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Impact of a clinical audit on the improvement of mechanical ventilation for patients admitted to a postoperative care unit.

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Resumen

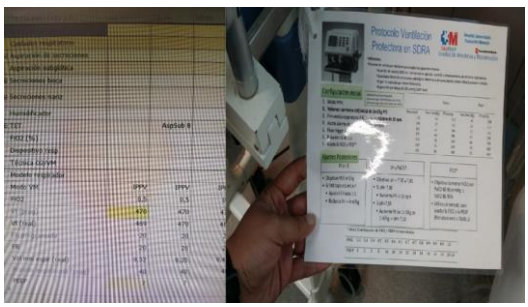
Objective: describe the adherence to lung protective mechanical ventilation recommendations, before and after implementing educational interventions in our postoperative intensive care unit, by conducting three cycles of clinical audit.

Material and methods: longitudinal and descriptive study carried out in a single centre. Data collection took place in three different periods, the first audit was carried out in 2017 and results were obtained from arterial blood samples and mechanical ventilation registry. Ventilation was classified into three categories: unnecessary hyperventilation, acceptable ventilation and optimal ventilation. After the first cycle, several educational interventions were implemented and a lung protective ventilation protocol was created. After the application of these measures, a second audit was carried out in 2018 and another in 2019.

Results: following the implementation of the previous measures, the rate of unnecessary hyperventilation decreased from 15% to 1,9% and the rate of optimal ventilation increased from 2% to 22.9%. There was a significant shift from the initial broad use of pressure-controlled ventilation (66% of registrations in 2017) to a later predominant use of volume-controlled ventilation (89% in 2019).

Conclusions: clinical audit is a useful tool to improve our clinical practice. We have demonstrated an improvement in mechanical ventilation parameters in patients admitted to our postoperative care unit, after implementing some educational and feedback measures.

Introduction



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Acute Respiratory Distress Syndrome (ARDS) is a type of acute diffuse inflammatory lung injury, associated to a mortality rate up to 40-50% (1, 2).

The only therapies that have shown to be effective are lung-protective mechanical ventilation strategies, with low tidal volume (4-6 ml/kg) of ideal body weight and plateau pressure of 30 cmH2O or below (1, 2, 3).

On the other hand, protective ventilation strategies for patients with non-injured lungs remain controversial and more studies are needed (4). Nevertheless, few clinical studies suggest mechanical ventilation with low tidal volumes benefit critically ill patients without ARDS but at risk of developing this syndrome; for instance, in patients who have undergone a primary physiological insult such as critically ill patients with sepsis, pneumonia, trauma or high risk surgical patients requiring intensive postoperative care (4, 5, 6).

Despite clinical studies, we detected in our postoperative care unit a great difference in the mechanical ventilation patterns, and therefore the need to develop a lung protective mechanical ventilation protocol. We considered carrying out a clinical audit and implementing some changes. Clinical audit is a quality improvement process that seeks to improve patient care and outcomes through a systematic review of clinical practice and the implementation of change (7).

Our aim was to describe the adherence to lung protective mechanical ventilation recommendations after implementing educational interventions and establishing a protocol in our postoperative care unit. We intend to verify the impact of the application of these measures on the way our staff works.

Materials and methods

In a retrospective descriptive study, we reviewed records of patients during 6 months in the three cycles of audit.

We included all adult patients admitted to our postoperative intensive care unit who required 24 hours or more of mechanical ventilation, in volume or pressure-controlled ventilation modes. Our postoperative care unit consist of 5 intensive care beds, and includes postoperative patients from general, vascular, gynecology, trauma, urology and ENT surgery.

Exclusion criteria were patients who did not complete 24h of mechanical ventilation, cardiogenic respiratory failure or records of patients in non-controlled mode of ventilation (pressure support, non-invasive mechanical ventilation or spontaneous ventilation).

Data collected of each patient were: records every 12h (while meeting criteria) of arterial oxygen pressure, arterial CO2 pressure, pH, bicarbonate, peripheral oxygen saturation, tidal

volume, respiratory rate, peak pressure, plateau pressure, PEEP.

Taking these data into account, records were classified in 3 different categories of ventilation, as shown in Table 1: optimal ventilation, which meets the criteria for protective ventilation (2); acceptable ventilation, in which higher tidal volumes or pressures are explained by associated metabolic or respiratory acidosis; and unnecessary hyperventilation, with high tidal volumes, as in the traditional ventilation treatments (2), not explained by any acid-base disorder.

OPTIMAL VENTILATION	ACCEPTABLE VENTILATION	UNNECESARY VENTILATION
-TV 4-6 ml/kg + P plateau ≤ 30 cmH2O + pH > 7.30	-pH < 7.15 with any ventilation -TV 6-11 ml/kg with any pH -P plateau 30-35 cmH2O with any pH -TV > 11ml/kg + pH < 7.35 -P plateau > 35 cmH2O + pH < 7.35	-TV > 11 ml/kg + pH > 7.35 -P plateau > 35 cmH2O + pH > 7.35

Table 1. Types of ventilation categories. TV: tidal volumen. P plateau: plateau pressure.

First audit cycle was carried out in 2017, after that, some measures were implemented: a session was presented with the results from the data collection to both Anaesthesia staff and the postoperative care unit nurses, a lung protective mechanical ventilation protocol was developed and also presented in session, cognitive aid cards were incorporated to each ventilator, and the informatic system used was modified (automatic alerts were added when setting parameters out of range) (Figure 1).

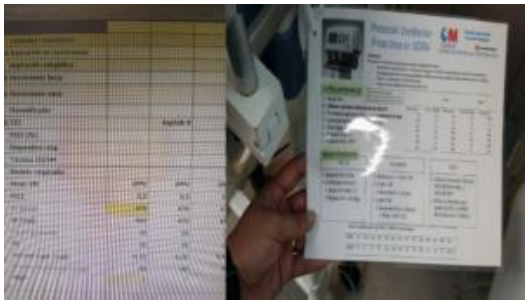

Figure 1. On the right: cognitive aid cards incorporated to each ventilator which includes the main guidelines for lung protective ventilation. On the left: visual alerts in yellow in the informatic system when parameters are set out of range.

Later in 2018, a new audit cycle was carried out to evaluate the results after the application of the measures, in this year these results were also presented to our staff and the measures implemented in 2017 were recalled. Finally, in 2019 the last data collection was carried out without any intervention between this phase and the previous one, except for the session presented.

Results

In 2017, 602 records were collected from 26 patients, with a mean age of 69.9 years, a mean stay in the postoperative care unit of 14.8 days and a mean time of mechanical ventilation of 11.9 days.

In 2018, 280 records were collected from 14 patients, with a mean age of 70.6 years, a mean stay in the postoperative care unit of 22.1 days and a mean time of mechanical ventilation of 15.3 days.

In 2019, 319 records were collected from 35 patients, with a mean age of 67.4 years, a mean stay in the postoperative care unit of 13.9 days and a mean time of mechanical ventilation of 10 days.

Regarding the classification of ventilation, as shown in Figure 2, in 2017 the following values were

obtained: optimal ventilation in 2% of the records, acceptable ventilation in 83%, and unnecessary hyperventilation in 15%. One year later, after the intervention, optimal ventilation was obtained in 8%, acceptable ventilation in 81.4%, and unnecessary hyperventilation in 10.6%. In 2019, the results were: optimal ventilation 22.9%, acceptable ventilation 75.2%, unnecessary hyperventilation 1.9%. It should be noted that this last 1.9% corresponds to records from one same patient. These results were statistically significant (Fisher's test < 0.001).

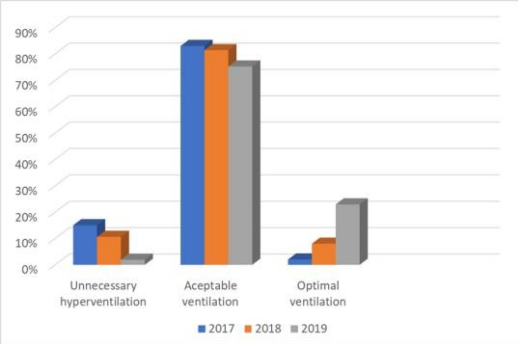

Figure 2. Histogram of unnecessary hyperventilation, acceptable ventilation and optimal ventilation percentages in the three cycles of the audit (years 2017, 2018 and 2019).

The main ventilation mode in the first phase in 2017 was the pressure-controlled mode (66.3%), while volume-controlled mode was half frequent (33.7%). However, this relationship was reversed in 2018, with the volume-controlled mode being more frequent (56%). In 2019 the use of volume-controlled mode increases significantly (in 89%).

Discussion

Anaesthesia has a long tradition of improving clinical safety and outcome by continuous critical examination of our practice. However, changing the increasingly complex clinical systems in which we work and making those changes last, is a difficult task (7).

To do so we can rely on tools such as clinical audits. The first step would be to identify what we want to change: in our case, we observed that there was no clear pattern for patients undergoing mechanical ventilation in the postoperative care unit. Simultaneously, scientific evidence and/or expert opinion was also needed, since any quality improvement project requires evidence that compliance will improve patient outcomes (7). There is currently evidence showing that lung protective ventilation improves de prognosis of patients with or at risk of ARDS (3, 5, 6, 8). The next step was an audit of current clinical practice and then implement a change to improve the quality of care. Finally, again carry out a re-audit that includes these improvement changes (7).

Education and feedback both improve adoption of lower tidal volumes for critically ill patients in the intensive care unit setting (9). According to this, we demonstrate a significant improvement in our clinical practice after the implementation of educational interventions in our unit. We have been able to increase our optimal ventilation rate from 2% to 22.9% and decrease our unnecessary hyperventilation rate from 15 to 1.9%. It should be noted that between the second and third phase of the audit, no new changes were implemented. However, data was presented in a new session to our staff to present the results of that second cycle, as such feedback has been shown to improve adherence in other studies (9). In addition, the substantial improvement of the way of ventilation may be associated to the fact that initial measures are accessible on daily basis, such as: protective ventilation protocol, cognitive aids in respirators and alarms in the computer system.

On the other hand, the last data collection obtained higher results of

volume-controlled ventilation, according to other studies (7). It may be associated with a better control of the tidal volume administered to the patient.

Weakness of this study include the implementation of measures and data collection in only one centre. Moreover, number of records were limited by number of surgical interventions performed in the established audit times.

Conclusion

Take into account the audit as a useful tool to improve our clinical practice. In our hospital, we performed an audit aimed to mechanical ventilation strategies and have demonstrated how applying specific guidelines (conducting sessions and presenting the results, establishing a protocol and providing cognitive aids on ventilators and computer programs) has almost eliminated unnecessary hyperventilation in our patients with or at risk of ARDS.

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