos.

Descritores: Amplitude de movimento articular; Pacientes internados; Unidades de terapia intensiva

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