

hyperemia directly after release of the blood pressure cuff. As stated in our article, we did not measure reactive hyperemia but performed our measurements in all groups after 20 min of reperfusion. It is, therefore, unlikely that reactive hyperemia caused the observed differences between groups. We agree that further studies are needed to clarify more the mechanisms of helium preconditioning in human endothelium.

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Differentiating Inspiratory and Expiratory Valve Malfunctions

To the Editor:

We appreciate Dr. Kodali's recent review of capnography outside the operating room environment.¹

Two small yet important details would benefit from further clarification. Figure 2C is purported to display the malfunction of an inspiratory valve in an anesthesia breathing circuit. Unlike a stuck, open expiratory valve, an inspiratory valve that remains open during expiration shows the end-tidal carbon dioxide baseline *returning to zero*.

The best way to understand this is to consider taking the circle system breathing circuit and removing the inspiratory valve entirely from the circuit. During expiration, one half of the exhaled carbon dioxide-rich gas will "exhale" into the inspiratory limb of the breathing circuit. With the next inhalation, roughly the first half of the inspired breath will contain this exhaled gas, and the last part of inspiration will be fresh gas from the absorber and the fresh gas flow, *i.e.*, carbon dioxide-free gas, which allows the capnogram to return to the zero baseline. Compared with the normal capnogram, with a competent inspiratory valve, the inspiratory downstroke will sluggishly return to a zero baseline (or a B angle greater than 90 degrees) as appropriately depicted in the cartoon in

figure 2C. This subtle difference that occurs with the baseline returning to zero helps elucidate the difference between malfunctioning inspiratory and expiratory valves or exhausted carbon dioxide absorbent.

The second point is that in figure 3 A–D, the apparent presence of inspired carbon dioxide is an abnormal finding, and suggests that in this sedation case, there is evidence of rebreathing in the microenvironment around the face, which may occur as a result of draping. The normal inspired carbon dioxide during sedation is expected to be zero.

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1. Kodali BS: Capnography outside the operating rooms. *ANESTHESIOLOGY* 2013; 118:192–201

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In Reply:

I thank the authors Giordano, Gravenstein, and Rice for their valuable comments on the subject of "Capnography Outside the Operating Rooms."¹ Due to the limitations of word count for "Clinical Concepts Commentary," a detailed account of each capnogram was not provided. Given the wider scope of electronic accessibility, the intention of the article was to provide a comprehensive review of the use of capnography outside operating rooms not only to anesthesiologists and certified registered nurse anesthetists, but also to physicians in other specialties and nurses who provide sedation. Therefore, the article was scripted to provide a concise physiologic background and clinical applications of capnography.

Giordano *et al.* raised important comments regarding capnograms 2C and 3A–D of the article.¹ Analysis of capnograms 2C and 3A–D in the aforementioned article is a little more complex than the explanation provided by Giordano *et al.* Regarding 2C, they state that the inspiratory downstroke will sluggishly return to a zero baseline (or a β angle >90 degrees) during inspiratory valve malfunction. This may be true in the typical circumstance described by Giordano *et al.*, where an assumption is made that half of the expiratory gases will enter the inspiratory limb. However in reality, the quantity of expiratory gases entering the inspiratory limb is dependent on the resistance to the flow of expiratory gases in each limb of the circuit. The resistance in turn is dependent on the design of the valves, extent of malfunction of the inspiratory valve, fresh gas flows, and the length of the circuit. In addition, the carbon dioxide concentration across the inspiratory limb is also dependent on turbulent *versus* laminar flow of expiratory gases and mixing of carbon dioxide-free fresh gases with expiratory gases in the inspiratory limb (expiratory gases do