Editorial III

2000 – Time to apply Occam’s razor to failure of hypoxic pulmonary vasoconstriction during one lung ventilation

The matching of ventilation with perfusion has a particular relevance to thoracic anaesthetists because of the unique circumstances that arise as a consequence of implementing one lung ventilation (OLV) – their stock-in-trade. It is to be expected that a significant proportion of cardiac output will continue to perfuse the non-ventilated lung. A major cause of debate relates to observations that this is rarely as much as 50% and usually, under experimental circumstances, closer to 25%. The operation of passive (mechanical) and active (biological) forces are suggested for the smaller than anticipated shunt fraction. The most elusive to demonstrate is hypoxic pulmonary vasoconstriction (HPV). HPV is regarded as a primary and homeostatic mechanism that assures perfusion is matched to ventilation in the normal subject. It invokes a sensing system within the lung that detects the presence of a hypoxic gas mixture or, perhaps, blood oxygen content and reflexly activates a vasoconstrictive response that regulates the blood flow to poorly ventilated alveoli or lung zones. It developed a piquancy for thoracic anaesthetic practice when it was shown that the potent inhalational agents of the day instituted processes on the functional residual capacity (FRC) of the lung being used to maintain life. In clinical practice, these all result in hypventilation of the lung undergoing OLV and are only realistically reversible by the single force of effective ventilation via the long and narrow conduit – paediaic in dimensions – that is the bronchial lumen of standard double lumen tubes. Occam’s razor, so-called after a 14th century monk, William of Ockham, is a tool of logic and philosophy that is used for rationalizing scientific debate by paring the hypothetical. Most commonly translated as ‘entities must not be multiplied beyond necessity’, it is used to argue that of two or more explanations for a phenomenon, the simplest is the most likely to be true. In context, the questions therefore posed are – is there an alternative significant determinant of perfusion of the ventilated lung that is operational on the institution of OLV, and is it the more likely mechanism? Certainly to practitioners, the earlier explanations, and what is more, greater perfusion, is just one concern about the statistics. The failure of HPV caused by potent inhalational agents appeared to contribute 4–5% of the shunt fraction – a level that is clinically marginal and, arguably, biologically insignificant.

By the end of the 1980s, two of the main exponents in the field appeared to agree that HPV had less significance for OLV than previously thought. Though viewed as academically important, the issues raised were regarded as unlikely to have any clinical impact. By increasing the inspired oxygen concentration and changing the ventilation pattern, putatively deleterious effects on oxygenation were easily, safely and non-specifically remedied, without greatly impeding surgical access.

However, even now, with clinical reports that the shunt fraction to the non-ventilated lung is 35–45% with techniques considered to have only a small influence on HPV, the concept of failure of HPV continues to impact and exercises an undue influence on trainees and examination candidates. If asked to rank the causes of hypoxia during OLV, trainees put failure of HPV, due to the presence of a potent inhalational agent, second to perfusion of the non-ventilated lung on the list of importance and size of contribution to the shunt. Common and remediable causes, such as the position of the double lumen endobronchial tube, sub-optimal ventilation of the dependent lung, and the effects of the activities of the surgeons, are excluded. This distraction by side issues related to the non-ventilated lung, means that most learners actively need to be taught that a far more significant contribution to the size of the shunt is made by the forces of the anaesthetic and surgical processes on the functional residual capacity (FRC) of the lung being used to maintain life. In clinical practice, these are founded variables of pulmonary pathology. Studies were with small numbers and not conducted on uniform cohorts of right or left hemithorax operations: a bias or type error due to the normal or larger size of the right lung, and hence greater perfusion, is just one concern about the statistics. The failure of HPV caused by potent inhalational agents appeared to contribute 4–5% of the shunt fraction – a level that is clinically marginal and, arguably, biologically insignificant.

The counter-argument goes, that with the onset of surgery the main determinants of preferential flow to the ventilated, dependent lung are passive (mechanical) namely: the effects of the open or artificial pneumothorax and absorption atelectasis on the pulmonary vascular resistance of non-ventilated (and often, in practice – pathology containing) lung; and a gravitational effect on blood flow on adoption.
of the lateral decubitus position in those undergoing thoracotomy.

The debate between the chimerical and the visible was healthy for science and clinical practice so long as it was kept in a perspective that did not result in harm to patients. The focus of trainees on the hypothetical is of concern to the teachers and supervisors because remediable conditions can remain undetected and treatment unlearnt. Reversible pathophysiology, such as a collapsed lobe as a result of slight movement of a tracheal tube, may go unnoticed with longer term consequences for morbidity; poor technique may be encouraged. However, the potential to cause patients harm during anaesthesia is remote as the conduct of and selection for OLV nowadays is better: hypoxaemia is easily spotted and readily corrected.

But the arguments have gone beyond being between academic and journeyman. A fundamental axiom of the use of OLV – that it is never so essential that risks should be taken with a patient’s life to achieve it – has been breached. It has become necessary to apply a brake of some sort and, and/or introduce them to the routine of thoracic anaesthetic management. It is cheap, safe and curative, and rarely required, and that it is such an infrequent requirement, and that first line actions usually are corrective, point to the thesis that the mechanisms that make the shunt fraction reach a critical level during OLV relate to hypoventilation of ventilated lung rather than diversion of perfusion to non-ventilated lung.

Periodically, those charged with overseeing and those considering conducting clinical advances need direction from the practitioners in the field to help define standards. The change of millennium is an appropriate time to review guidelines for ethical research. It is also an appropriate time to take stock of HPV, its relevance and the vexed questions that the concept of its failure has raised for nigh on 30 yr. But, the debates must be returned to an academic framework. No further risk, such as exposure to toxic drugs, should be borne by those whose care is entrusted to us. In this instance, applying Occam’s razor will create the logic for a moratorium to be put on studies that have a high potential to be harmful and are therapeutically unjustified. Failure of HPV is cast as a doubtful clinical entity: certainly, it does not require a specific therapy. Without any raison d’etre, the intent to test novel and experimental therapies and/or introduce them to the routine of thoracic anaesthetic practice can, and should, be declared unethical.

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