Anesthesia practice in the era of artificial intelligence

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Artificial intelligence (AI) is a new advanced technology in the field of computer science aimed to create systems or machines capable of performing the task which otherwise require human intelligence like reasoning, learning, understanding the language, problem solving and decision making, by processing data in real time through the input neurons, perceptrons and nucleus ultimately producing an output. AI is categorized as - machine learning (supervised and unsupervised and reinforcement learning, uses both labeled and hidden data to predict outcomes), deep learning (interpreted and analyzed medical images and waveforms) and natural language processing.[1]

Supervised machine models algorithm in a patient for pre-anesthesia evaluation can analyze the patient data to identify individuals at the high risk for adverse events to occur. In airway assessment, AI helps to predict difficult intubation by using imaging techniques like ultrasound, nasal endoscopy and, facial and airway structures' anatomy recognition techniques. Hence, ultimately helps anesthesiologists to optimize preoperative planning and strategies, to choose appropriate equipment and appropriate anesthetic technique. Such prior prediction by AI enhances better patient's safety and improves outcome.[2,3]

During intra-operative and postoperative period, AI analyzes data from various monitors simultaneously and can detect early signs of altered physiology like hypoxia, hypotension, hypovolemia, arrhythmias etc. enhancing situational awareness. Hypotension prediction index is a machine learning algorithm, developed from intraoperative mean arterial pressure (MAP) waveforms and is used in Acumen IQ cuff and Acumen IQ sensor devices that predict episodes of hypotension (MAP less than 65mmHg for 1 minute) 15 minutes in future, allowing time for anesthesiologists to intervene by fluid therapy and vasopressors preventing organ hypo-perfusion and damage. AI prevents ventilator induced lung injury and ensures adequate oxygenation and ventilation to the patient by continuously adjusting mechanical ventilator parameters like tidal volume, positive end expiratory pressure, respiratory rate and oxygen concentration.[4]

Depth of anesthesia is analyzed by the Electroencephalogram (EEG) signals or Bi-spectral Index (BIS), detecting minimum neural changes prior to the clinical signs appear and prevent intra-operative awareness and excessive use of anesthetics.[3-5] It has incorporated drug delivery system which calculates the optimum dose of anesthetics and analgesics based on patient's details like age, weight, co-morbidities and real time physiological data ensuring stable drug response, minimizing side effects and faster emergence from anesthesia at the end of procedure. Closed Loop Anesthesia Delivery System (CLADS) algorithm use in AI continuously monitor depth of anesthesia and hemodynamic, and automatically adjust mechanical ventilation and administer goal directed intravenous fluid and drugs like opioids, propofol and vasopressors via syringe pumps. Its use can control blood glucose by insulin delivery system.[5]

Real time ultrasound images are analyzed by AI deep learning models identifying the nerves, anatomical structures and guide to optimal needle trajectories improving success rate and minimizing complications and procedure time in regional anesthesia.

Analyzing preoperative features including preparation time, frailty index, intraoperative use of vasopressors by machine learning models in electronic anesthesia records give accuracies up to 87.75% for prediction of postoperative delirium. Brain Natriuretic Peptide, C-reactive protein, and Lactate dehydrogenase was identified as contributors of postoperative delirium suggesting the role of inflammation and cardiac biomarkers. These biomarkers support clinically to the AI prediction.[3]

Similar surgeries might have variable postoperative pain due to autonomic and physiologic variations in individual. Prediction of postoperative pain by machine learning based algorithm that is The Nociception Level Index (NOL) assessed nociceptive stimulus (intubation, trocar insertion) levels in anesthetized patient and predict postoperative pain which ultimately might tailored multimodal analgesia plan and reduce intraoperative opioid consumption and side effects.[4,6]

Though AI in anesthesia offers several benefits mentioned above including no human error, it left behind many challenges and limitations like difficulties in integrating with existing hospital systems, high implement and maintenance cost, need of specialized and extensive trainings to clinicians

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and staff, poor data quality and poor population generalization, and reduce clinical skill of clinicians in long run.[3]

Responsibility for any complication to the patient may be unclear among clinician, hospital or AI developer. Accountability for the adverse outcome and transparency of AI in decision making process must be ethically clear before clinical use and must always apply under the supervision of trained anesthesiologist. Larger clinical trials require to draw the confirmed conclusions.[4,5]

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