Pharmacological Treatment of Hypoxemia during One-lung Ventilation

To the Editor:

We read with great interest the Case Scenario on hypoxemia during one-lung ventilation (OLV) reported by Rozé *et al.*,[1] and we would like to add some comments on pharmacological treatment.

First, the title of the section, "Pharmacological treatment to limit hypoxic pulmonary vasoconstriction," could, in our opinion, lead to confusion. Almitrine does not limit hypoxic pulmonary vasoconstriction but enhances this mechanism in nonventilated areas. Inhaled nitric oxide can inhibit hypoxic pulmonary vasoconstriction in patients with chronic obstructive pulmonary disease breathing room air[2]; however, during OLV this gas vasodilates ventilated lung areas, shifting the pulmonary blood flow toward these zones without modifying hypoxic pulmonary vasoconstriction.[3]

Regarding the use of inhaled nitric oxide, a European board of experts on this topic concluded that there is no evidence to support the routine use of inhaled nitric oxide for the prevention or reversal of hypoxemia during OLV, although some patients with severe hypoxemia may benefit from this drug.[4] On the other hand, the text suggests that inhaled nitric oxide improves hypoxemia only when it is used with positive end-expiratory pressure, but it has also been useful when administered without positive end-expiratory pressure in patients with severe hypoxemia.[5]

Concerning almitrine, the hemodynamic effects on pulmonary circulation are dose-related,[6,7] and pulmonary hypertension is not expected if a low-dose combined with inhaled nitric oxide is used during OLV.[6] Peripheral neuropathy related to almitrine has been observed in patients who received this drug for several months, usually with complete recovery,[8] and is related to high plasma concentrations of almitrine (400 ng/ml).[9] However, when low-dose almitrine is administered for a short time its plasma concentration is less than the concentration seen with long-term therapy[6,7] and returns to values close to zero within 12 h after cessation of the infusion.[7]

Almitrine and inhaled nitric should not be used routinely. Nevertheless, they can dramatically improve oxygenation[6,10,11] and thus might be considered as alternative treatments when other strategies fail to improve hypoxemia during OLV.

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Supported by grants from Fondo de Investigación Sanitaria, Ministerio de Ciencia e Innovación, Madrid, Spain: 98/1049, 01/1586.

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(Accepted for publication April 26, 2011.)

In Reply:

Thank you for your interest in our article.[1] We read with great interest Dr. Russell's study reporting beneficial effects of intermittent positive airway pressure on the nonventilated lung in patients suffering from hypoxemia (*i.e.*, pulse oximetry less than 95%) during one-lung ventilation (OLV).[2] Oxygen administered into the nondependent lung should be used to treat and prevent hypoxemia during OLV. As mentioned in our article,[1] oxygen may be used in different ways on the nondependent lung with or without continuous positive airway pressure and transient reinflation of the collapsed lung without interfering with surgery. The method described by Russell *et al.* seems very interesting.[2] These authors reported that slow and very brief inflation with pure oxygen is sufficient to treat hypoxemia. However, the efficiency of this simple technique depends on the importance of the shunt-like effect and hypoxemia that requires treatment.[3,4]

We completely agree with Drs. Tripathi and Papadimos that oxygen saturation measured by pulse oximetry (Sp_{O_2}) below 90% is an arbitrary limit. We are also aware that hypoxemia does not necessarily involve hypoxia and organ injury, as you so pertinently point out. However, this is an educational article and we feel the need to have a clear message. In order to refer to hypoxemia a threshold must be established; 90% seems to be a commonly accepted, logical, and adequate limit.* Obviously, as with all constants and medical situations, the clinical context holds the same importance as the definition itself.

Crossing the limit is as noteworthy as the manner in which it is decreasing, sometimes sharply and rapidly. In addition, although the patient's tolerance may remain satisfying, any new incident has the potential for dramatic consequences given a lack of margin. Consequently, it appears reasonable for us to take action as soon as Sp_{O_2} drops below 90%.

We completely agree that a lower Sp_{O_2} may be acceptable in patients suffering from acute respiratory distress syndrome. We have had similar experiences in our center among patients with acute respiratory distress syndrome who have refractory hypoxemia and are undergoing veno-venous extracorporeal membrane oxygenation. The arterial oxygen saturation is only one component for oxygen delivery.[5,6] However, it seems difficult to test, within a randomized controlled trial, the hypothesis that Sp_{O_2} below 80% would be safe during anesthesia in planned surgery. Most surgical patients are prepared for surgery. Therefore, hemoglobin concentration and cardiac status are known and deemed satisfying before the intervention. Nonetheless, both may require monitoring and correction to optimize oxygen delivery to tissues.[7,8]

As mentioned in your response to our manuscript, "vigilant consideration must be given to a myriad of parameters that need to be perfectly controlled before discontinuation of surgical procedure." Certain selected patients with hypoxemia may benefit from extracorporeal gas exchange in order to undergo thoracic surgery.[9]

However, it seems important not to avoid overcomplication; pulmonary catheter, mixed venous oxygen saturation, and continuous cardiac output do not qualify as day-to-day monitoring in ordinary thoracic surgery. Based on our belief and experience, an OLV situation where the Sp_{O_2} is below 90% with a fraction of inspired oxygen of 100% first must always be tagged as an unusual and potentially dangerous situation, requiring, if not an immediate pause in the procedure, at least more acute attention from the anesthesiologist and understanding of the hidden physiopathologic mechanism behind this hypoxemia, with the specificities of OLV.

We agree with Gallart *et al.* that the chapter's title "Pharmacological Treatment to Limit Hypoxic Pulmonary Vasoconstriction" could lead to confusion. Consequently, the following title "Pharmacological Treatment to Limit the Shunt-like Effect" might be better. Regarding the effects of inhaled nitric oxide (iNO) on oxygenation during OLV, the improvement of oxygenation is not systematic. Indeed, iNO improves oxygenation by reducing intrapulmonary shunt in patients with severe hypoxemia during OLV.[10,11] This hypoxemia is correlated with the lung perfusion ratio between the operated lung and the ventilated lung; Pa_{O_2} decreased proportionally with perfusion of the operated lung.[4] In this situation, iNO improves oxygenation by increasing the perfusion of the ventilated lung without modifying hypoxic pulmonary vasoconstriction. Concerning positive end-expiratory pressure, it may paradoxically impair oxygenation by shifting pulmonary blood flow to the nondependent lung, thereby increasing intrapulmonary shunt.[12] Indeed, increasing airway pressure in the dependent lung is responsible for high pulmonary vascular resistances because of the compression of the intraalveolar vessels. Thus positive end-expiratory pressure in the dependent lung may divert blood flow away from the ventilated lung. This may counteract hypoxic pulmonary vasoconstriction in the nondependent lung and result in an increase in the pulmonary shunt fraction. In this specific situation, iNO may be useful in its ability to reduce the shunt while a positive end-expiratory pressure is applied to ventilated lung during OLV.[13] We agree that almitrine during OLV must be administered at a low dose and during a short period of time, but potential toxicity needs to be known. In conclusion, almitrine as well as iNO should not be routinely used, however, but should be considered when other strategies fail to improve oxygenation.

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(Accepted for publication April 26, 2011.)

Management of Unanticipated Difficult Airway in the Prehospital Emergency Setting

To the Editor:

We were greatly interested in the recent article of Combes *et al.*[1] that prospectively validated a prehospital difficult-intubation algorithm. In this clinical study, the tracheal intubation with direct laryngoscope proved impossible in 160 patients. However, of these 160 patients, 15 had a laryngeal view of the Cormack and Lehane (C&L) class I or II, which is generally regarded as an easy laryngoscopy.[2] The ease of direct laryngoscopy is not synonymous with ease of tracheal intubation, but the laryngeal view obtained by direct laryngoscopy usually is an important determinant of successful intubation. We would like to know the detailed cause of failed intubation in these patients with an easy laryngoscopy. Moreover, the authors did not clearly describe whether their algorithm required for use of an endotracheal tube with a malleable stylet at the initial intubation attempt. In managing difficult intubation, mounting the endotracheal tube onto a stylet and angling the distal tip upward help to guide the tube tip toward the glottis and improve the success rate of tracheal intubation.[3] This measure is especially useful when a poor laryngeal view is obtained during direct laryngoscopy or when using a flexible endotracheal tube without a natural anterior curve. In general, when speed of tracheal intubation is important (as in a patient with a full stomach or chest compression), an endotracheal tube should always be equipped with a stylet.[4]

In this difficult-intubation management algorithm, the authors recommended that if the tracheal intubation failed after either two attempts with a C&L class less than IV or a single attempt with a C&L class IV, along with optimal upper airway and head manipulations, the participants were requested to move to the next step of the algorithm, the gum elastic bougie (GEB). GEB-guided intubation was used as first choice and the intubating laryngeal mask airway (ILMA) as a backup. However, what usually determines the successful intubation with the GEB is part or complete visualization of the epiglottis with or without laryngeal structure. For an intubator who has no extensive experience in the GEB-guided intubation, if direct laryngoscopy can not expose any epiglottic structure as an objective mark (*e.g.*, C&L class IV), blindly inserting the GEB into the trachea will be very difficult. In clinical practice, the GEB-guided intubation is really most suitable for patients with a C&L class less than IV.[5] Thus, we consider that in their difficult-intubation management algorithm, the rescue step to use the GEB-guided intubation as first choice may be suitable only for the patients with a C&L class less than IV. After a single intubation attempt failed in patients with a C&L class IV, the rescue airway algorithm should move directly to the step that uses the ILMA to ventilate the patients and then to intubate the trachea, but not to the step that attempts reintubation with the GEB because it has high risks of failed intubation and increased airway trauma. For this situation, we completely agree with the editorial view of Drs. Isono and Ishikawa that maintenance of oxygenation is the final goal of airway management.[6]

The authors did not clearly state the type of the ILMA used for this difficult-intubation management algorithm. When an ILMA is used as a rescue airway device in the prehospital setting, we recommend use of the ILMA CTrach™ (Laryngeal Mask Company Limited, San Diego, CA) with the integrated fiberoptic channels and a detachable liquid crystal display viewer, rather than the ILMA Fastrach™ (Laryngeal Mask Company Limited). It has been shown that compared with the ILMA Fastrach™, the ILMA CTrach™ can enable a higher first-attempt success rate of tracheal intubation because of the view of the glottis it provides, the way it optimizes placement of the device, and the ability to observe the process of tracheal intubation through the device.[7] In addition, data from the study of Nickel *et al.*[8] suggest that the ILMA CTrach™ is a suitable device for emergency airway management in the prehospital setting because it provides ventilation and facilitates intubation with a very high success rate.

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