Caveats of pressure control: lung non-protective ventilation

Editor—Lung-protective ventilation (LPV), in which the tidal volume is restricted to 6 ml kg\(^{-1}\) and the plateau pressure to <30 cm H\(_2\)O, is the accepted standard of care for patients with acute lung injury (ALI) and the acute respiratory distress syndrome (ARDS). A growing body of evidence supports the implementation of LPV in patients with other forms of acute respiratory failure and even in patients with healthy lungs undergoing general anaesthesia for elective surgery. The evidence behind LPV is largely based upon studies that have used volume-controlled modes of mechanical ventilation. Pressure-controlled modes of ventilation offer the theoretical advantages of better patient–ventilator synchrony and improved patient comfort. However, in critically ill patients, airway resistance and lung compliance change on a minute-to-minute basis; therefore, the delivery of a fixed inspiratory pressure may result in gross under- or over-ventilation. Although pressure-controlled modes of ventilation have been the mainstay of ventilation bundles in British intensive care units (ICUs) for decades, conciliating this strategy with a lung-protective model may prove difficult.

Our large medical/surgical ICU is located in a tertiary care centre. A Bi-level/pressure support-based, nurse-led ventilation strategy is the default for all patients, with patients generally weaned from Bi-level to pressure support as soon as able. We retrospectively analysed data extracted from the electronic patient records of 200 mechanically ventilated patients sequentially admitted to ICU for mechanical ventilation during a 6 month period (November 2013–April 2014). The tidal ventilation administered was determined by averaging the hourly tidal volume recorded over the first 24 h of admission. An ‘ideal’ tidal volume (6 ml kg\(^{-1}\)) was calculated for each patient based on ideal body weight. The average age of the study population was 58, with an average duration of mechanical ventilation of 4.1 days and an ICU length of stay of 6.1 days: 43% of patients were admitted after abdominal or vascular surgery; 29% of patients were ventilated for neurological protection; 20% of patients had ALI/ARDS on admission; and 5% had community-acquired pneumonia.

Analysis of the data revealed that average tidal volume received by the patients during their first 24 h of admission was 536 (40) ml, which represents an excess of 88.2 (30) ml over the ‘ideal’ lung-protective tidal volume (\(P<0.05\)). Moreover, in patients with ALI/ARDS, the tidal volume delivered was 544 ml (30), which represents an excess of 95 (25) ml (\(P<0.05\)) over ideal volumes. These figures demonstrate that, in our institution, the application of a pressure control-based ventilation strategy resulted in the delivery of ventilation significantly larger than the recommended LPV standard. This effect was observed in both mandatory (Bi-level) and spontaneous (pressure support) modes of ventilation.

While the effect of restricting tidal volumes to 6 ml kg\(^{-1}\) in spontaneously ventilating patients remains controversial, given the state of the evidence, it seems reasonable to adhere to LPV recommendations at least in the initial acute stage of respiratory failure, where the potential for ventilation-induced lung injury is highest. Achieving this with the use of pressure-control-based ventilation requires regular and meticulous titration of pressures, significantly increases the nursing workload, and, as demonstrated by our results, may be ultimately unfeasible in a busy tertiary referral centre. The recently developed dual-control modes of ventilation, which are pressure-based but have auto-regulation mechanisms that restrict delivered volumes, may represent a promising middle ground that warrants further assessment in the clinical setting.

Declaration of interest

None declared.

I. de Asua*
S. McKechnie
Oxford, UK
E-mail: ignaciodeasua@yahoo.co.uk

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Indications of extracorporeal life support in poly-trauma

Editor—Major trauma is a leading cause of death, particularly among young patients. New strategies in management are needed to improve poor outcome of severe trauma. Conventional therapies for post-traumatic cardiovascular shock and acute pulmonary failure may sometimes be insufficient and even dangerous.\(^1\)\(^2\) New approaches in trauma care and advanced treatments are needed to modify the actual therapeutic strategy and treatment protocols. Extracorporeal life support (ECLS) has proven to be effective in acute cardiopulmonary failure of different aetiologies, in particular when conventional therapies fail.\(^3\)\(^4\)\(^5\)

We are using ECLS as a rescue therapy in severe poly-trauma patients with a refractory clinical setting (cardiogenic shock, cardiac arrest, and/or pulmonary failure): the rationale for using ECLS in trauma patients is to treat refractory pulmonary and cardiopulmonary failure, providing adequate systemic perfusion, avoiding consequent multi-organ failure, and permitting organ recovery.\(^6\)\(^7\) From our experience, we have identified several pre-ECLS patient characteristics useful in predicting ECLS treatment appropriateness.
From December 2008 onwards, in our hospital (a tertiary level referral trauma centre), the ECLS team was alerted on 35 clinical scenarios and applied ECLS in 20 adult trauma patients [mean age 44.2 (16.2) yr (range 15–69)] with severe refractory cardiopulmonary failure. In four patients, the ECLS treatment failed due to inability to maintain adequate ECLS blood flow and patient perfusion. From clinical evaluation data, we have identified that ECLS suitability was successfully obtained in patients with pre-implantation significantly lower injury severity score, lower blood lactate level, lower blood units transfused, and significantly higher pH and Hb concentration. The receiver operating characteristic curves were used to dichotomize continuous variables based on a cut-off value, corresponding with the highest Youden index. These cut-off values were used successively to identify independent predictors of unsuitability and unsuccessful ECLS treatment with univariate and multivariate analysis: the parameters with highest negative impact were blood lactate level >14.4 mmol litre\(^{-1}\) (mean of last 3 evaluations), blood pH <7.01 (mean of last 3 evaluations) and injury severity score >63. Interestingly, no ultrasonography or haemodynamic parameter contributed significantly to the prediction of ECLS success or failure (Table 1).

In the patients efficiently supported by ECLS, cardiac index, mean arterial pressure, blood lactates concentration, \(P_\text{aCO}_2\), \(P_\text{aO}_2\), and \(\text{pH}\) showed quick significant improvement with normal values reaching at 3.2 (14) h.

From our data, ECLS seems to be a valuable option to resuscitate severe trauma patients with refractory cardiopulmonary failure when conventional therapies are insufficient: it is safe, feasible, and effective in providing haemodynamic support and blood gas exchange and could be lifesaving when it is promptly initiated in a specialized centre.

In our view, advanced management of poly-trauma patients should include ECLS in the case of refractoriness of the clinical conditions to conventional treatments and if no predictor of ECLS failure is present.

Furthermore, our data was able to identify strong predictors of ECLS non-suitability and unsuccessful in poly-traumatized patients: this might be helpful in deciding whether the ECLS should be implanted, explicitly in patients who are severely complex and compromised.

Future improvements in materials and techniques are expected to make ECLS even easier and safer to manage, leading to a further extension of its use in disastrously injured patients.

**Table 1** Multivariate analysis (multivariate logistic regression stepwise model) of significant predictors associated with ECLS failure revealed by univariate analysis. ISS, injury severity score; SEM, standard error of arithmetic mean; CI, confidence interval

<table>
<thead>
<tr>
<th>Patient’s data</th>
<th>Regression coefficient</th>
<th>SEM</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISS &gt; 63</td>
<td>1.45273</td>
<td>0.1754</td>
<td>4.2748</td>
<td>1.373–13.314</td>
<td>0.0407</td>
</tr>
<tr>
<td>pH &lt; 7.01 (mean of last 3 evaluations)</td>
<td>1.97044</td>
<td>0.1716</td>
<td>7.1738</td>
<td>2.480–20.752</td>
<td>0.0137</td>
</tr>
<tr>
<td>Blood lactates &gt;14.4 mmol litre(^{-1}) (mean of last 3 evaluations)</td>
<td>2.52623</td>
<td>0.69933</td>
<td>12.5063</td>
<td>4.473–34.974</td>
<td>0.0251</td>
</tr>
</tbody>
</table>

**Declaration of interest**

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M. Bonacchi*
G. Harmelin
M. Bugetti
G. Sani
A. Peris
Florence, Italy
'E-mail: mbonacchi@unifi.it


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**Unexpected benefit of videolaryngoscopy**

Editor—The use of videolaryngoscopy, while increasingly established and gaining popularity, has not yet become the ‘gold standard’ for managing tracheal intubation. Videolaryngoscopy may have a number of benefits including improved view of the larynx (especially in the obese), and decreased rates of difficult laryngoscopy and successful intubation when direct laryngoscopy fails.\(^1\)\(^2\) Videolaryngoscopy is also a helpful tool when managing a predicted difficult airway.\(^3\)