

Ambulatory and Perioperative Blood Pressure: Comment

To the Editor:

We read with great interest the paper by Saugel *et al.*¹ reporting that preinduction and lowest intraoperative blood pressure measurements are different than ambulatory measurements made during the daytime and nighttime.

Without entering the debate as to whether intraoperative blood pressure measurements can be used as surrogates for organ perfusion,² and the fact that there is only an *association* and not direct causation between intraoperative mean arterial pressures lower than 65 mmHg and adverse clinical outcomes,³ we would like to address some methodologic issues concerning this study.

The two blood pressure monitors used in the study were not calibrated. It is possible that in the same individual there would be differences between simultaneous blood pressure measurements done with the two devices. Additionally, in the ambulatory setting, the blood pressure was measured on the nondominant arm. There is no information on whether this was also done in the operating room. This is an important issue as in many people there are differences in blood pressure measurements between the two arms.⁴ Moreover, in obese patients (who were not excluded), noninvasive blood pressure measurements are highly inaccurate when compared with invasive measurements.⁵

The arbitrary exclusion of very low and very high ambulatory blood pressure measurement “artefacts” and measurements done during the retiring and rising period could have skewed the results. Ambulatory blood pressure was measured at 30-min intervals, but then compared with intraoperative measurements made at 3-min intervals and invasively measured blood pressure at 1-min intervals. There were thus at least 10 times more measurements in the operating room than in the ambulatory setting, and it is well possible that the ambulatory measurements do not represent the variability in blood pressure for someone awake or asleep.

Moreover, comparing intraoperative invasive with ambulatory noninvasive blood pressure measurements is problematic. First, these are totally different technologies that cannot be treated as equivalent. In the operating room, during hypotension, noninvasive blood pressure tends to be

higher than invasive blood pressure, and during hypertension, the noninvasive blood pressure tends to be lower than invasive blood pressure.⁶ Second, placing and zeroing of the transducer for invasive blood pressure measurement must be standardized and checked continuously. A height difference of only 5 cm from the left atrium to the transducer results in a 4-mmHg reduction or elevation of the invasive blood pressure measurement. Third, technical issues such as air bubbles (causing “damping” and false lower blood pressure measurements) or amplifying of the signal (causing “overshoot” and false high blood pressure measurements) must be taken into consideration.⁷

Knowing the “normal” patient’s blood pressure may help to optimize the intraoperative hemodynamics. But with the methods used in this study, the value of the results is questionable since in our opinion, “apples were compared with pears.”

Competing Interests

The author declares no competing interests.

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In Reply:

Dr. Alexander Avidan asserts that hypotension is only associated with adverse outcomes. In fact, a randomized trial identified a 27% reduction in the relative risk of a composite of serious complications in patients assigned to tight individualized *versus* routine blood pressure management.¹ Available evidence thus suggests a *causal* relationship.

Dr. Avidan asks whether various monitoring methods might explain differences between ambulatory and perioperative pressures in our recent report.² We recorded ambulatory pressures with upper-arm cuff oscillometry, a well-validated technique.³ Oscillometric ambulatory pressures better estimate individual blood pressure than single office measurements⁴ and are considered the reference method for assessing out-of-office pressures.⁵ For example, an international consensus group recently defined automated ambulatory blood pressure monitoring as “the optimal method to establish baseline values” before surgery.⁶

We similarly used upper-arm oscillometry to measure blood pressure before induction of general anesthesia and in 98% of patients during surgery. The relationship between oscillometrically and directly measured pressures is thus irrelevant to our assertion that preinduction pressure poorly represents normal ambulatory pressure. Upper-arm cuff oscillometry is by far the most common intraoperative blood pressure monitoring approach and is routinely used by clinicians to guide care. As with any monitor, oscillometric pressures are imprecise, but systematic bias is small.⁷

Dr. Avidan notes that arm-to-arm blood pressure differences may have contributed to the poor relationship we observed between preinduction and ambulatory pressures. Population average systolic and diastolic pressures are similar in the right and left arms.⁸ There can be inter-arm differences in individual patients,⁸ but substantive differences are relatively rare. In patients like ours, for example, only about 5% of patients have a systolic inter-arm difference of 10 mmHg or more.⁹ Presumably, inter-arm differences in mean arterial pressure would be even less.

Only 2% of our patients had an arterial catheter. Our clinical routine is to correctly level and zero pressure transducers, and repeatedly evaluate signals for incorrect damping. Importantly, we report mean arterial pressures, which are hardly influenced by damping. And again, errors would presumably be random and unlikely to influence our conclusions.

Dr. Avidan notes that we recorded ambulatory pressures at 30-min intervals and, of course, monitored pressures far more often intraoperatively. The issue, though, is not the frequency *per se*, but whether the frequency was sufficient to identify clinically important variation under each condition. Ambulatory pressures presumably change slowly compared to intraoperative pressures—which is exactly why intraoperative pressures are recorded frequently. Our monitoring intervals were therefore appropriate for each period.

Our definitions of daytime and nighttime pressure and our approach to identification and exclusion of artefactual blood pressure readings followed international guidelines.^{10,11} The number of excluded artifacts during ambulatory blood pressure monitoring was well below accepted standards used to define “complete recording.”¹²

In summary, our study methodology was sound and fully justifies our conclusion that preinduction mean arterial pressure cannot be used as a surrogate for the normal daytime mean arterial pressure, and that intraoperative mean arterial pressures are lower than the lowest nighttime mean arterial pressure in most patients.

Competing Interests

The authors declare no competing interests.

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Prevention and Prediction of Postsurgical Pain: Comment

To the Editor:

Although we applaud the Heart Surgery and Persistent Postsurgical Pain (Heart PPPAIN) study by Anwar *et al.*¹ for highlighting and addressing the complex and challenging condition of chronic pain after sternotomy, we would like to clarify some details before adopting their protocol into clinical use. The authors well recognize the