In Reply:

We read with interest the letter from Shelley *et al.* commenting on our editorial.[1]

Interestingly, although Shelley *et al.* disagree with our *"editorial's implication that there is something inherently limiting about the photophlethysmography signal that would prevent its use during high-risk surgery,"* we actually strongly feel that this letter echoes what we pointed out in our editorial. Our point—and Dr. Shelley's point—was that the photophlethysmography signal is complex and requires sophisticated processing to obtain a meaningful information. That does not imply that the photophlethysmography signal cannot be used during high-risk surgery. It only means that a simple analysis is limited. As stated in our editorial, we are convinced that more sophisticated signal analysis will help to better define the use of the photophlethysmography signal during high-risk surgeries, and we feel that Dr. Shelley's technique of using both frequency domain and time domain approaches is promising.[2] We also believe that any study assessing the ability of the photophlethysmography signal to predict fluid responsiveness during surgery should actually test the predictive value of the photophlethysmography signal (by performing volume expansion and testing the ability of the photophlethysmography signal to predict responders and nonresponders) and not just compare the photophlethysmography signal to the arterial pressure waveform.[3]

Ironically, in the interval between our editorial was published and the present exchange of letters to the editor, another article assessing the ability of the photophlethysmography signal to predict fluid responsiveness during major surgery was released in the British Journal of Anaesthesia.[4] In this study, Vos *et al.* showed that the photophlethysmography signal is as accurate as the arterial pressure waveform for the prediction of fluid responsiveness in this setting. It is important to note that this study used a rigorous fluid responsiveness prediction methodology and a complex digital signal processing.

There is nothing inherently limiting about the photophlethysmography signal that would prevent its use during major surgery. We just need to identify the correct way to analyze this complex signal to extract the relevant information in the appropriate setting.

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References

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In Reply:

First of all, we would like to thank Shelley *et al.* for the positive critique and discussion of our recent study in Anesthesiology.[1] The letter of Shelley *et al.* pointed out the role of the venous blood pool variation in the generation of the photophlethysmography signal. Indeed, by study design, this component of the photophlethysmography signal was neglected in our article. Our purpose was to evaluate the correlation between ventilation-induced variations of signals acquired by arterial pressure transducer and by pulse oximetry by using commercially available monitors. Operating this way, we used the same devices as previous teams who compared time-point measurements.[2,3] We found a weak correlation between both signals acquired all along the anesthetic procedure. The numerous explanations noted in our article and the letter of Shelley *et al.* for this discrepancy have a two-fold source. The signal processing on one hand and the complex physiologic components of the photophlethysmography signal on the other hand. The latter involve stroke volume, sympathetic activity, and ventilatory-induced arterial and venous pressure variations. Extracting the last component could be an elegant manner to gain information on blood volume variation before the cardiac output being affected. However, this extraction requires sophisticated signal processing involving frequency domain analysis, and the way to a clear indicator is not that simple. Several steps toward a reliable monitor remain to be carried out.[4] But whatever the future signal, it will have to prove efficiency in low- and high-risk surgery patients. Our feeling is that no one would be confident in a monitor providing reliable indications in low-risk patients, but failing if this patient becomes at risk for whatever intraoperative event, or of no use in high-risk patients.

We believe that the future of the photophlethysmography signal use is the development of a more advanced signal processing. Dr. Shelley's letter adds further interest in the photophlethysmography signal suggesting extraction of hidden information included in the venous modulation.

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