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Pulse oximetry: Mandatory for sedation during regional/local Anaesthesia (but watch for hypoventilation!)

Hypoxia and hypoventilation are the two most potent dangers during anaesthesia. The pulse oximeter is a simple, safe, rapid, noninvasive and reliable indicator of hypoxia. Large observational studies,^[1] randomized controlled trials^[2] and systematic reviews^[3] have confirmed that monitoring by pulse oximetry effectively detects hypoxia and reduces the incidence of non-fatal adverse outcomes compared to clinical monitoring alone. There is universal agreement that pulse oximetry has led to an exponential leap in patient safety and that pulse oximetry is mandatory during anaesthesia. The minimum monitoring standards for providing anaesthesia adopted by the Indian Society of Anaesthesiologists (ISA) in 2007^[4] state that "It is mandatory for Oxygenation to be further monitored by Pulse Oximetry...". This recommendation has been wholeheartedly accepted by the anaesthesia community in India. The WHO has made pulse oximetry an integral part of its Safe Surgery Saves Lives campaign, and the question "Is the pulse oximeter on the patient and functioning?" is an essential item in the WHO Surgical Safety check list.^[5]

This enthusiastic endorsement of pulse oximetry must however be modulated by understanding that hypoxia may only be a late manifestation of a serious complication, and while a low SpO₂ provides a warning signal, it does not provide any clue to the cause of hypoxia. Hypoventilation is an important cause of hypoxia during anaesthesia, especially in awake patients receiving sedatives and opioids. Hypoventilation leads to a high PaCO₂ which then results in a low PaO₂. The Oxygen supplementation can correct hypoxia, but will not correct hypoventilation or its cause.

In this regard, it is worth considering that patients

receiving sedation with local anaesthesia (LA), often termed Monitored Anaesthesia Care (MAC) in the Western literature, and those receiving sedation with regional anaesthesia (RA) may in fact be highly prone to hypoventilation and hypoxia. Metzner *et al.*^[6] analysed trends in the American Society of Anaesthesiologists (ASA) Closed Claims database from 1985 to 2007. Claims arising from MAC increased from 2% of claims in the 1980s, to 5% in the 1990s and to 10% of claims in 2000 and later. Death was the most common outcome (38%) in claims associated with MAC in 1990–2007. Death was significantly more common in claims associated with MAC than in claims associated with general anaesthesia (GA) or RA during this time period. Bhananker *et al.*^[7] focused on claims related to MAC in the ASA Closed Claims Database since 1990. More than 40% of claims associated with MAC involved death or permanent brain damage, similar to GA claims. Respiratory depression after absolute or relative overdose of sedative or opioid drugs was the most common specific damaging mechanism in MAC claims. Nearly half of these claims were judged as preventable by better monitoring, including capnography, improved vigilance, or audible alarms.

Patients receiving GA are usually extensively monitored, and pulse oximetry is almost always used. However, the same cannot be said for patients undergoing sedation with LA or RA. It is not uncommon to find a more relaxed atmosphere in the operating room when surgery is being performed under RA or LA, and such cases are often delegated to junior anaesthetists. At times, a single anaesthetist may simultaneously supervise multiple cases if one or more cases are being performed under LA and sedation. Thus, these patients may not be monitored adequately,

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the anaesthetist may not be present continuously, and appropriate care including oxygen supplementation may not be provided, either during the procedure or in the immediate postoperative recovery period. Several patients may receive LA or RA because they have significant medical disease. Patients undergoing cataract surgery are often elderly and may have unpredictable responses to sedatives and opioids, and can develop dangerous respiratory depression.

High levels of central neuraxial blockade can weaken the respiratory muscles, and hypoventilation is compounded by the depression of respiratory drive by sedatives and opioids. Attempts to overcome patchy or inadequate regional anaesthesia by increasing sedation or by “subanaesthetic” doses of ketamine or propofol can lead to airway obstruction, respiratory depression, and hypoventilation. A similar chain of events can occur during recovery from anaesthesia due to the residual effects of anaesthetics, opioids, and neuromuscular blocking agents as well as drugs given for postoperative analgesia.

Oxygen supplementation does correct hypoxia due to hypoventilation, and must be provided in all patients receiving sedation with LA or RA. However, if oxygen is not provided, or if oxygen supplementation is stopped either when the procedure is completed or when the patient is shifted to the ward, persistent, undiagnosed and untreated hypoventilation can lead to life-threatening hypoxia and cardiac arrest.

In this context, the report by McHugh *et al.*^[8] published in this issue of the *IJA* is extremely timely and relevant. Their paper describes the results of a pilot study from four hospitals in one State in India, a subset of a larger multinational study on the Global Oximetry (GO) project published by Walker *et al.*^[8] The GO project was launched as an initiative between the World Federation of Societies of Anaesthesiologists (WFSA), the Association of Anaesthetists of Great Britain and Ireland (AAGBI), and GE Healthcare. The overall goal of the GO project was to increase patient safety during anaesthesia and surgery in low and middle income countries by decreasing oximetry costs and increasing oximetry utilisation.^[8,9] There are a few interesting observations in this study that send out an important message.

First, during December 2007 to January 2008, just over three and a half years ago, in the four hospitals studied in Haryana state (including a tertiary referral hospital for that state), it was not possible to monitor

every patient undergoing a surgical procedure with a pulse oximeter. There was a deficiency of between two and nine oximeters in the four hospitals, making the oximetry gap between 38% and 83%. Individuals and institutions should make every effort to ensure that there is a working, functional oximeter for every patient undergoing surgery, and that there are sufficient spares and supplies (finger probes, batteries, etc.) to ensure uninterrupted operation.

Second, there were a significant number of desaturation episodes associated with RA and LA. In the operating room, more desaturation events happened during RA (46%) than during GA (43%). Moreover, 51% patients who had a caesarean section and 14% patients undergoing female sterilisation experienced desaturation episodes. In our country, these form a large proportion of operations in women, and are performed in healthy young patients; 52% patients undergoing general surgery by RA, 15% patients undergoing eye surgery and 12% patients having surgery under LA experienced episodes of desaturation. The authors do not provide information about the nature of sedation given or other details of RA or LA. These inadequacies in the paper should not detract from the main message: Hypoxia occurs in a significant number of patients, especially those receiving regional and local anaesthesia, and complications can be easily avoided by simple monitoring of oxygenation by pulse oximetry.

In most of the above patients, hypoventilation was probably the major reason for hypoxia. Just as hypoxia can be easily detected by pulse oximetry, hypoventilation can be easily detected by capnography or capnometry, which is also safe and noninvasive. Capnography is the gold standard method for detecting esophageal intubation, and its universal use can help eliminate the dreaded phenomenon of undetected esophageal intubation, hypoxia and brain damage or death. Capnography can help diagnose esophageal intubation in seconds, while pulse oximetry would detect hypoxia late, after a few minutes. The ASA Task Force on sedation and analgesia by non-anaesthesiologists^[10] opined that the primary causes of morbidity associated with sedation/analgesia are drug-induced respiratory depression and airway obstruction. They recommended that all patients undergoing sedation/analgesia should be monitored by pulse oximetry and that monitoring of exhaled carbon dioxide should be considered for all patients receiving deep sedation and for patients whose ventilation cannot be directly observed during moderate sedation.

The ISA standards^[4] state that “For every patient under anaesthesia... In addition to clinical observation, it is mandatory for ventilation to be monitored by analysis of expired carbon-dioxide level... Display of capnograph is strongly recommended.” However, capnography has not been adopted as wholeheartedly and as willingly as pulse oximetry by anaesthetists in our country. Perhaps cost and technical and maintenance related issues may be deterrents. Nevertheless, monitoring for hypoventilation by capnography must be increasingly implemented.

Thus hypoventilation and hypoxia remain a threat to patient safety even today, especially during innocuous and ‘minor’ procedures performed under LA and sedation, and in the postoperative period. In patients undergoing procedures under LA and sedation, MAC should stand for maximum anaesthesia caution, not minimal anaesthesia care.^[11] It is imperative that all anaesthetists comply fully with the minimum monitoring standards laid down by the ISA.^[4] These include:

“The anesthetist providing anaesthesia for a patient shall be present throughout the surgical procedure...”

“All patients undergoing surgery under regional anaesthesia or sedation shall be monitored as required under general anaesthesia.”

“In all cases a minimum monitoring with ECG, Pulse Oximeter and NIBP is mandatory.”

“Every patient shall be monitored in the post-operative recovery area with continuous monitoring of ECG, Pulse Oximeter and NIBP or Invasive Arterial monitoring.”

Finally, the pulse oximeter is the last line of defense in detecting hypoxia due to a variety of causes. Always keep a finger on the patient’s pulse and a pulse oximeter on the patient’s finger!

JV Divatia

Department of Anaesthesia, Critical Care and Pain,
Tata Memorial Hospital, Mumbai 400 012, India.
E-mail: jdivatia@yahoo.com

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