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Out-of-bed extubation: a feasibility study

Extubação fora do leito: um estudo de viabilidade

ABSTRACT

Objective: In clinical intensive care practice, weaning from mechanical ventilation is accompanied by concurrent early patient mobilization. The aim of this study was to compare the success of extubation performed with patients seated in an armchair compared to extubation with patients in a supine position.

Methods: A retrospective study, observational and non-randomized was conducted in a mixed-gender, 23-bed intensive care unit. The primary study outcome was success of extubation, which was defined as the patient tolerating the removal of the endotracheal tube for at least 48 hours. The differences between the study groups were assessed using Student's *t*-test and chi-squared analysis.

Results: Ninety-one patients were included from December 2010 and June 2011. The study population had a mean age of 71 years \pm 12 months, a mean APACHE II score of 21 ± 7.6 , and a mean length of mechanical ventilation of 2.6 ± 2 days. Extubation

was performed in 33 patients who were seated in an armchair (36%) and in 58 patients in a supine position (64%). There were no significant differences in age, mean APACHE II score or length of mechanical ventilation between the two groups, and a similar extubation success rate was observed (82%, seated group versus 85%, supine group, $p > 0.05$). Furthermore, no significant differences were found between the two groups in terms of post-extubation distress, need for tracheostomy, duration of mechanical ventilation weaning, or intensive care unit stay.

Conclusion: Our results suggest that the clinical outcomes of patients extubated in a seated position are similar to those of patients extubated in a supine position. This new practice of seated extubation was not associated with adverse events and allowed extubation to occur simultaneously with early mobilization.

Keywords: Airway extubation/methods; Respiration, artificial; Patient positioning

INTRODUCTION

In the intensive care setting, the discontinuation of mechanical ventilation (MV), defined as the abrupt or gradual withdrawal of ventilatory support, contributes to at least 40% of the overall MV period.^(1,2) Weaning from MV has recently undergone drastic changes due to the implementation of standardized care, which includes less sedation, daily trials of spontaneous breathing (SBT), and physical therapy in the earliest days of critical illness.⁽³⁻⁷⁾

The benefits of these interventions are supported by several publications. In a multicenter randomized trial, Girard et al. assigned 336 mechanically ventilated patients to either an intervention group that received daily interruption of sedatives paired with SBT or to a control group.⁽⁵⁾ The intervention group was weaned earlier from MV (11.6 versus 14.7 days, $p=0.02$) and discharged earlier from the hospital (14.9 versus 19.2 days, $p=0.04$)⁽⁵⁾ compared to the control group. In another clinical trial, Schweickert et al. randomly assigned 104 patients to an intervention group that received early exercise and mobilization during daily periods of sedation interruption or to a control group. The intervention group exhibited shorter MV duration (4.5 versus 6.9 days, $p=0.05$) and better functional status at time of hospital discharge (29% versus 19% of participants in the control group).⁽⁷⁾

Wide practice variability was noted in our intensive care unit (ICU) after the implementation of an institutional weaning protocol based on these trials.^(3,5-7) When early mobilization occurred concurrently with weaning, some physicians preferred to keep the patients in a supine position, with the head elevated until SBT and extubation were performed, while others first initiated mobilization and then proceeded to a 30-minute period of SBT. Following successful SBT, some physicians preferred to return the patient to bed before extubation, while others preferred extubation with the patient seated in an armchair.

This lack of practice standardization leads to several unanswered questions: should mobilization be delayed before performing an SBT and extubation; should patients who had already been mobilized, be seated in an armchair, and tolerant of SBT be returned to bed before extubation; and can the removal of the endotracheal tube be performed in a seated in an armchair patient? Currently, there are no objective guidelines to answer these questions, and the safety of performing an extubation in an unusual position (seated in an armchair) is an important concern. The aim of this study was to attempt to address these questions by retrospectively analyzing the success of extubation in seated in an armchair patients compared to supine position patients in our unit.

METHODS

We conducted a retrospective review that included all consecutive adult patients weaned from MV between December 2010 and June 2011 using an institutional

weaning protocol involving sedation, daily SBT and early physical therapy.^(3,5-7) Exclusion criteria included under 18 years old, unplanned extubation, and the lack of a description of position at extubation. The *Hospital Ernesto Dornelles* Ethics Committee approved this research (002/2012) with a waiver of informed consent.

The sample was divided into two groups: seated in an armchair and supine position. The primary outcome, extubation success, was defined as patient survival without reintubation for at least 48 hours following extubation. Noninvasive positive-pressure ventilation was not indicated for any of the groups in the case of postextubation respiratory distress, as its utilization in this setting remains controversial.^(1,8) All patients who developed postextubation respiratory distress were reintubated.

Secondary outcomes included duration of MV, need for tracheostomy, ICU length of stay (LOS), and ICU mortality. Because extubation failure in an unusual position (seated in an armchair group) was our main concern, we also evaluated reintubation technical difficulties and respiratory distress (defined as hemoglobin oxygen saturation (SaO_2) $<90\%$ or a partial pressure of oxygen (PaO_2) $<80\text{mmHg}$ on a fraction of inspired oxygen (FiO_2) $\geq 40\%$). Other complications, such as shock, cardiac arrest, airway trauma, inability to perform bag-and-mask ventilation or inability to place the endotracheal tube, were documented.

Institutional weaning protocol

In our 23-bed medical-surgical ICU, once the patient was considered stable by the attending physician, the weaning protocol was initiated by light sedation as assessed with the Richmond Agitation-Sedation Scale (RASS).^(9,10) Patient stability was determined by MV without the need of neuromuscular blockers and by improving or stable blood gases. An assistant nurse was responsible for titrating sedative infusions (aiming for an RASS score between 0 to -2) and for performing daily interruption of sedation, generally before early morning multidisciplinary rounds. The most commonly used sedatives were midazolam, fentanyl and dexmedetomidine.

During morning rounds, the attending physician and the physiotherapist jointly determined the timing of early mobilization and SBT for both the supine position and seated in an armchair patients, with the final decision requiring the agreement of the remaining members of

the multidisciplinary team. The criteria used to make the decision included patient cognitive awareness, motor capability, ventilatory parameters, hemodynamic condition and logistical issues (i.e., transportation need for diagnostic reasons, operating room, etc.).

The physiotherapist along with a nurse and a nurse technician were responsible for the early mobilization protocol, which involved a stepwise progression from passive range of motion (stage 1, for the unconscious), to sitting on the bed or transfer to an armchair (stages 2 or 3, conscious with strength >III), to finally standing and then walking (stages 4 and 5), as previously described.⁽⁶⁾

Daily SBT trials were performed based on the decision of the multidisciplinary team, and extubation was attempted once the patient had tolerated 30-120 minutes of SBT; had adequate mentation, respiratory pattern and cough (defined by respiratory frequency <30 breaths per min without signs of respiratory muscle fatigue or increased work of breathing); had a low volume of respiratory secretions; and was hemodynamically stable (i.e., less than 20% change of cardiac frequency or blood pressure).^(1,4) The final decision to extubate was made at the attending physician's discretion with the extubation position being a subjective choice due to the lack of objective recommendations on the matter.

Extubation failure in an unusual position (seated in an armchair, early mobilized patients) was an important concern because our armchair was not able to recline fully flat to 180 degrees. To avoid complications, the reintubation protocol required the physiotherapist to secure airway management equipment and a team consisting of at least one physician, one nurse and three nurse technicians present before placing a mechanically ventilated patient in the seated position. If reintubation was needed, the nurse was responsible for administering medications (including sedation) while the other professionals were responsible for returning the patient back to bed.

Descriptive data are summarized as percentages, means, and standard deviations. The Shapiro-Wilk test was used to demonstrate the normal distribution of the sample, and Student's *t*-test and the chi-square test were used to compare the seated in an armchair and supine position groups for continuous and dichotomized outcomes. Statistical analyses were performed using SPSS® v. 16 (IBM Inc., Armonk, NY). All *p* values were 2-tailed, and a *p* value ≤0.05 was regarded as being significant.

RESULTS

From December 2010 to June 2011, 152 patients required MV, 101 of which were extubated. Ninety-one patients were included in the current analysis (ten patients were excluded due to insufficient or inadequate data). The baseline characteristics of the patients are presented in table 1. In this sample, 36% of all extubations were performed in seated in an armchair patients (n=33), while the remaining 64% were performed in supine position patients (n=58). The demographic characteristics of the two groups are described in table 2.

Table 1 - Baseline characteristics of 91 patients weaned from mechanical ventilation over the 7-month study period

| Characteristics | N=91 |
|---|-----------|
| Age (years) | 71 ± 12 |
| Male | 33 (36) |
| APACHE II score | 21 ± 7.6 |
| Pre-ICU conditions | |
| Heart disease | 36 (42) |
| Pulmonary disease | 19 (20) |
| Neoplastic disease | 16 (20) |
| Chronic renal disease | 12 (13) |
| Liver disease | 8 (8) |
| Alcohol use | 15 (16) |
| Others | 12 (13) |
| Reason for mechanical ventilation | |
| Sepsis | 30 (33) |
| Heart failure | 22 (24) |
| Post operative | 24 (26) |
| Neurological | 9 (10) |
| Other | 6 (6) |
| Spontaneous breathing trials before extubation | 1.3 ± 0.6 |
| Duration of mechanical ventilation before extubation (days) | 2.6 ± 2 |

APACHE - Acute Physiologic and Chronic Health Evaluation; ICU - intensive care unit. The results are expressed as number (%) or mean ± standard deviation.

Similar extubation success rates were observed in both groups (82% in the seated in an armchair group [n=27] versus 85% in the control group [n=49], *p*=0.84). There were no significant differences between the groups in the need for tracheostomy, ICU LOS or ICU mortality, as shown in table 2.

The data from the seated in an armchair patients who failed extubation (n=6) were reviewed. Three seated in an

Table 2 - Sample characteristics and extubation outcomes according to extubation position

| Characteristics | Seated in an armchair N=33 | Supine position with elevated head N=58 | p value |
|-----------------------|----------------------------|---|---------|
| Age, mean (years) | 71±13 | 70±11 | 0.93 |
| Male | 11 (33) | 22 (38) | 0.57 |
| APACHE II score | 22.6±5.5 | 20.7±8.6 | 0.23 |
| Duration of MV (days) | 3.5±2.3 | 2±1.6 | 0.057 |
| Extubation success | 27 (82) | 49 (85) | 0.84 |
| Need for tracheostomy | 3 (9) | 3 (5) | 0.91 |
| ICU's LOS (days) | 10±5 | 12.3±5.6 | 0.19 |
| ICU's mortality | 6 (18.2) | 9 (15.5) | 0.89 |

APACHE - Acute Physiologic Assessment and Chronic Health Evaluation; MV - mechanical ventilation; ICU - intensive care unit; LOS - length of stay. The results are expressed as number (%) or mean±standard deviation.

armchair patients needed reintubation while still seated; there were no technical difficulties with reintubation, respiratory distress, or other complications in this group. In the remaining three cases, respiratory failure occurred more than 12 hours after extubation, and patients were already back in bed when they required reintubation, which occurred without complication.

DISCUSSION

The present retrospective analysis, which compares 33 patients extubated while seated in an armchair with 58 patients extubated in the supine position with the head elevated, shows a similar extubation success rate between the two groups. Based on these results, this new practice may allow extubations to be performed simultaneously with early mobilization.

The primary reason to extubate a seated patient is to prioritize early mobilization, which can occur concurrently with weaning from MV. From a multidisciplinary perspective, if SBT and extubation need to be conducted prior to the initiation of physical therapy it can delay patient mobilization. From a different perspective, there is no recommendation on how long one should wait after an extubation to initiate physical therapy. In a Brazilian sample, more than 70% of the patients needed to wait more than 24 hours after extubation to get out of bed.⁽¹¹⁾

This original study addresses a new extubation “problem”: extubating an awakened patient who is seated in an armchair and tolerates SBT. Patient safety is of paramount importance because reintubation is associated with greater than 5-fold higher mortality and because

reintubation difficulties are also associated with higher mortality.⁽¹²⁾ In the current study, the overall proportion of reintubation was 16%, which is consistent with the range reported in the literature.^(1,12) In addition to similar extubation outcomes between the SA and supine position groups, the seated in an armchair group did not experience increased reintubation difficulties or complications in this case series. Although this was a small sub-sample (n=6), all reintubations were performed without complication. It is also interesting to note that half of these failures occurred later than 12 hours following extubation, when these patients were already back to bed rest, indicating that respiratory dysfunction occurred independent of patient position. The late onset of extubation failure in this group was similar to that published in a cohort of 2,007 critically ill adult patients in which 75% of extubation failures occurred after 6 hours.⁽¹²⁾

This is the first publication evaluating out-of-bed extubation, although some of the present results have been previously reported in abstract form.⁽¹³⁾ The optimization of weaning is mandatory because MV and extubation failures are associated with serious complications and ICU costs.^(1,10,12,14) Weaning begins with a readiness assessment that may be highly influenced by sedation practices and followed by a spontaneous breathing trial to determine the likelihood of successful extubation.^(1,4) Weaning from MV has evolved drastically after the implementation of standardized weaning protocols that incorporate less sedation, daily trials of spontaneous breathing and early mobilization. These new practices result in increased ventilator-free days, decreased delirium, lower ICU and hospital LOS, improved functional outcomes at hospital discharge, and decreased ICU expenses.⁽³⁻⁷⁾

Although the harmful effects of complete bed rest have been recognized for more than 60 years,⁽¹⁵⁾ only recently has the practice of complete bed rest for mechanically ventilated ICU patients been challenged.⁽¹⁶⁾ Our mobilization protocol was adapted from an original prospective cohort study of 330 mechanically ventilated patients that found mobilization resulted in a reduction in ICU LOS (5.5 versus 6.9 days, p=0.025), decreased hospital LOS (11.2 versus 14.5 days, p=0.006), and a low complication rate.⁽⁶⁾

Mobilization requires patients to be alert, which requires a minimization of sedation for this to be feasible.⁽¹⁶⁾ Maintaining light levels of sedation in

adult ICU patients is independently associated with a shorter duration of MV, shorter ICU LOS and reduced mortality.^(9,17) Interestingly, in a study that paired the daily interruption of sedatives and SBT, the intervention group was less likely to die at any instant during the year after enrollment than were patients in the control group (HR 0.68, 95%CI 0.50 to 0.92; $p=0.01$).⁽⁵⁾ In this context, the North American guidelines for the management of pain, agitation, and delirium in adult patients in the ICU recommend either daily sedation interruption or a light target level of sedation to be routinely used in mechanically ventilated patients.⁽⁹⁾

The connection between sedation, delirium, mobilization and ICU stay was examined by Needham et al. in a quality improvement project to improve sedation practices and increase mobilization in a medical ICU. After the quality improvement initiative, benzodiazepines and narcotics were given less often, and patients were awake and alert on twice as many ICU days. The implementation of this quality improvement project doubled the number of days without delirium, decreased ICU and hospital length of stay and increased ICU admissions.⁽¹⁸⁾ This study highlights not only a possible link between delirium, sedation and mobilization but also emphasizes the effect that cultural shifts in the ICU can have on patient outcomes.

We believe that coordinated actions (such as daily interruption of sedation, daily spontaneous breathing trials, early mobilization, delirium assessment, etc.) are key components for safer patient care and better outcomes; however, this level of coordination requires a multidisciplinary team approach. Careful communication between physicians, nurses, and physiotherapists is needed to optimize sedation practices as well as the timing and progression of patient activity.⁽¹⁶⁾

We acknowledge that the current study is limited by the use of retrospective data collection and the lack of an adequate sample size calculation. Despite a thorough chart review, the ability to robustly categorize the reasons for weaning failure was also limited, as was our ability to characterize the patients. Nevertheless, in a large cohort of critically ill patients, older age, male sex, and initial severity of illness were all associated with a greater likelihood of extubation failure,⁽¹²⁾ which may allow the groups from the current study to be considered as homogeneous. Furthermore, the total number of patients in each group was uneven, and even

though the physicians' decision to extubate a patient in a seated position was strictly subjective, patient severity influenced this decision, as previously shown in others publications.^(11,16,19) Additionally, in this small, observational, single center study, the mean duration of MV was very short (2.6 days), and most patients had simple weaning. There was an observed tendency towards shorter MV duration in supine position extubation (3.5 versus 2 days, $p=0.057$), most likely related to simple weaning of typical surgical patients (i.e., early postoperative extubation). Furthermore, almost 10% of immediate reintubations in the seated in an armchair group occurred while the patients were in a seated position. Our sample size and the absence of this information in the supine position group limit the proper comparison of the immediate reintubation rate between the groups. All of these limitations prevented the adequate assessment of the safety of this procedure; only a well-designed, randomized trial can fully examine the safety implications of the seated position during extubation.

CONCLUSION

Our results suggest that the success of extubation of patients in a seated position is similar to that of patients extubated in a supine position. In this retrospective, observational, non-randomized study, the new practice of seated extubation was not associated with adverse events and allowed extubation to occur at the same time as early mobilization. Further studies are needed to evaluate this practice in the intensive care unit settings of other institutions to determine how it might impact the clinical management of mechanically ventilated patients.

Author's contributions

Dr. Dexheimer Neto initiated the study, participated in the design of the study and drafted the manuscript. Ms. Vesz, Ms. Leães and Mr. Rodrigues participated in the conceptualization of the study, designed and executed the study protocol, and collected the data. Dr. Cremonese, Dr. Raupp, Dr. de Andrade and Dr. Townsend participated in the design of the study, executed the study protocol, and helped with draft revisions. Dr. Maccari and Dr. Teixeira participated in the design and conceptualization of the study and in the data analysis.

RESUMO

Objetivo: O desmame da ventilação mecânica é acompanhado, na prática clínica em terapia intensiva, de concomitante mobilização precoce do paciente. O objetivo deste estudo foi comparar o sucesso da extubação realizada com pacientes sentados em uma poltrona à extubação de pacientes na posição supina.

Métodos: Foi realizado um estudo retrospectivo, observacional e não randomizado em uma unidade de terapia intensiva de 23 leitos, que atende pacientes clínicos e cirúrgicos. O desfecho primário do estudo foi o sucesso da extubação, definido como a tolerância da remoção do tubo endotraqueal por, pelo menos, 48 horas. As diferenças entre os grupos do estudo foram avaliadas utilizando-se o teste *t* de Student e o qui quadrado.

Resultados: Foram incluídos 91 pacientes no período compreendido entre dezembro de 2010 e junho de 2011. A população do estudo tinha uma média de idade de 71 anos \pm 12 meses, escore APACHE II médio de $21 \pm 7,6$ e duração média da ventilação mecânica de $2,6 \pm 2$ dias. A extubação foi realizada

em 33 pacientes enquanto permaneciam sentados em uma poltrona (36%) e 58 pacientes mantidos em posição supina (64%). Não houve diferenças significantes entre os grupos em termos de idade, escore médio APACHE II ou duração da ventilação mecânica. Foi observada uma taxa de sucesso da extubação similar entre os grupos sentado (82%) e em posição supina (85%), com $p > 0,05$. Além disso, não se encontraram diferenças significantes entre os dois grupos em termos de disfunção respiratória pós-extubação, necessidade de traqueostomia, duração do desmame da ventilação mecânica, ou tempo de permanência na unidade de terapia intensiva.

Conclusão: Os desfechos clínicos de pacientes extubados em posição sentada foram similares aos de pacientes extubados na posição supina. A nova prática de extubação na posição sentada não se associou a eventos adversos e permitiu que a extubação ocorresse simultaneamente à mobilização precoce.

Descritores: Extubação/métodos; Respiração artificial; Posicionamento do paciente

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