Pulseless Pulse Oximetry

To the Editor:

We read with great interest the article by Aldrich et al in this issue of CHEST (see page 1484). In 2003, we reported our trial of measuring noninvasive arterial saturation during a pulseless situation (cardiopulmonary bypass [CPB]) by inducing a simulated pulse. We were interested in finding a way to obtain pulse oximeter function during CPB at the time because we had experienced a mortally instructive cardiac case in which the routine anesthesia practice of turning off the pulse oximeter during CPB resulted in severe hypoxic brain damage.

Aldrich et al did not describe their method in detail, so we are not sure whether the method they used was the same as ours. We applied a BP cuff at the forearm or finger, which was intermittently (0.5-1 Hz) inflated by a makeshift air pump to produce simulated pulses. A conventional pulse oximeter and its probe were attached to an ipsilateral finger.

Our system worked under most conditions, and the method was patented, but we could not pursue further development because, ironically, the algorithms used and the features integrated into conventional pulse oximeters to eliminate undesirable clinical noise prevented us from achieving steady and reliable measurements. The current assumption that only arterial blood is pulsating may not be valid because our method of inducing pulsation definitely changed over the past decade regarding concern for direct current ratios, making pulsations unnecessary. Rather than measuring a ratio of alternating current/direct current ratios, we take a ratio of directly measured changes in attenuance of each wavelength that occur immediately after release, resulting venous and tissue pulsation artifacts alluded to an ipsilateral finger.

Aldrich et al should be commended on their approach to developing a designated oximeter for this purpose as our approach of using a conventional pulse oximeter has serious limitations. We needed industry to cooperate with us, but unfortunately this proved difficult because of a perception of small clinical need. Conditions have changed over the past decade regarding concern for patient safety and for continuous oxygenation monitoring of pulseless conditions. In addition to its use in CPB, patients on extracorporeal membrane oxygenation and those with an artificial heart have now been added to the wish list.

The current common practice of depending solely on intermittent arterial blood gases from the CPB circuit alone is critically flawed. All pulseless conditions should be monitored for arterial oxygenation.

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CONFLICT OF INTEREST: None declared.

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Response

To the Editor:

We appreciate the interest of Drs Asahina and Miyasaka in our article and our technique. Our method was described in more detail at the 2014 Health and Bio Technology Summit in New York. It is indeed different from the technique based on artificial pulses generated by oscillating inflation of occluding cuffs that is described by Asahina et al and explored in more detail by Schoevers et al. We use momentary arterial (and specifically not venous) occlusion and release, rather than cuff occlusion, and, to estimate arterial oxygenation, we take a ratio of directly measured changes in attenuation of each wavelength that occur immediately after release, rather than measuring a ratio of alternating current/direct current ratios, making pulsations unnecessary.

We believe that a crucial element of the technique is that changes in blood content of the digit during measurement should be exclusively arterial. Consequently, simple cuff occlusion is unsuitable because of the resulting venous and tissue pulsation artifacts alluded to...
by Drs Asahina and Miyasaka. An alternative might be to use rapid two-stage cuff occlusion, the first above arterial pressure and the second below arterial but above venous pressure; the blood content change between the two stages should be arterial alone, and measurement would be of changing attenuation ratios, as we describe, between the two occlusions.

We fully agree that pulseless oximetry would provide an important level of safety above and beyond intermittent blood gas monitoring for patients with cardiopulmonary bypass, extracorporeal membrane oxygenation, left ventricular assist devices, and any other pulseless or near-pulseless condition with preserved digital perfusion. Perhaps the most valuable use would be in ambulatory patients with left ventricular assist devices, for whom arterial puncture for blood gas monitoring is particularly unappealing.

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