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## Review Article

# Dynamic physiotherapy for all patients admitted to the ICU according to their clinical status—describing a quality improvement program

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## Abstract

Immobilization and prolonged bed rest is associated with many complications, including delirium, muscle atrophy, decubitus ulcers, atelectasis, and bone demineralization. Early mobilization strategies in the ICU are safe and may result in the prevention and reduction of critical illness polyneuropathy, delirium, ICU and hospital length of stay, may decrease mortality during hospitalization, and improve the patient's quality of life after hospital discharge.

We agreed upon a quality improvement program for ICU, proposed by a multidisciplinary team with the objective to improve the quality of care through the mobilization of patients admitted to the ICU, and consequently improve clinical outcomes of the disease, decrease delirium, mechanical ventilation days and length of stay, and improve the functional capacity of patients at ICU discharge. It is a program divided in 7 phases, from 0 (most instability) to 6 (selected patients stable enough to go out to exterior areas of the hospital but not to be discharged from ICU), that can include all patients admitted to ICU in any of them. One of the differentials of our program compared to others is the inclusion of all patients in one of the mobilization phases (even in the period of maximum instability, some type of mobilization can be applied in a protocolized manner). We also contemplate the precocity of the intervention (always respecting the stability of patients), starting at the same time of admission, while the literature describes the beginning of mobilization after 24-72h of admission to ICU. After a period of implementation, efforts will be made to measure the target variables and compare them with those of a pre-implementation period of the quality improvement program.

## Background

Immobilization and prolonged bed rest is associated with many complications, including muscle atrophy, decubitus ulcers, atelectasis, and bone demineralization [1]. Patients who stay several days in intensive care unit very frequently develop a condition called critical illness polyneuropathy, with a multifactorial etiology and several independent risk factors for their development: severity of the disease, the presence of Systemic Inflammatory Response Syndrome (SIRS), organ

failure, days of mechanical ventilation and length of stay in ICU, metabolic alterations, in addition to the use of potentially myotoxic or neurotoxic drugs, such as corticosteroids and neuromuscular relaxants [1].

Immobility and local and systemic inflammation act synergistically by promoting significant muscle loss in the critically ill patient [1-4]. Prolonged bed rest leads to decreased protein synthesis in the muscle, increases urinary nitrogen excretion (indicating muscle catabolism) and decreases muscle

mass, especially in lower extremities [1]. The negative effects of these changes cause between 1%-1.5% loss of strength in the quadriceps for each day of rest in bed, with greater impact for elderly patients [1]. After 7 days of mechanical ventilation, 25% to 33% of patients have significant muscle weakness, which acts in a vicious circle prolonging the duration of mechanical ventilation and length of stay in ICU [5,6]. Upon discharge from ICU, patients also have decreased fitness and exercise tolerance [1,5,6].

Early mobilization strategies in the ICU may result in the prevention and reduction of critical illness polyneuropathy, delirium, ICU and hospital length of stay, may decrease mortality during hospitalization, and improve the patient's quality of life after hospital discharge [1-4,7-10]. The early mobilization for critical patient, according to the literature, is defined as a series of progressive physical activities that may induce an acute physiological response (improving ventilation, central and peripheral circulation, muscle metabolism and attention) [10-12], which begin the day after admission to the ICU.

There is no unanimity for the optimal time for initiate mobilization on ICU, but it is generally considered appropriate to start it when physiological stabilization is achieved, which considers neurological, respiratory and cardiovascular stability [9,13]. The systematic use of mobilization protocols is one of the strategies used by multidisciplinary teams to facilitate the progression of mobilization activities during the hospitalization of a patient, in addition to ensuring greater safety in therapeutics [2,8,10,11,13].

In general, protocols are based on the progression of mobilization according to neurological function, cardiorespiratory stability and limb muscle strength [11,12]. Even passive mobilization strategies have demonstrated significant beneficial root effects at the cellular level, confirming the positive effect of early onset of rehabilitation in critical patients with mechanical ventilation and deep sedation [2,8,12]. Those movements include the elevation of the head of the bed, postural changes, passive exercises, assisted assets and subsequently active exercises in bed, seat in bed, seat in armchair, seat on the edge of the bed, and wandering.

Mobilization of critical patients is safe; in all published studies, the percentage of serious complications resulting from mobilization is less than 1% [1,10,11]. But upon initiation of mobilization activities, it is necessary to assess whether the patient meets the inclusion criteria and especially if he does not present contraindications for it, which should be evaluated on a daily basis, taking into account the warning signs of complications or instability [10,11]. It is also recommended that a broader assessment that includes the medical history, review of prior and current medication, prior activity and mobilization capacity, cardiovascular and respiratory reserve, and a daily assessment of other factors that may hinder or counterproductive mobilization (neurological, hemodynamic and respiratory instability, hemoglobin <7.0g/dL, platelet count <20,000 cells, fever, glycerite, agitation, pain, fatigue, emotional state, orthopedic contraindications, etc.) [10].

## Supporting

Considering all that has been said above, we perceived the need to apply a quality improvement program in our ICU, forming a multidisciplinary team of intensivist and rehabilitative physicians, physiotherapists, nurses, nursing assistants and orderlies. The objective is to improve the quality of care through the mobilization of patients admitted to the ICU, trying to exclude or minimize the harmful concept of absolute rest in bed, applying the appropriate techniques and exercises to each patient at each stage of their disease. One of the differentials of our program compared to others is the inclusion of all patients in one of the mobilization phases (even in the period of maximum instability, some type of mobilization can be applied in a protocolized manner). We also contemplate the precocity of the intervention (always respecting the stability of patients), starting at the same time of admission, while the literature describes the beginning of mobilization after 24-72h of admission to ICU. This seems important, given that not all patients are unstable at admission, but that many enter the ICU for intensive surveillance, and in some cases, as in patients who enter for immediate postoperative thoracic surgery, respiratory physiotherapy is initiated before surgery. In addition, the success of a mobilization program can vary greatly depending on the characteristics of each intensive care unit, the material and human resources available, and the cultural change in mobilization, so it is important to assess the implementation of the different programs and protocols available in other centers individually.

It is essential to create a safe environment to promote the mobilization of critical patients, many of them with physical injuries, under sedation or vasopressors infusion, with drains, catheters and tubes. To this end, is essential training of staff, with training sessions over time, initiating patient interventions from the ones with less risk and progressively applying the entire protocol, and allowing the discussion and participation of all staff members in the process.

This program has been newly implemented in our unit, having not been observed, in those few months, any adverse events or complications that compromise the safety of patients.

## Objective

The objectives of this Quality Improvement program are:

- To form a multidisciplinary team to apply mobilization in patients admitted to intensive care unit, including those receiving invasive mechanical ventilation.
- To establish safety criteria that allow patients admitted to the ICU to be included in the mobilization protocol, establishing inclusion and exclusion criteria, as well as the ones for interruption of the protocol, through the joint daily assessment of the patient upon initiation of mobilization.
- To prevent post-ICU syndrome, decreasing neuromuscular complications that can occur after stay in ICU, and that can be short, medium and long-term limitations, also implying the lower incidence of

delirium and mechanical ventilation days, improving the quality of life of patients at ICU discharge.

- To plan and agree each intervention carefully, according to the severity of the patient, with sufficient time and staff, to ensure at all times the medical and physical safety of the patient.

### Quality improvement program

**Inclusion criteria:** All patients admitted to ICU.

**Exclusion criteria:** Defined in each phase.

**Definition of clinical stability:** It is essential to evaluate individualized and according to the whole health care staff, subject to change at any time.

### Respiratory

- Safe airway.
- Ratio between partial oxygen pressure and inspired oxygen fraction ( $\text{PaO}_2/\text{FiO}_2$  or  $\text{PaFi}$ )  $>200$  with  $\text{FiO}_2 <0,5$  and Positive End-Expiratory Pressure (PEEP)  $<10$ .

### Hemodynamic

- Mean Arterial Pressure (MAP)  $>65\text{mmHg}$  + noradrenaline (NA)  $<0,2\text{mcg/kg/min}$  and/or Dobutamine (DBT)  $<8\text{mcg/kg/min}$ .
- Heart rate (HR)  $<140\text{bpm}$  or  $>40\text{bpm}$ .
- No active bleeding.

### Neurological

- Agitation control, score on Richmond Agitation-Sedation Scale (RASS)  $+1$  or lower.
- Pain control, score on Visual Analog Scale (VAS) or Verbal Numerical Rating Scale (VNRS)  $<4$ .
- Intracranial pressure (ICP)  $<15$ .

### Infectious

- Temperature  $<38^\circ\text{C}$ .

### Mobilization Interruption Criteria

#### Respiratory:

- Respiratory rate (RR)  $<10\text{bpm}$  or  $>35\text{bpm}$ .
- Oxygen Saturation ( $\text{SpO}_2$ )  $<88\%$ .
- $\text{PaFi}$   $<200$ .
- Patient misfit from the mechanical ventilator.

#### Hemodynamic

- MAP  $<65\text{mmHg}$  and NA  $>0,2\text{mcg/kg/min}$  or DBT  $>8\text{mcg/kg/min}$ .
- Systolic arterial pressure (SAP)  $>200\text{mmHg}$  and MAP  $>100\text{mmHg}$ .

- HR  $>140\text{bpm}$  or  $<40\text{bpm}$ .
- Active bleeding.

### Neurological

- Agitation that has needed “extra” sedative medication in the last 30 minutes.
- RASS  $\geq +2$ .
- Seizures.
- Uncontrolled pain (VAS or VNRS  $>4$  or ESCID  $>4$ ).

### Infectious

- Temperature  $>38^\circ\text{C}$  with hemodynamic instability or clinical repercussions.

### Restrictions

Stable patients at risk of instability due to regional involvement (limb fracture, unstable spinal injury or spinal injury, surgical intervention, venous thrombosis...), will be considered suitable for mobilization with appropriate restriction, agreed between the medical treatment teams. To better identify those patients, after the number of the mobilization phase it will be placed a R (restriction) to call the attention for a restrictive situation.

### Phases of mobilization in icu

**Phase 0-Postural care:** It is an alert phase, in which the patient is in a period of maximum instability (hemodynamic, respiratory or neurological). At this stage, the recommendation is the absolute rest in bed, with the patient unconscious and/or under deep sedation, and strictly necessary postural care will be performed (e.g. rotation of the position of the head in patients in prone decubitus), until patients regain some stability and can move on to the next phase.

**Phase 1-Passive exercises in bed+Postural changes:** It is the initial phase of the mobilization itself. The patient may be still instable, or even with fluctuating stability. It is applied to patients with moderate-deep sedation, coma or immobilized by a neurological cause, unable to collaborate, with RASS  $-2$ .

Passive limbs mobilization and postural changes should be initiated at this stage (if the patient's clinical and orthopedic situation allows). Passive mobilization should be performed 2-3 times a day (1 time per shift, depending on the workload and respecting the patient's night rest), lasting 15-20 minutes per session. Postural changes should be made every 2-4 hours.

It will be attempted to raise the headboard of the bed to chair position 70 degrees, except medical contraindication, twice a day.

The family can be taught and encouraged to participate in the process, in selected cases, by instructing them to always perform the exercises with the previous authorization of the staff members.



The objective at this phase is to achieve clinical stability and the withdrawal of sedation, in order to make progress possible to the next phase.

**Phase 2-Active-assisted and active in bed exercises:** Stable, conscious, and quiet patients with RASS -1/+1, with light sedation or no sedation, able to collaborate minimally.

Besides the activities of the first phase, active-assisted kinesitherapy in bed are added, lying or semi-incorporated, about 20minutes twice a day, according to tolerance. In patients with mechanical ventilation, initiation of the respiratory physiotherapy regimen should be assessed depending on the phase. Respiratory physiotherapy, including incentive spirometer exercises, should also be evaluated in patients without invasive mechanical ventilation. The family should be encouraged to participate on it. Patients may sit on bed on chair position if the clinical conditions allow it. If available, exercises could be performed with a cycle ergometer.

Cognitive exercises, supported by intelligent communication systems such as electronic tablets, and occupational therapy exercises can be initiated. The family may participate in the whole process, always after health education and with the authorization of the staff members for the mobilizations.

When the patient manages to raise his arms for more than ten seconds, he or she will be deemed to be able to move on to the next phase.

**Phase 3-sedestation:** Stable patients, without sedation or with light sedation, able to collaborate.

At this stage postural changes can be assisted by the patient. The previous phases guidelines are maintained, and limbs active exercises and chest control exercises are added, initiating the retraining to daily life basic activities. The main goal is to increase the strength of the chest, move the lower limbs against gravity (not indicated in recent abdominal surgery), sit in armchair, preparing to tolerate the body weight.

**This phase will be divided into 3 stages:**

- ❖ Passive mobilization to the armchair shall be carried out twice a day, without standing, using cranes and harnesses for passive transfer. The use of soft chest clamping in the chair should be considered for patients with inadequate chest control.
- ❖ With the help of staff members, the patient may seat at the edge of the bed twice a day. The mattress must be in the maximum inflation position. Foot support should be used so the patient can support the entire sole of the feet on a flat surface.
- ❖ The patient will be able to sit at the edge of the bed without the help of the staff members, although supervised by the physical therapist or nurse, especially in patient with mechanical ventilation.

It is important to encourage respiratory physiotherapy and effective coughing. The patient may use electronic devices for communication and cognitive activities, in addition to occupational therapy activities.

When the patient manages to keep the lower limbs elevated for more than ten seconds at the edge of the bed (except for recent abdominal surgery), he or she may move on to the next phase.

**Phase 4-Bipedestation and active transfer to armchair:** This phase applies to the patient without sedation, or with light sedation and RASS 0. The goal of this phase is the body weight tolerance and sit in armchair, training bipedestation, in addition to performing some daily living activities.

It includes the above guidelines, and adds sit in armchair twice a day, with active transfer, being the patient able to maintain the bipedestation, although he or she is not yet able to walk. We can progress in occupational therapy activities.

**This phase is also divided into stages:**

- ❖ The bipedestation and active transfer to the armchair is done with the help of the staff members (orderly, nurse and/or physical therapist).
- ❖ The patient can carry out transfer to armchair without the help of the staff members, although it must be supervised.

In selected cases, the patient can be accompanied to the sink using the wheelchairs adapted for this purpose.

**Phase 5-Walking:** At this stage the patient should be without sedation (although he or she may need analgesia at appropriate doses to tolerate the orotracheal or tracheostomy tube), and in addition to being able to perform the guidelines of the previous phases, he or she should initiate wandering. Invasive mechanical ventilation should not constitute a contraindication for walking. This phase goal is to regain wandering and autonomy for the daily living basic activities.

**It will be divided into 5 stages:**

- ❖ Patients in continuous invasive mechanical ventilation (with orotracheal tube or tracheostomy cannula) who can start the march, always with the help of staff members (three or more people, including an orderly, nurse and/or physical therapist and a doctor). At this stage cranes and harnesses will be used to increase the patient's safety, as well as a walker to facilitate mobilization. The patient must be monitored with a portable monitor, as well as all mechanical ventilation equipment.
- ❖ Patient in mechanical ventilation weaning phase, with several hours a day without mechanical ventilation, or weaned patient, who starts the march with the help of staff member (two or more people, including orderly and nurse and/or physical therapist). Cranes and harnesses will be used to increase patient safety, as well as a walking frame to facilitate mobilization. The patient should be monitored during wandering.
- ❖ The patient can walk with the help of a person, in addition to a walking frame. It is recommended to have a wheelchair nearby in case the patient gets tired and cannot continue the wandering. Patients with high-



flow nasal cannula oxygen therapy with low oxygen needs may be included in this phase.

- ❖ The patient can walk autonomously with the help of a walking frame. It is recommended to be accompanied by at least one person (orderly, nurse or physical therapist, depending on the clinical situation).
- ❖ The patient can walk autonomously and without the help of a walking frame. It is recommended to be accompanied by at least one person (orderly, nurse or physical therapist, depending on the clinical situation).

Basic activities of daily living (eating alone, combing, etc.) will be introduced progressively.

**Phase 6-Exit to the garden:** In this phase we will include, in selected cases, patients that are stable enough to make longer wanderings or who can be taken in a wheelchair outside the ICU until the garden or another exterior area. They may

or may not be in mechanical ventilation, depending on an individualized assessment by the equipment that serves the patient. The patient must be accompanied by a doctor, a nurse and/or a physical therapist and an orderly, with appropriate monitoring to each situation. The family should be invited to participate in the process.

**Human resources needed**

According to the severity of the patients, it is necessary that each planned treatment intervention has sufficient staff members (orderly, nurse, nurse manager, physical therapist, occupational therapist, doctors specialized in ICU and rehabilitation), who guarantee the patient’s physical and medical safety all the time. The family is also an interested part and must be involved in the process, always in selected phases, after health education and authorization by staff responsible for the patient. Interventions will be agreed daily between the medical staff responsible for the patient in the ICU and the rest of the health care team Table 1.

**Table 1:** Quality improvement program for patient mobilization in ICU.

Phase	Definition	Indication	Staff
0	<b>Postural care</b> Rest in bed at 30°-45°, except contraindication Postural care every 4 hours.	Unconscious patient, deep sedation. Cardiovascular, respiratory or neurological instability.	Nurse±nurse manager±orderly.
1	<b>Passive in bed+postural changes</b> Passive limb mobilization. Bed seat (chair position 70°) twice a day (except contraindication for abdominal surgery until authorization by responsible surgeon, or other restriction).	Unconscious patient, with moderate-deep sedation or muscle weakness that does not allow active mobilization.	Nurse±nurse manager±orderly±physical therapist. Family (in selected cases, after health education and prior authorization of staff members).
2	<b>Active-assisted and active in bed</b> Exercises in bed, lying down or semi-incorporated. Active-assisted exercises and limb assets. Bed seating (except contraindication). Respiratory physiotherapy.	Conscious patient, with light sedation or no sedation, who cannot sit in chair because of muscle weakness or lack of cardiorespiratory reserve.	Nurse±nurse manager±orderly±physical therapist±occupational therapist. Family.
3	<b>Sedestation</b> Respiratory physiotherapy. Chest control exercises. Occupational therapy. Introduction to daily living activities.	Stable, conscious and collaborator patient with muscle weakness who is unable to stand up.	Nurse±nurse manager±orderly±physical therapist±occupational therapist. Family.
3a)	Passive transfer to armchair, without bipedestation, using or not crane, twice a day.		
3b)	Passive transfer to armchair and seat on the edge of the bed twice a day, with the help of staff members.		
3c)	Seating on the edge of the bed without help, with staff members supervision		
4	<b>Bipedestation - active transfer</b> Respiratory physiotherapy. Bipedestation and active transfer to armchair twice a day.	Patient conscious, stable and collaborative.	Nurse±nurse manager±orderly±physical therapist+doctor. Occupational therapist. Family.
4a)	With staff members help.		
4b)	With staff member supervision and walking frame assistance.		
5	<b>Walking</b> Respiratory physiotherapy. Occupational therapy. Wandering. Patient with mechanical ventilation.	Patient conscious, stable and collaborative, in weaning phase from mechanical ventilation or without it.	Nurse±nurse manager±orderly±physical therapist+doctor. Occupational therapist. Family.
5a)	Walk with the help of 2 or+people, using cranes and harnesses and walking frame.		
5b)	Walk with the help of 2 or+people, using cranes and harnesses and walking frame. Patient without continuous mechanical ventilation.		
5c)	Walk with help of 1 person and walking frame.		
5d)	Walk in an autonomous way with a walking frame.		
5e)	Walk autonomously without the help of a walking frame (with staff member’s supervision).		
6	<b>Out into the garden</b> Wheelchair–Walking frame.	Long-term patient, with clinical stability, in selected cases.	Nurse±nurse manager+orderly±physical therapist+doctor. Occupational therapist. Family
R	Patients at risk of instability due to regional involvement (fractured limb, unstable vertebral injury or spinal injury, surgical intervention, venous thrombosis...), will be considered suitable for mobilization with the appropriate restriction, agreed among the medical treatment teams.		

**Alarm/disruption criteria:** Tachycardia >140bpm, bradycardia <40bpm, tachypnea >35bpm, bradypnea <10bpm, SAP >200mmHg, MAP <65mmHg and NA>0,2mcg/kg/min or DBT>8mcg/kg/min, desaturation <88%, active bleeding, seizures, RASS+2, fever >38°C.



$$QI = \frac{\text{Number of patients in any phase other than 0}}{\text{Number of patients that could be in any phase other than 0}}$$

Figure 1: Quality indicator.

## Material resources needed

Ideally, to carry out mobilization and other rehabilitation exercises in ICU patients, several materials are needed to facilitate the tasks.

- Incentive spirometer
- Cycle ergometer
- Peak flow
- Wheelchair adapted for washing use
- Iron walking frame
- Foot support
- Cranes
- Harness for transfer from bed to armchair or for wandering
- Closed shoes with Velcro (must be brought by the family)
- Material of disclosure of the protocol among the personnel involved.

## Quality indicator

We use as a Quality Indicator (IC) the relationship between the number of patients being mobilized and the number patients that could be included in any phase of mobilization but phase 0 Figure 1.

The objective is that in the first year at least 50% of patients admitted to ICU are in one phase of the protocol other than phase 0.

After a period of implementation, efforts will be made to measure the target variables and compare them with those of a pre-implementation period of the quality improvement program. The points to be assessed will be neuromuscular atrophy, the incidence of pressure ulcers, the incidence of delirium, mechanical ventilation days, ICU and hospital length of stay, and the functional situation at the ICU and hospital

discharge, always adjusted to the severity of patients through scales (eg APACHE II, SOFA). In each of these points it should be assessed the dimension of the improvement observed.

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