Intraoperative nociception monitoring gadgets- present status

Dear Editor,

Artificial intelligence (AI) is the study of algorithms that give machines and monitors the ability to reason and perform functions such as problem-solving, object and word recognition, inference of world states, and decision-making. AI has found tremendous applications in anesthesia and perioperative care, intensive care, and pain management. Currently, AI has been utilized in the depth of anesthesia monitoring, target-controlled infusions, prediction of events such as hypotension, recovery from a neuromuscular block and general anesthesia, and intraoperative nociception.[1]

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage." Nociception is not a feeling perceived by the patient but is the result of the processing of the noxious stimuli by the peripheral and central nervous systems sustained by the tissues. Technological advances have given the anesthesiologists gadgets to monitor anesthetic depth (Bispectral index, Spectral Entropy), neuromuscular blockade with the train of four, hemodynamic parameters using continuous cardiac output monitoring. However,

monitoring and treating intraoperative nociception still is a wild guess.[2]

There are several ways in which anesthesiologist's could assess intraoperative nociception as perceived by the patient under general anesthesia. This might not be reliable with the use of beta-blockers, blood loss, hypovolemia, anticholinergic medications, presence of a pacemaker, and arrhythmias. Anesthetic drugs *per se* cause vasodilatation which could be unrelated to nociception. Other parameters that are indirect indicators of intraoperative nociception are cold hands, sweating of hands, dilated pupils, electroencephalographic, and electromyographic changes. Intraoperatively, presumed nociception is managed with further doses of analgesics which are usually opioids. These surrogate markers are not only inaccurate but are subjective. Therefore, the anesthesiologist either undertreat or overtreats the nociception based on their interpretation, both of which are detrimental for patient outcomes.

Recently there have been several gadgets introduced in the market which use different principles and algorithms and thus provides a score that gives information about intraoperative nociception. All these monitoring systems have their plus and minus points. Therefore, to date, there is no validated gadget that can be recommended as the device of choice for monitoring intraoperative nociception.[3]

Analgesia Nociception Index or ANI (MetroDoloris Medical Systems, Lille, France) is derived from the analysis of heart rate variability from the electrocardiography used during surgery under anesthesia. Surgical interventions (incision, stretching, pneumoperitoneum) affect ANI which alerts the anesthesiologist. Any event causing nociception leads to a decrease in parasympathetic tone and thus would decrease in ANI scores. A score of 100 is suggestive of maximum parasympathetic tone and low nociceptive levels, while a score of 0 suggests a minimum parasympathetic tone and high nociceptive levels.[4]

Nociception level (NoL) Index is available in the PMD-200 monitor (Medtronic®). This consists of a noninvasive finger probe fitted with four sensors (photoplethysmography wave amplitude, galvanic skin response, peripheral temperature, and accelerometery) which extracts multiple pain-related physiological signals. The algorithm analyses heart rate, heart rate variability, pulse wave amplitude, skin conductance level, skin conductance fluctuations, skin temperature, and movement. These parameters are analyzed by algorithms to identify the patient's pain-related pattern, which is depicted on the monitor as a number (between 0 and 100, 0: no pain/nociceptive response and 100 represents extreme pain/nociceptive response).[5]

The surgical pleth index (SPI, GE Healthcare, Helsinki, Finland) is a score generated from the photoplethysmographic analysis of the pulse wave and the heartbeat interval. SPI as a number denoted the patient's responses due to increased sympathetic activity as a result of nociceptive stimuli. SPI scores monitored intraoperatively reflect a patient's autonomic response to certain nociceptive stimuli. The SPI scores range from 0 to 100, with a high value associated with significant nociception.[6]

qNOX score (between 0 and 99) is an electroencephalography and electromyography-based score marketed by Quantium Medical S.L. and distributed by Fresenius Kabi. A qNOX score less than 40 signifies a very low likelihood, a score of 40-60 a low likelihood, and more than 60 suggests a higher likelihood of a response to nociception. Unlike other scores, a qNOX does not rely on autonomic nervous system activity. However, as it needs an EMG, the use of neuromuscular blocking drugs could probably interfere with the quantification. Presently there are no robust studies that mention its superiority over other scores.[7]

Although these indexes have been used quite satisfactorily, there is no validated gadget that can be recommended as the device of choice for monitoring intraoperative nociception. Well-designed studies and results of systematic review and meta-analysis subsequently could enlighten us about this dilemma.

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