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The Monitoring of the Autonomic Nervous System: Myth or Reality

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Abstract

Every physiological or pathological change of the body is mirrored in a parameter alteration, but still there are elements that cannot be measured. In literature, authors tried to find a way to monitor the Autonomic Nervous System activity through different algorithms. A pleth-wave derived parameter, the Perfusion Index, could be helpful in monitoring the Autonomic Nervous System modifications. The Perfusion Index is modified by any vasoconstrictor or vasodilatative stimuli. In literature, there are studies that correlate the Perfusion Index with several external influences. As anesthesiologists, there are many situations where this index may be useful.

In our department, we observed and noted the Perfusion Indexmodifications on 20 patients (15 scheduled for elective surgery and 5 from the ICU) before and after induction, laryngoscopy, incision, emergence from anesthesia, regional anesthesia, vasoactive drug administration and body temperature changes. In these situations, Perfusion Index modifications occurred.

Keywords: Plethysmography; Pulse oximetry; Perfusion Index; Perf Index; PI; Autonomic Nervous System; Non-invasive monitoring; Pleth wave

To the Editor:

Every physiological or pathological change of the body is mirrored in a parameter alteration.

Technology made huge steps forward allowing us to obtain precise and multiple measurements, but still there are elements that physicians cannot monitor. Moreover, some of the monitoring devices are expensive, invasive and their usage could represent a risk for the patient. It may be possible to read the Autonomic Nervous System (ANS) response, but in literature authors tried to find a way to monitor the ANS activity through different algorithms with poor results [1]. Therefore, what if something is hidden beyond the plethismographic wave? Plethysmography is wide spread. It is cheap, fast, and information-rich. Nowadays, even low-end devices display the pleth waveform and the perfusion index (PI) as a saturation reliability indicator. This index measures the relative height of the pleth wave compared to the non-visible and non-pulsatile height of that wave, and it is displayed as a percentage value [2]. Therefore, every vasoconstrictor stimulus reduces the PI as well as any stimulus that acts on the sympathetic nervous system. On the contrary, every vasodilatative stimulus or any other that stimulates the parasympathetic or inhibits the sympathetic nervous system increases the PI.

In literature there are studies that correlate the PI with external influences. Takayama et al. [3] described the PI as a parameter resembling the body response to pain or stress hormones. The gravitational posture influence on PI has been investigated by Colombo et al. [4]. Furthermore, many authors presented the PI as a parameter to assess fluid responsiveness, but the results are controversial [5]. In a recent work by Tanaka et al, the PI was described as an early indicator of blood losses after delivery, earlier than other parameter alterations such as heart rate and blood pressure [6].

As anaesthesiologists, there are many situations where this index may be useful. In our department, we observed and noted the PI modifications on 20 patients: 10 patients were scheduled for elective surgery in general anaesthesia, 5 patients for elective surgery in regional anaesthesia, 5 patients were critically ill from the ICU. For each patient, the PI was recorded in different situations related to the anaesthesiological management.

Since the PI is a continuously provided measurement and the basal PI (the PI measured before any modification takes place) varies from patient to patient, only a PI "increase" or "decrease" was noted. Therefore, any PI "increase" or "decrease" noted was chosen to be at least equal to the amount of the basal PI value and remained stable for at least 30 seconds to be considered reliable. This definition was not always applied to the 5 ICU patients because it was not possible to measure the basal PI value before every modification took place.

Regarding the patients scheduled for general anaesthesia, the PI values were observed before and after induction, laryngoscopy, incision and emergence from anaesthesia.

In all 10 patients the PI increased after induction. On the contrary, it decreased after laryngoscopy, after incision and during emergence. This helped to unveil an imperfect or overestimated analgesia for laryngoscopy or surgery, being the pain a factor affecting the sympathetic tone. During the emergence form anaesthesia, the PI decreased actually before the patient's awakening, suggesting that the sympathetic tone is rising before consciousness.

Regarding the patients scheduled for regional anesthesia, PI values were noted before and after the regional anesthesia for a 10-minute-period, being careful to place the pulse-oximeter to the limb where the block was performed. In all five patients, a PI increase within the 10-minute period was recorded. Since no systemic drugs were administered, it is possible that the PI increase is due to the sympathetic blockade provided by the local aesthetic, resulting in vasodilation [7,8].

Regarding the critically ill patients,the PI was noted when vasoactive drugs were administered, when body temperature changes (i.e. warming up after cardiac surgery induced hypothermia) and sedation modifications occurred. In ICU, the PI appeared to be inversely correlated with consciousness status and vasoactive drug administration, and positively correlated with body temperature. As stated previously, it was not possible to measure the basal PI for all those patients. In the cases of vasoactive drug administration and sedation stop, the PI value after the modification was subtracted from the PI recorded before that modification took place. If the resulting number was at least equal to the PI after the modification, the PI was considered decreased.

In detail, a decrease was noted after sedation was stopped, supporting the findings on the patients observed in the operating theatre during emergence from anaesthesia. A decrease was also noted in patients starting vasoactive drug administration. In the latter case, the PI was already low (<1) before the administration and it was further reduced, so it is possible that the plethysmographic wave and the PI signal strength were not technically reliable. In the end, an increase in the PI was recorded when the patients' body temperature increased by warming up after cardiac surgery induced hypothermia.

Even though these preliminary data seem to be interesting, further data validation is required. In conclusion, the PI could be applied in several medical scenarios. It is diffused and cheap. Every physician can see the changes in the pleth wave height, where in the PI is not directly measured. We believe that the monitoring of the autonomic nervous system with the plethysmographic technique is now a reality and not only a myth.

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