Reply to the Editor:

We thank Dr Li and colleagues for their important comments to our article and appreciate their remarks. In particular, their results in patients during the postoperative period concerning determinants and implications of oxygen consumption (VO_2), a patient group that was not included by us, are essential.¹

In addition, their work presents the important conclusion that also other predictive equations published by LaFarge-Miettinen, Lundell and associates², Wessel and colleagues,³ and Lindahl⁴ do not accurately estimate VO_2 . Of course we should have cited their article.^{1,5}

Our study was especially designed to assess the importance of measured VO_2 in the preoperative diagnostic hemodynamic evaluation during cardiac catheterization. Our results emphasize that both the Krovetz-Goldbloom formula,⁶ which was used so far in our institution, and the most commonly used formula published by LaFarge and Miettinen² are not feasible in all patients to assume VO_2 to calculate cardiac output by using the Fick principle.

In contrast to the studies by Li and associates,^{1,5} VO_2 was measured with the standard commercial metabolic monitor Deltatrac II (Datex-Engström, Helsinki, Finland). This system is an open-air system equipped with a fast differential paramagnetic oxygen sensor to measure a differential signal between inspired and expired gases and a gas dilution system to measure flow.^{7,8} In contrast to the mass spectrometer method used by Li and associates, in our design no special adaptation in ventilated patients was necessary. After exclusion of any relevant air leak, the Deltatrac II device is easy to handle and allows a feasible and reliable method to measure VO_2 .

U. Fakler, MD

J. Hess, MD, PhD

German Heart Center

Department of Pediatric Cardiology and

Congenital Heart Disease

Technische Universität München

Lazarettstraße 36

D-80636 Munich, Germany

References

1. Li J, Bush A, Schulze-Neick I, Penny DJ, Redington AN, Shekerdemian LS. Measured versus estimated oxygen consumption in ventilated patients with congenital heart disease: the validity of predictive equations. *Crit Care Med*. 2003;31:1235-40.

2. LaFarge CG, Miettinen OS. The estimation of oxygen consumption. *Cardiovasc Res*. 1970;4:23-30.
3. Wessel HU, Rorem D, Muster AJ. Continuous determination of oxygen uptake in sedated infants and children during cardiac catheterization. *Am J Cardiol*. 1969;24:376-85.
4. Lindahl SG. Oxygen consumption and carbon dioxide elimination in infants and children during anaesthesia and surgery. *Br J Anaesth*. 1989;62:70-6.
5. Li J, Schulze-Neick I, Lincoln C, Shore D, Scallan M, Bush A, et al. Oxygen consumption after cardiopulmonary bypass surgery in children: determinants and implications. *J Thorac Cardiovasc Surg*. 2000;119:525-33.
6. Krovetz LJ, Goldbloom S. Normal standards for cardiovascular data. I. Examination of the validity of cardiac index. *Johns Hopkins Med J*. 1972;130:174-86.
7. Tissot S, Delafosse B, Bertrand O, Bouffard Y, Viale JP, Annat G. Clinical validation of the Deltatrac monitoring system in mechanically ventilated patients. *Intensive Care Med*. 1995;21:149-53.
8. Takala J, Keinänen O, Väisänen P, Kari A. Measurements of gas exchange in intensive care: laboratory and clinical validation of a new device. *Crit Care Med*. 1980;18:638-44. doi:10.1016/j.jtcvs.2005.09.029

Anesthetic preconditioning as the alternative to ischemic preconditioning

To the Editor:

We read with interest the article by Canyon and Dobson¹ presenting a combination of the adenosine A1 agonist 2-chloro-N6-cyclopentyladenosine (CCPA) and lidocaine as a possibly useful alternative to ischemic preconditioning in the clinical setting. As Canyon and Dobson¹ state, "A goal for more than 2 decades has been to develop a pharmacologic mimetic of IPC [ischemic preconditioning] to protect the heart during acute regional ischemia." Canyon and Dobson¹ unfortunately did not mention that volatile anesthetics are potent triggers of preconditioning, especially in the perioperative setting. Volatile anesthetic-induced preconditioning leads to a profound infarct size reduction, as effectively as does ischemic preconditioning,² and follows a dose-response relationship.³ Desflurane, enflurane, halothane, isoflurane, and sevoflurane induce anesthetic preconditioning.^{4,5} Apart from these experimental data, there is clear evidence for preconditioning by volatile anesthetics in human beings. Recent clinical studies indicate that volatile anesthetics confer cardioprotective effects in high-risk patients undergoing coronary surgery.⁶⁻⁸ Sevoflurane-induced preconditioning has

been seen to preserve myocardial function and decrease troponin I levels after cardiopulmonary bypass⁷ and even to reduce the incidence of late adverse cardiac events during the first year after surgery.⁸ Canyon and Dobson¹ emphasized that coadministration of lidocaine and CCPA was able to prevent life-threatening arrhythmias during ischemia and reperfusion. Again, volatile anesthetics show similar qualities: anesthetic preconditioning significantly reduces arrhythmias after ischemic periods.⁹ Stimulation of adenosine A1 receptors, among other membrane receptors, is part of the signal transduction pathway of anesthetic preconditioning.¹⁰ Therefore, it is unlikely that the administration of a selective adenosine A1 agonist in addition to a volatile anesthetic would further enhance cardioprotection. Canyon and Dobson¹ suggest intracoronary administration of CCPA and lidocaine for percutaneous interventions, off-pump and on-pump heart surgery, and perioperative applications. Apart from percutaneous coronary interventions, patients are anesthetized throughout these procedures. An inhalational anesthetic regimen would therefore appear to be the method of choice for patients at risk for perioperative ischemia because it would confer profound cardioprotection without the need for potentially deleterious additional intracoronary medication. Patients undergoing percutaneous coronary interventions might benefit from emulsified volatile anesthetics, administered intravenously at subanesthetic doses, in the near future.¹¹

In conclusion, there is a large body of evidence demonstrating that volatile anesthetics effectively induce cardioprotection, to the benefit of high-risk cardiac patients. Therefore, the need for adjuvant CCPA or lidocaine administered additionally to a patient already being protected by volatile anesthetics is questionable and remains to be proven.

Markus Lange, MD

Norbert Roewer, MD, PhD

Franz Kehl, MD, PhD, DEAA

Department of Anesthesiology

University of Würzburg

Würzburg, Germany

References

1. Canyon SJ, Dobson GP. Pretreatment with an adenosine A1 receptor agonist and lidocaine: a possible alternative to myocardial ischemic preconditioning. *J Thorac Cardiovasc Surg*. 2005;130:371-7.