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SCIENTIFIC LETTERS

Extracorporeal membrane oxygenation (ECMO) and ultraprotective mechanical ventilation for near-fatal status asthmaticus☆

Membrana de oxigenación extracorpórea (ECMO) y ventilación mecánica ultraprotectora en el estatus asmático casi fatal

Dear Editor,

Mortality among asthmatic patients has decreased substantially thanks mainly to advances in drug treatment. Nevertheless, in some cases and despite optimum pharmacological treatment, invasive ventilatory support proves necessary. The risk of barotrauma, which can have fatal consequences, is directly related to pulmonary insufflation secondary to air trapping and an increase in plateau pressure (Pp) – prolonged expiratory times and even disconnection from the respiratory being needed to lower the intrinsic positive end-expiratory pressure (PEEP).[1] The mortality risk among patients with severe asthma requiring invasive mechanical ventilation is 6.5–10.3%.[2]

We present the case of a 21-year-old woman and smoker of tobacco and cannabis, with a history of extrinsic intermittent asthma since childhood. The patient was admitted to the Intensive Care Unit of our hospital due to a severe asthma attack that failed to respond to intensive drug treatment, and noninvasive mechanical ventilation (MV) proved necessary. Under conditions of muscle exhaustion with respiratory acidosis (pH 7.29, $PaCO_2$ 63.2 mmHg), invasive MV was decided from the first three hours of admission to intensive care. During the first days of her stay, deep sedation-relaxation proved necessary (midazolam, fentanyl and cisatracurium), with very high-dose inhaled bronchodilators (salbutamol 5 mg/h, ipratropium 0.5 mg/h, adrenalin 1 mg/2 h), intravenous corticosteroids (6-methylprednisolone 80 mg/8 h) and intravenous rescue

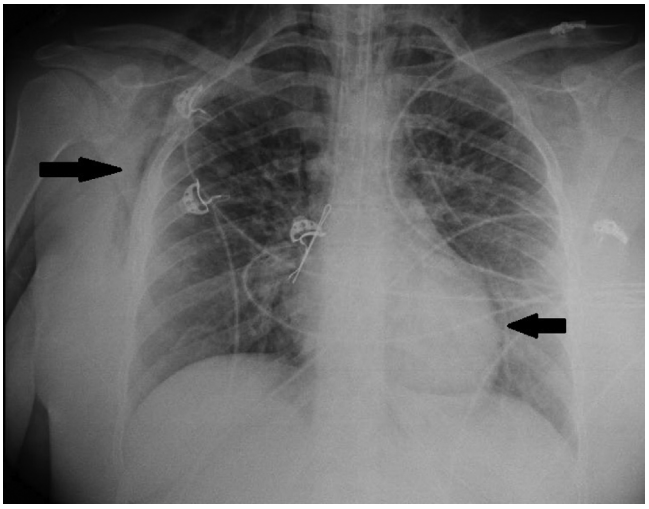

Figure 1 Chest X-ray prior to VV-ECMO. The arrows show the pneumopericardium and interstitial and subcutaneous emphysema.

medication in the form of ketamine 60 mg/kg/min in continuous perfusion, magnesium sulfate 12 g/24 h and theophylline 0.8 mg/kg/h. Following these measures, severe airflow obstruction was seen to persist, however, with air trapping despite protective ventilation with permissive hypercapnia: under a tidal volume (Vt) of 440 ml, an inspiration/expiration ratio of 1:4, a flow of 36 l/min, PEEP 7 mbar and FiO_2 0.5, a peak pressure of 55–60 mbar was generated, with Pp 35 mbar, compliance 23 ml/mbar and total PEEP 16 mbar. After 72 h of admission, the patient showed evidence of barotrauma (pneumopericardium, with interstitial and subcutaneous emphysema [Fig. 1]), associated to progressive severe respiratory acidosis (pH 7.14 and $PaCO_2$ 124 mmHg). At this point we decided to start femorojugular veno-venous extracorporeal membrane oxygenation (VV-ECMO) in order to perform ultraprotective ventilation with lung rest. Over the next few days the respiratory obstruction persisted (Fig. 2), together with very poor lung distensibility (Vt < 4 ml/kg, inspiration/expiration ratio 1:4, compliance 28 ml/mbar, intrinsic PEEP 9 mbar), and with the continued need for high-dose drug treatment, as well as fibrobronchoscopic bronchoalveolar lavage (BAL) and lung voiding maneuvers. After five days of ECMO the obstruction subsided, allowing slow modification of the ventilatory parameters, and with weaning from ECMO by day 7. The subsequent clinical course was slow but favorable, and

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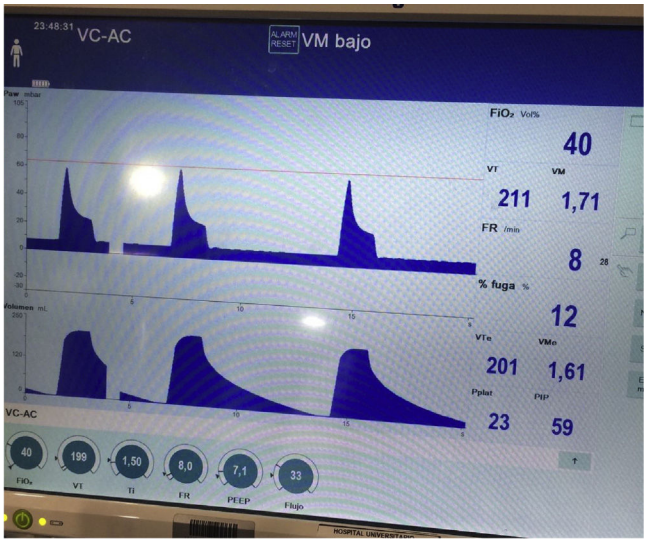

Figure 2 Pressure and volume curves in the patient subjected to VV-ECMO and ultraprotective ventilation with Vt 199 ml and peak pressures of 59 mbar were reached.

the patient was discharged after 25 days of admission. As associated complications, she suffered respiratory infection caused by methicillin-sensitive *S. aureus* and critical patient myopathy.

veno-venous extracorporeal membrane oxygenation is a temporary respiratory assist strategy for the management of respiratory failure refractory to conventional treatment. It improves oxygenation, reduces the CO_2 levels, and lessens the risk of ventilator associated lung injury thanks to the provision of protective (Vt 4–6 ml/kg) or ultraprotective ventilation (Vt < 4 ml/kg).[3]

The use of VV-ECMO could improve the prognosis of patients with severe hypoxemic acute respiratory failure, as in acute respiratory distress syndrome (ARDS), though it is still regarded as a rescue treatment strategy lacking sufficient scientific evidence.[4]

The evidence on the use of VV-ECMO in adult near-fatal status asthmaticus is limited to a number of published case series.[5,6] The Extracorporeal Life Support Organization described the evolution of patients with status asthmaticus administered supportive treatment with ECMO in its international registry between 1986–2006.[7] Of the 1257 patients requiring respiratory support, only 24 corresponded to severe asthma cases – ECMO being performed with a mean pH of 7.14 (standard deviation [SD] 0.16) and a mean $PaCO_2$ of 119.7 mmHg (SD 58.1). This has been the largest series published to date, with a survival rate of 83.3%. However, despite the good results obtained, the technique was associated with significant complications: cannula-related or pulmonary bleeding in 37.5% of the cases, infections in 8.3%, circuit-related complications in 41.4%, and even intracranial bleeding and brain death in 12.5%. In a recent series, Di Lascio et al. studied 16 adults with near-fatal asthma during 5 years and subjected to ECMO support.[8] Prior to the start of ECMO, the mean pH was 6.89 (SD 0.014), with a mean $PaCO_2$ of 111 mmHg (SD 4.24), and the patients underwent fibrobronchoscopic bronchoalveolar lavage on a daily basis. All the patients survived, and there were no relevant complications.

Specific devices have recently been developed for the extracorporeal elimination of CO_2 that are technically less complicated than ECMO, and which could prove useful in patients requiring lung rest.[9] The use of such devices has been considered in ARDS and in exacerbated chronic obstructive pulmonary disease (COPD), though experience in cases of status asthmaticus is still limited.[10]

On analyzing our case and the published series on status asthmaticus, in view of its reversible nature, ventilatory support with extracorporeal assist could be regarded as an early treatment option, particularly in the more aggressive or near-fatal presentations of the disorder. However, we still need to define the specific clinical or blood gas criteria for introducing ECMO in cases refractory to conventional management, as in the patients with ARDS. On the other hand, ECMO has frequent complications, and careful assessment of the risk–benefit balance of each individual patient is required, without being able to predict the moment in which bronchospasm will subside.

In our patient, assist was decided when we observed incipient signs of barotrauma, despite the maintenance of moderate permissive hypercapnia. Even so, 5 days of ECMO with Vt < 4 ml/kg were needed in order for bronchospasm to subside. Fortunately, we will never know the risk we would have had to accept had more conventional ventilatory management been used.

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Life-support treatments at end of life: Costs and ethical aspects. Point of view in an intensive care unit based on Q methodology☆

Tratamientos de soporte vital al final de la vida: costos y aspectos éticos. Punto de vista en una unidad de cuidados intensivos basado en la metodología Q

Dear Editor,

The present letter describes the results of a study on the subjectiveness and analysis of different points of view regarding the ethical aspects and costs of treatments at end of life as perceived by the staff of an Intensive Care Unit (ICU), based on Q methodology.

In studies based on Q methodology, the interviewee – through a statement classification procedure known as the ''q-set'' – offers his or her point of view about a given study topic. Person factors analysis is subsequently used to identify significant correlation groups that can be interpreted as distinguishable points of view.[1–7]

The Q methodological approach to data analysis implies the sequential utilization of three statistical procedures: correlation, factor analysis and factor computing.[8]

A total of 44 interviews were carried out. The first factor analysis applied to the correlation matrix identified 8 factors. The value corresponding to each factor, and the explained percentage of variance, are reported in Table 1.

The scree plot of the factors obtained showed a flattening of the curve to the right of the third factor. We therefore selected the first three factors for the posterior rotational (varimax) analysis.

The correlation between factor 1 and factor 2 was 0.41; that between factor 1 and factor 3 was 0.46; and that between factor 2 and factor 3 was 0.58.

Table 2 presents the full composition of the statements for the three factors, showing the ideal positioning of the statements in the grid, for each of the points of view.

The three perspectives found in this study underscore the plurality of the points of view and the importance of furthering understanding of the issues referred to this topic in the critical care setting.

Point of view 1 (*The importance of the family and environment in end of life decisions*), predominant in the explored sample, represents a perspective in which the rights of patients to life and their environment are of paramount importance. Life is seen as precious, and so economical costs should not be spared, even though the benefits obtained may be considered limited. This opinion perspective considers that treatments should be applied if the patients and their families consider that such treatments will be of benefit. On the other hand, it is also considered that patients should be able to reject life-prolonging treatments if they so wish.

However, although it could be understood that people who agree with this view would not support a special policy referred to limitation of treatments at end of life, there may be doubts in this regard. Such doubts would not be due to a belief that these treatments should not be provided, but rather to disagreement with the overall cost-effectiveness analysis, as a guide to provision and

Table 1 Inherent value of each of the factors, and the percentage of variance explained.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Inherent value	16.06	4.20	3.23	2.70	2.54	1.88	1.68	1.46
Variance explained (%)	37	10	7	6	6	4	4	3

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