Effectiveness of a visual tool developed to promote adherence to early mobilization protocol and increase the out-of-bed mobilization rate for adult patients in the intensive care unit: a quality improvement before-and-after study

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Article

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Abstract

Background

The ABCDE bundle in critical care is recommended to reduce long-term consequences of intensive care unit (ICU) and to promote better outcomes for the patients. Early progressive mobilization, represented as letter “E”, despite of had been proposed as a safe strategy in intensive care unit, it is still considered challenging by the inherent ICU barriers and poor adherence to early mobilization protocol. Recently, the letter “F” was incorporated into the bundle, representing the patient’s family participation, which can optimize care and patient’s recovery. The aim of this study was to evaluate the effectiveness to improve the adherence to the early mobilization protocol after a quality improvement multifaceted strategy which resulted in the development of a specific visual tool, the “mobility clock”, in order to involve in the process beyond the healthcare professionals the patients, and family members.

Methods

A single-center before-after study was conducted using data from medical records or hospital electronic databases. A sample size of 88 patients per period was calculated to verify a reduction by 10% on the non-compliance rate with the institutional early mobilization protocol.

Results

Patients from different periods presented similar baseline characteristics. After the intervention, a decline in non-compliance with the protocol was observed compared to the previous period (10.11% vs. 26.97%, $p < 0.004$). Regarding mobility landmarks, the proportion of patients walking was significantly higher in the “after” period (49.44% vs. 29.21%, $p < 0.006$). The ICU readmission rate was lower on the “after” period (2.25% vs. 11.24%; $p = 0.017$).

Conclusions

The multifaceted strategy specifically designed to the institutional barriers was effective in increasing adherence to early mobilization protocol causing an increasing in the out of bed mobilization rate in the adult ICU of a tertiary hospital.

Background

The continuous improvement in critical illness survival has led to an increasing recognition of the long-term consequences of intensive care unit (ICU) care, regarding the physical and mental health function, in addition to the growing concern in the management of the patient during this period. At present, bundle ABCDEF is considered a remarkable strategy to optimize ICU care recovery and outcomes. Early

progressive mobilization, represented as “E” bundle component, has been proposed as a safe strategy to reduce ICU-acquired weakness which can cause a direct impairment of functional status that can perpetuate after hospital discharge, affecting the quality of life and social reintegration[1–7]. Although mobilization is considered essential and recommended to start immediately after physiologic stabilization, the number of patients mobilized out of bed is considered low and is less than predicted by known safety criteria and patient clinical condition[8,9]. The barriers to the ICU environment are considered multifactorial and may be related to the structural context, the process, and the ICU culture, in addition to patient-related factors[5,8–13]. Challenging the mobility level must consider the barriers present at the moment[14] and, therefore, a multidisciplinary approach towards early mobilization (EM) is recommended to set strategies to face previously identified barriers[15–22].

The first early mobilization protocol was developed in adult ICUs in 2011, and its use started in the same year. It was elaborated with four progressive intervention plans based on the Medical Research Council (MRC) grading system to evaluate patients who are alert and attentive; otherwise, the Surgical Intensive Care Unit Optimal Mobilization Score (SOMS) [23]. In 2018, the evidence-based knowledge on early mobilization was reviewed, leading us to prioritize mobilization whenever possible. Based on that update process, mobilization was considered as any movement against gravity that involved axial loading (landmark mobility of sitting over the edge of bed or greater level) named in our institutions as “verticalization rate”. Based on this concept, we started to quantify the proportion of patients who were mobilized out of bed, as prioritized in our protocol, as well the proportion of non-compliance with the protocol (prevalence of patients who despite not having contraindications were not mobilized out of bed).

Every month since 2018, a one-day point-prevalence collection is performed by a physical therapist (without the previous team knowledge), to verify the proportion of patient’s mobilized out of bed through the patient’s medical record from the preceding 24 hours, as well as the reasons not to mobilize and barriers involved. For any uncertainties concerning an active questioning of the employers on duty can be performed.

Analysis of preliminary data of this indicator demonstrated that our verticalization rate was 36.3% and the non-compliance rate with the protocol was 24%, considered as a nonconformity once some level of verticalization was expected in those patients[24].

Based on this data and multidisciplinary perception, consolidated in a workshop, a multifaceted improvement strategy was proposed. The aim of our study was to evaluate the effectiveness of these strategies in improving the verticalization rate and reducing the non-compliance rate with the protocol.

Methods

Ethics approval and consent to participate

We received ethics approval from the research ethics committee of the Hospital Sírio Libanês/ Sociedade Beneficiente de Senhoras (CEPesq/HSL), with a reference number: CEPesq HSL2019-84. This committee in addition to releasing the research protocol, waived Informed consent form since the study was a retrospective review ofdata from the medical records or hospital electronic database. The methods were carried out in accordance with the relevant guidelines and regulation.

Project design

The study was conducted at the Sírio-Libanês Hospital, São Paulo, Brazil. The multifaceted improvement strategy was evaluated using a before-after study (Figure 1). The data were collected based on the physiotherapy service indicator of the out-of-bed mobilization rate. Consecutive patients who meet the inclusion and exclusion criteria of the study were part of the sample. Therefore, only patients aged > 18 years who were included in the indicator screening, without a mobility contraindication were considered. Contraindication was defined as any hemodynamic, neurological, or respiratory instability, medical contraindications, medical indication to priorities comfort measures, patient refusal, and admission or discharge day from the unit.

The “before” period corresponded to the previous months to the improvement strategy implementation, while the “after” period to the time following the executed intervention. The data were obtained in a decreasing and growing way in the months until the sample size was achieved.

This study is a quality improvement project, and the revised Standards for Quality Improvement Reporting Excellence (SQUIRE2) guidelines were followed.

Figure 1. Study design

Setting

During the study period, the adult ICUs consisted of 49-beds. Two general ICUs (21 beds), one neurological ICU (8 beds), and two cardiologic ICUs (20 beds). The staff was composed of a physician (staff-to-patient ratio 1: 5), registered nurse (staff-to-patient ratio 1: 2), and physiotherapist (staff-to-patient ratio 1: 5). A daily multidisciplinary round to determine the goals of care was performed in both periods, considering the ABCDEF bundle.

Data collection

Data were collected from admission to hospital discharge from medical records or hospital electronic databases. Patient baseline information including demographics, comorbidities, and severity of illness at ICU admission were obtained from Epimed Solutions ®.

The verticalization and non-compliance rate collection was made by the same professional in charge for the institutional indicator that used a standardized checklist, to maintain greater reliability and validity. We also considered variables related to risk factors as ICU-acquired weakness (ICU-AW) (mechanical

ventilation > 72 hours, sedation, analgesia, neuromuscular blockers, corticosteroids, sepsis, septic shock, and immobilism, defined as the permanence on bed for more than 50% of the day), related to the outcomes (length of stay, MRC or SOMS, and barriers for mobilization), and the highest achieved mobility landmark of the day, those information's were collected by the project researchers through our institutional electronic medical records. All perceived barriers were also recorded. If any patient's information was missing, the researchers or the professional in charge of the institutional indicator could access the assistance team. The checklist and the spreadsheet used to compute de data were double-checked to avoid any data loss or incomplete data.

Improvement strategy

To elaborate the improvement strategy, initially, we performed a summary of the evidence considering out-of-bed mobilization. Posteriorly, we optioned to understand the problem in the perception of the multidisciplinary team through a brainstorming during a workshop freely listed by the participants, with results were grouped in an Ishikawa diagram, and an online multiple-choice questionnaire. Both addressing the modifiable barriers related to environment, patient, staff, and process. Finally, the team perception was paired with the data obtained from a meticulous verification of the patient's medical records to elucidate modifiable barriers involved in the cases of patients who were able to be mobilized and were not[24].

After analyzing the results of these activities, it was verified the importance of improving communication between the characters involved, planning, and individualizing the process considering the specific barriers at the moment, in addition to including the patient and family more actively. Considering these points, a visual tool was developed named as "mobility clock" (Figure 2) to simultaneously quantifies, informs, and monitors the patient's functional level. This, instead of hours, it displays the different landmarks of mobility based on the ICU mobility scale[25].

An action plan was prepared and set in motion to inaugurate the mobility clock in the week of mobilization. To sensitize the team about the importance of early mobilization, the weak was opened with a talk show where a patient who developed quadriplegic and his family members, in addition to the professionals involved in the care, shared their experience during the period of hospitalization in the ICU and the impact of this, after hospital discharge. During this week, a lecture was given with updated data from the literature on out-of-bed mobilization in the ICU, demonstrating at the end the result of the internal audit of our modifiable barriers and presenting the "mobility clock" through an animation produced specifically to explain its development and application. At the end a challenge that lasted four weeks, was opened, to formalize and establish its use in a routine way by the team. During this period a podcast explaining how to use the "mobility clock" and the challenge rules was broadcasted on the institution's channels. Banners referring to mobility were displayed at the entrance of each unit and to motivate the staff to the cause stickersand chocolates were distributed [25].

The “mobility clock” was fixed in the ICU rooms to be visible to the patient, family, and staff.Instead of hours, it displays the different landmarks of mobility. One clock pointer marks the mobility level that was set as the goal and the other the landmark that was performed by the patient. To improve the communication in the multidisciplinary round, the expected goal per patient was determined considering the barriers presented, as well as the physical condition of each individual. At this time, if possible, the importance of reaching the chosen mobility landmark on the day was explained to the patient and family. The clock hand that corresponded to the landmark achieved by the patient was moved during the day as soon as the mobility level was reached.

During the intervention period, no other institutional strategy regarding early mobilization was employed.

Figure 2. The mobility clock monitors the level of mobility in the intensive care units of Hospital Sírio-Libanês and is based on the ICU mobility scale. It presents ten mobility milestones (the higher the score, the higher the mobility level achieved by the patient). One of the hands of the clock represents the mobility level planned by the multidisciplinary team for the patient during the shift (goal), and the other, represents what was achieved. In the example above, the objective elaborated by the team was to “march on spot” (level 6) and the milestone achieved was to “sit on the edge of bed” (level 3). Thus, the objective was not reached because the level of mobility achieved was lower than planned.

Statistical analysis

The sample size (at least 88 patients per period) was calculated based on a previous pilot study considering the number necessary to reduce the non-compliance with the protocol on 10%, given a two-tailed type 1 error of 5% and a power of 80%. Quantitative continuous variables were compared using the Mann–Whitney U test for non-normally distributed variables with interquartile values used to represent data dispersion. The means of normally distributed variables were compared using Student’s t-test. Pearson’s chi-squared test and Fisher’s exact test were used to compare the categorical variables. The significance level was set at $p \leq 0.05$ (two-tailed).

Results

To achieve this, it was necessary to monitor the verticalization rate for a period of four months before and after the intervention. The verticalization rate without excluding patients with contraindications before the intervention was 36.3%, while it was 45.2% after the intervention. In the “before” period, 179 patients were screened. Of these, 90 were excluded because they presented at least one mobility contraindication. During the “after” period, 177 patients were screened, with the exclusion of 88 patients, remaining 89 patients on this period (Figure 3). Both groups had similar baseline characteristics (Table 1).

Figure 3. Study sample flowchart

The risk factors for ICU-AW presented at indicator data were similar between the groups except for the use of corticosteroids that was significantly greater in the “after” period (29.21% vs. 14.61%, p = 0.02) (Table 2). Regarding the perceived barriers, the need of non-invasive ventilation (6.74% vs 1.12%, p=0.12) and mechanical ventilation (11.24% vs 4.49%, p=0.16) was greater in the “after” period, however, no statistical significance was achieved (Table 3).

The ICU-AW identified by means of an MRC < 48 was similar between the groups. The proportion of patients whose MRC was not possible to be applied, requiring SOMS to be performed, was higher in the “after” period but without statistical significance (Table 4).

After the intervention, a lower non-compliance rate with the protocol was observed, compared to the previous period (10.11% vs. 26.97%, p<0.004) (Figure 4). Considering the mobility landmark, the proportion of patients walking was higher in the “after” period compared to the “before” period (49.44% vs. 29.21%, p=0.006), as well the stationary march that was performed in 4.49% of the patients on the “after” period while it was not performed on the period before intervention (p=0.04) (Figure 5).

Figure 4. Institutional protocol non-compliance rate

Figure 5. Proportion of highest mobility landmark achieved

No differences between the periods were observed in the hospital and ICU length of stay, as well as in the mortality rate. However, the ICU readmission rate was lower on the “after” period (2.25% vs. 11.24%, p=0.017) (table 5)

Discussion

Early mobilization is primordial to be performed in the ICU to prevent a loss of functional status that can perpetuate after hospital discharge, affecting the quality of life and social reintegration[1-7]. Besides considered feasible in cases of a favorable clinical condition and without any contraindications, out-of-bed mobilization frequently does not occur due to the barriers involved often modifiable in the ICU environment. In this way the non-compliance with early mobilization protocols can be secondary to failure to identify institutional barriers as well as failure to develop strategies to overcome it. The mobility clock was elaborated after understanding the problem of our institution considering the barriers not only perceived by professional in clinical practice but also verified through an active search in specific cases of non-compliance with our protocol. In this tool and in the way in which its use was oriented our institutional barriers related to environment, patient, staff, and process was integrated. After its development, strategies to sensitize and educate healthcare professionals, patients, and family members to prioritize out-of-bed mobilization were developed as well an execute strategic plan was done as recommended in literature[5,16,18]. Our institutional quality indicator of non-compliance rate with early mobilization protocol was used to verify the efficiency of our multifaceted strategy as the last stage foreseen in the quality improvement (QI) process[1].

There was no difference between the units in the before-after period in relation to the other items proposed in the evidence-based guide bundle ABCDEF, except for the proposed strategy directed to early mobilization. In this intervention, in addition to the creation and implementation of a specific visual tool of care management, at bedside, we also included the patient and family in a more active way in the process, as recommended most recently with the inclusion of the item “F” in the bundle, to optimize ICU patient recovery and outcomes[7].

The results during the monitored periods were similar regarding the risk factors for ICU-AW and perceived barriers. The reduction of non-compliance rate with the protocol for mobilization, suggests that the multifaceted intervention was effective in the short term to achieve our goals, in accordance with results from previous QI studies[16-18].

We believe that as well the lower non-compliance rate with the increase observed in highest level of mobility landmark archived in after period may be a result of the individualized discussion per patient, during the definitions of multidisciplinary goals considering the modifiable barriers present at moment, that improved the adherence and performance of the multidisciplinary team in addition to improving the communication. The visualization of the mobilization objective of the day moreover to continually demonstrating to the team the landmark to be reached on the day, may have led the patient and/or family members to perceive that out-of-bed mobilization in addition to being important, is feasible and safety in the ICU, making them partner in the process.

In the post-intervention period, a decrease in readmission rate was observed. It is important to note that this study was not designed to investigate this primary purpose. Certainly, it is an important data to be confirmed in further studies since after a long-term ICU stay (>72h), one year mortality was approximately 28% and was related to age, disease severity, comorbidities, and ICU re-admissions[26].

A limitation of our study was the before-and-after design that carries the biases inherent to the temporal variation and the impact of confounders that were not considered, as well as the single-center QI limiting the external validity. Further research on this topic should be implemented, including multicenter prospective randomized studies focusing on the clinical and economic outcomes of mobilization QI projects.

Conclusion

The multifaceted strategy was effective in increasing the rate of mobilization out of bed and achieving a higher level of landmark mobility in the adult ICU of a tertiary hospital.

Abbreviations

ICU
intensive care unit
MRC

medical Research Council
SOMS
surgical Intensive Care Unit Optimal Mobilization Score
ICU-AW
intensive care unit acquired weakness
BMI
body mass index
SAPS 3
Simplified Acute Physiology Score
SOFA
Sequential Organ Failure Assessment
DM
diabetes mellitus
SAH
systemic arterial hypertension
CKD
chronic kidney disease
HF
heart failure
COPD
chronic obstructive pulmonary disease
MV
mechanical ventilation
NMB
neuromuscular blocker
MCAD
Mechanical circulatory assist device
VADs
vasoactive drugs
RST
renal supplementation therapy
ETT
endotracheal intubation
NIV
non-invasive ventilation
HFNC
high flow nasal cannula.
QI
quality improvement

Declarations

Ethics approval and consent to participate

The study received an exemption from ethics review from Hospital Sírio Libanês Ethics Committee. Data were managed according to hospital privacy policies.

Consent for publication

Not applicable. This manuscript does not contain any data from any individual person.

Availability of data and materials

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

PNS conceptualized and designed the study, analyzed the data, reviewed, and revised the manuscript and approved the final manuscript as submitted. JBK conceptualized and designed the study, collected the data, reviewed, and revised the manuscript and approved the final manuscript as submitted. ASL collected the data, approved the final manuscript as submitted, JMM: collected the data, approved the final manuscript as submitted ALVM: revised the manuscript and approved the final manuscript as submitted LP: revised the manuscript and approved the final manuscript as submitted. WPY: Provided intellectual contribution during the project elaboration, reviewed, and revised the manuscript and approved the final manuscript as submitted.

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Tables

Table 1. Baseline characteristics

	Before	After	p
	(89 patients)	(89 patients)	
Female, n (%)	36 (40.45)	31 (34.83)	a 0.44
BMI, median (interquartile)	25.6 (23.1–29.35)	25.9 (23.4–28.4)	c 0.73
SAPS- 3, mean (± standard deviation)	46 (13.5)	44.9 (13.5)	d 0.56
SOFA, median (interquartile)	3 (1–5)	3 (1–5)	c 0.94
ICU admission reason, n (%)			a 0.69
Emergency surgery	6 (6.74)	6 (6.74)	
Elective surgery	22 (24.72)	27 (30.34)	
Clinic	61 (68.54)	56 (62.2)	
DM, n (%)	28 (31.46)	32 (35.95)	a 0.53
SAH, n (%)	49 (55.06)	52 (58.43)	a 0.65
CKD, n (%)	15 (16.85)	13 (14.61)	a 0.68
HF n (%)	23 (25.84)	13 (14.61)	a 0.06
COPD/asthma, n (%)	9 (10.11)	11 (12.36)	a 0.63

a Pearson chi-square, c Mann–Whitney, d t student

BMI, body mass index, SAPS 3, Simplified Acute Physiology Score, SOFA, Sequential Organ Failure Assessment, ICU: intensive care unit, DM, diabetes mellitus, SAH, systemic arterial hypertension, CKD, chronic kidney disease, HF, heart failure, COPD, chronic obstructive pulmonary disease

Table 2. Risk factors for ICU-AW

	Before	After	p
	(89 patients)	(89 patients)	
MV > 72 hours, n (%)	7 (7.87)	8 (8.99)	b 1
Sedation > 72 hours, n (%)	7 (7.87)	8 (8.99)	b 1
Analgesia, n (%)	11 (12.36)	19 (21.35)	a 0.19
NMB, n (%)	2 (2.25)	1 (1.12)	b 1
Septic shock, n (%)	9 (10.11)	11 (12.36)	b 0.81
Sepsis, n (%)	20 (22.47)	14 (16.09)	a 0.28
Corticosteroids, n (%)	13 (14.61)	26 (29.21)	**a 0.02**

a Pearson chi-square, b Fisher

MV: mechanical ventilation, NMB: neuromuscular blocker

Bold values denote statistical significance at the $p \leq 0.05$ level

Table 3. Perceived barriers

	Before	After	p
	(89 patients)	(89 patients)	
Sedation	4 (4.49)	8 (8.99)	b 0.54
Devices	37 (41.57)	48 (53.93)	a 0.10
MCAD	3 (3.37)	2 (2.25)	b 1
VADs, n (%)	14 (15.73)	12 (13.48)	a 0.67
RST	5 (7.87)	6 (6.74)	b 1
Pain	11 (12.76)	19 (21.35)	a 0.11
Weakness	25 (28.09)	23 (25.84)	a 0.74
ETT, n (%)	2 (2.25)	5 (5.52)	b 0.44
Tracheostomy, n (%)	9 (10.11)	7 (7.87)	b 0.79
MV, n (%)	4 (4.49)	10 (11.24)	b 0.16
NIV, n (%)	1 (1.12)	6 (6.74)	b 0.12
HFNC, n (%)	3 (3.37)	3 (3.37)	a 1

a Pearson chi-square, b Fisher

MCAD: Mechanical circulatory assist device, VADs: vasoactive drugs, RST: renal supplementation therapy, ETT: endotracheal intubation, MV: mechanical ventilation, NIV: non-invasive ventilation, HFNC: high flow nasal cannula.

Table 4. ICU-AW

	Before	After	p
	(89 patients)	(89 patients)	
MRC, n (%)			
0–23	8 (8.99)	1 (1.12)	a 0.06
24–35	4 (4.49)	3 (3.37)	
37–47	18 (20.22)	12 (13.48)	
48–60	45 (50.56)	50 (56.18)	
MRC < 48, n (%)	44 (49.44)	39 (43.82)	a 0.45
SOMS	14 (15.73)	23 (25.84)	b 0.13

a Pearson chi-square, b Fisher

MRC: Medical Research Council Scale, SOMS: Surgical Intensive Care Unit Optimal Mobilisation Score

Bold values denote statistical significance at the $p \leq 0.05$ level

Table 5. Hospital and ICU length of stay, hospital and ICU death and readmission rate

	Before	After	p
	(89 patients)	(89 patients)	
ICU days, median (interquartile)	4 (2–10.50)	3 (2–11)	c 0.53
Hospital days, median (interquartile)	15.5 (7.75–32)	15 (7–34)	c 0.91
Hospital death, n (%)	11 (12.79)	7 (8.64)	a 0.38
ICU death, n (%)	4 (4.49)	3 (3.37)	a 0.70
ICU readmission, n (%)	10 (11.24)	2 (2.25)	**a 0.017**

a Pearson Chi-Square, c Mann- Whitney

Bold values denote statistical significance at the $p \leq 0.05$ level

Figures

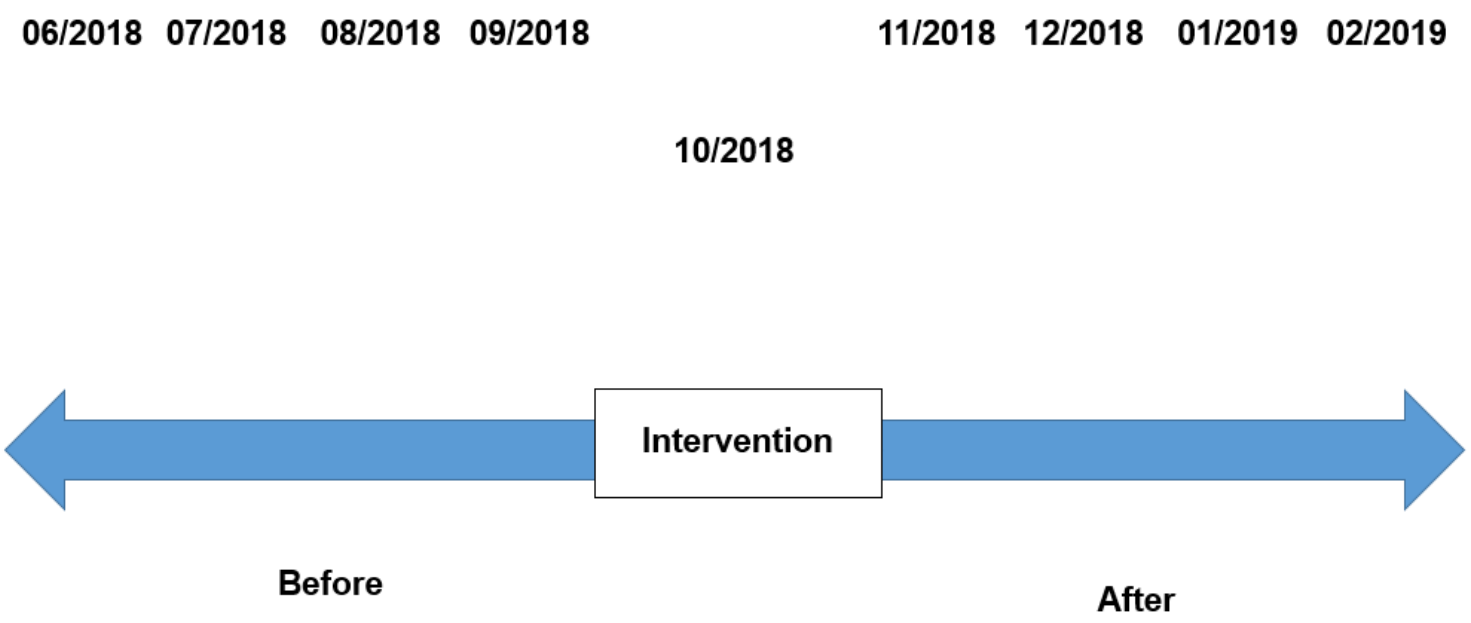

Figure 1

Study design

Figure 2

The mobility clock monitors the level of mobility in the intensive care units of Hospital Sírio-Libanês and is based on the ICU mobility scale. It presents ten mobility milestones (the higher the score, the higher the mobility level achieved by the patient). One of the hands of the clock represents the mobility level planned by the multidisciplinary team for the patient during the shift (goal), and the other, represents what was achieved. In the example above, the objective elaborated by the team was to “march on spot” (level 6) and the milestone achieved was to “sit on the edge of bed” (level 3). Thus, the objective was not reached because the level of mobility achieved was lower than planned.

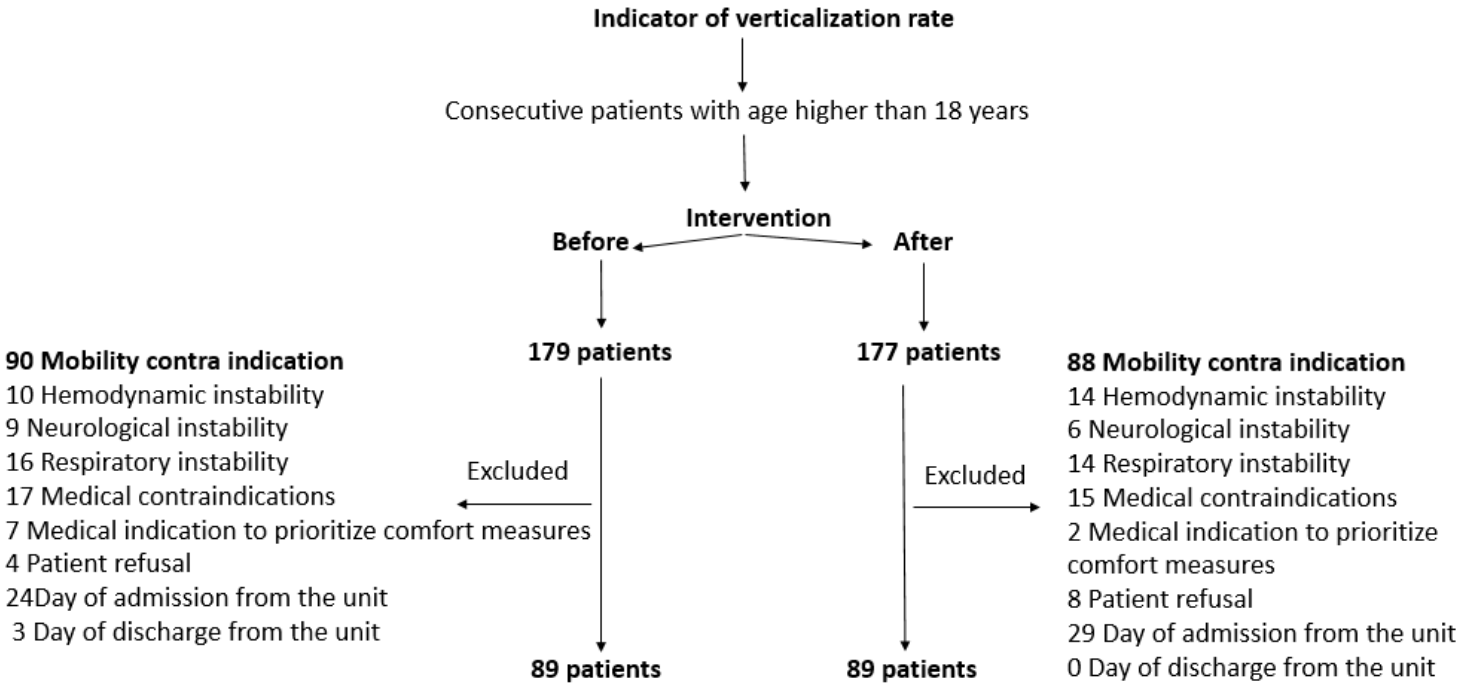

Figure 3

Study sample flowchart

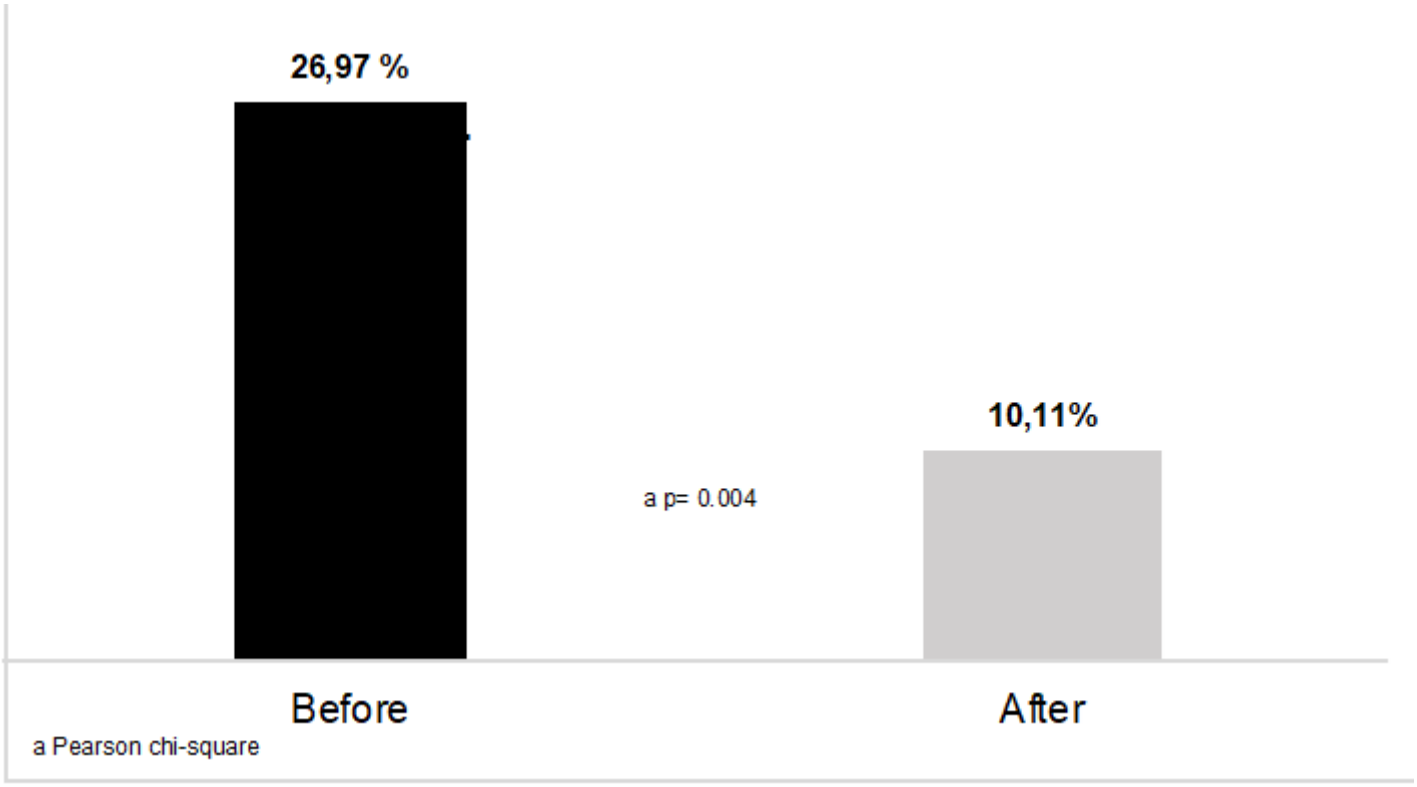

Figure 4

Institutional protocol non-compliance rate

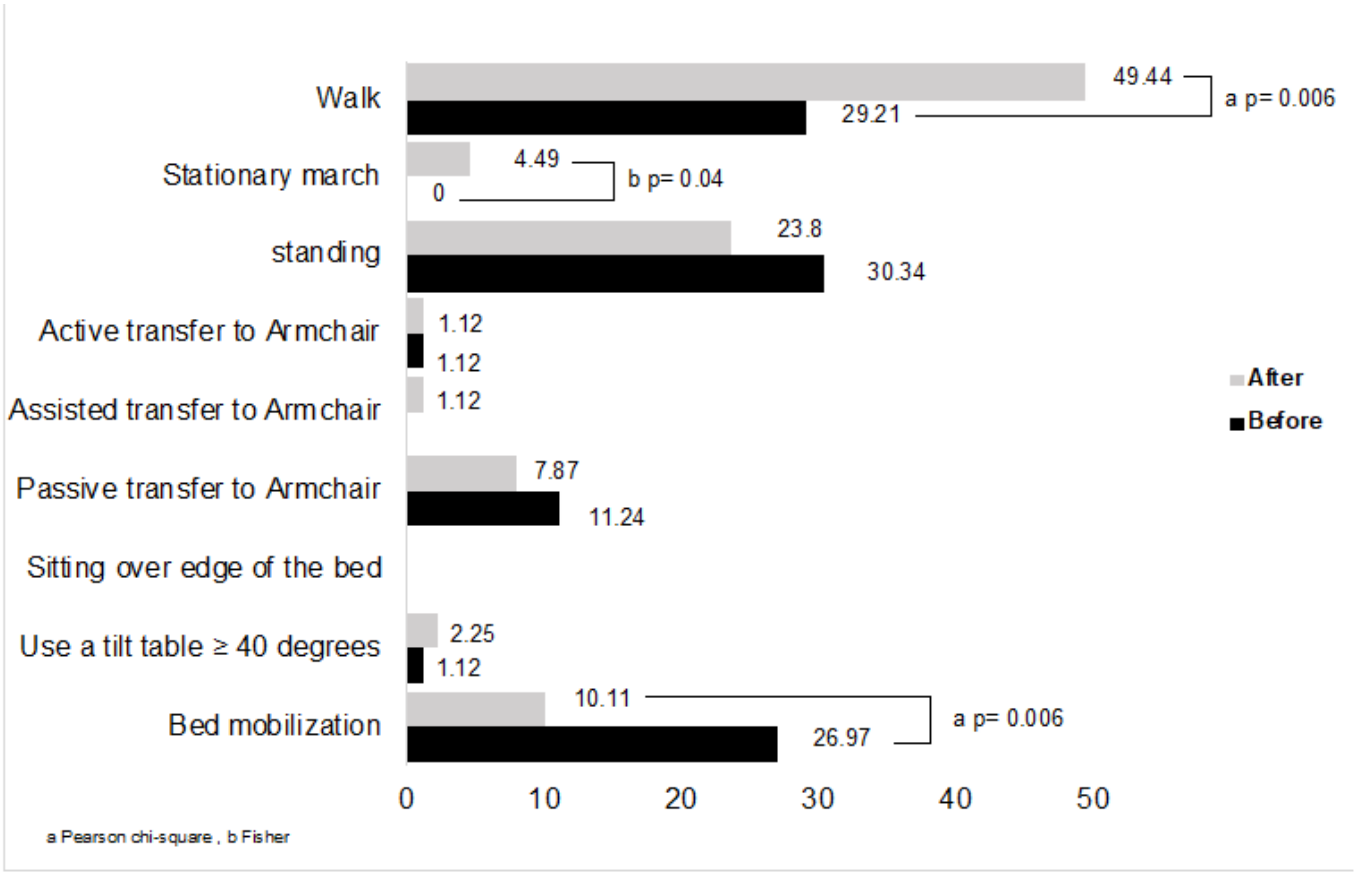

Figure 5

Proportion of highest mobility landmark achieved