NOL MONITORING IN BARIATRIC SURGERY

Introduction

Obesity is a major health problem that affects every organ system and is associated with numerous health consequences including an increased risk for coronary artery disease, dyslipidemia, hypertension, diabetes mellitus, degenerative joint disease, gallbladder disease, obstructive sleep apnea, and socioeconomic and psychosocial impairment (NIH, 1991) Obese patients have more annual admissions to the hospital, more outpatient visits, and higher prescription drug costs than non-obese adults. Obesity is generally classified based on body mass index (BMI).

BMI is calculated by dividing the weight in kilograms (kg) by the square of height in meters (m^2). A person with a BMI of 20 - 25 kg/m^2 has normal weight, whereas an individual with a BMI of 26 - 29.9 kg/m^2 is defined as overweight. A patient with a BMI of 30 - 39.9 kg/m^2 is called obese, a patient with a BMI > 40 kg/m^2 is called extreme/morbidly obese. A patient with a BMI > 50 kg/m^2 is superobese, and with a BMI > 60 kg/m^2 is super-superobese (Renquist K, 1997). The risk of developing one or more of the obesity- related perioperative complications is based on BMI, being low risk for overweight patients and being very high risk for morbid or super obese patients (Bray GA, 1992). However, overweight, obese and morbidly obese patients often have a lower incidence of complications and mortality than patients of normal weight. Patients with low BMI tend to have the highest mortality rates of the different BMI groups. This ‘obesity paradox’, whereby obesity may convey health benefits, is not fully understood (Wynn-Hebden A, 2020).

The prevalence of obesity has tripled over the past 40 years and there are now more than 650 million obese adults worldwide. Increases are greater in developing compared to developed countries. The USA has the highest rates of obesity; 88.5% of the population are overweight and 36.2% are obese. Rates are similar in Canada, Australia and New Zealand. The risk of anesthesia and surgery is higher in obese patients than the normal population. Clinical practice guidelines (Nightingale CE, 2015) require anesthesiologists to be familiar with the clinical management of obese patients for all types of surgery, especially for weight reduction procedures. They must completely assess the patients before the surgery to identify anesthesia- related potential risk factors and prepare for management during the surgery. Induction and maintenance of anesthesia and oxygenation, intubation, and pain management can be challenging in these patients.

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Bariatric Surgery

Almost all bariatric surgeries are now performed laparoscopically, and it is the most commonly performed elective surgery in patients with morbid obesity. The recently updated enhanced recovery after surgery (ERAS) society guidelines for bariatric anesthesia have also emphasized the need for protocol standardization and implementation (Stenberg E, 2022). The approaches implemented in bariatric surgery can be applied in obese patients undergoing other types of surgery. The main types of bariatric surgery are shown in *Figure 1 - Main Types of Bariatric Surgery*. The 3 most commonly performed operations are laparoscopic adjustable gastric banding (band), laparoscopic gastric bypass (bypass) and laparoscopic sleeve gastrectomy (sleeve).

Eipe et al (Eipe N, 2022) describe 4 key principles for improving perioperative pain in bariatric surgery. First and foremost, *medical optimization* should focus on the diagnosis and treatment of sleep-disordered breathing (SDB) including obstructive sleep apnea (OSA). The diagnosis and treatment of OSA can specifically improve the safety and outcomes of postoperative pain management and is an important modifiable risk factor for morbidity and mortality in bariatric anesthesia. Especially in moderate to severe OSA that remains undiagnosed or untreated, an opioid-centric approach to pain management in the perioperative period should be avoided. The second aspect of the preoperative period that can improve pain management after bariatric surgery is the recent emphasis on the better *physical preparation* of patients. Within the ERAS paradigm, active deep breathing and coughing with early ambulation all contribute to early discharge and return to baseline function. The third aspect of preoperative pain management is *patient education* to help set realistic expectations for the postoperative period with regards to reducing pain, analgesic requirements, and expected side effects. Fourth and finally, special attention should be made towards addressing *psychosocial factors*. Among these, optimizing anxiety, depression, and catastrophizing can contribute to reductions in postoperative pain.

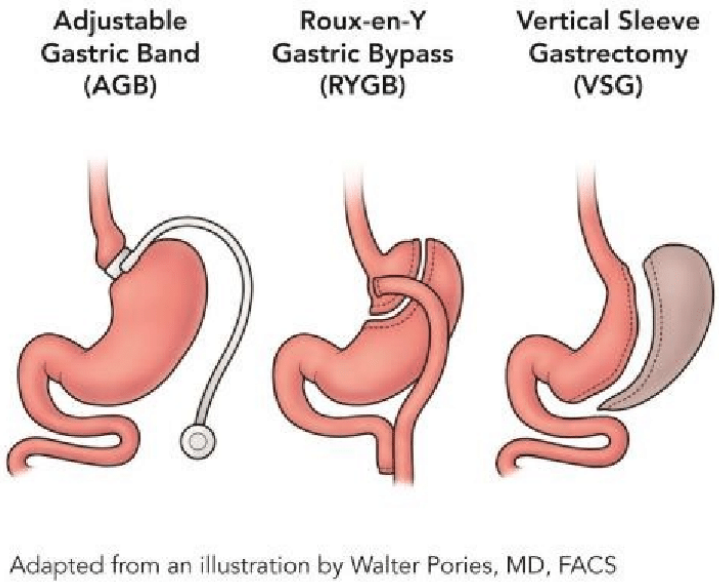

Figure 1 - Main Types of Bariatric Surgery

Anesthesia During Bariatric Surgery

TIVA with propofol offers a number of potential advantages over volatile anesthesia for the obese patient (Al-Rifai Z, 2016): rapid offset of action; 'clear-headed' emergence; reduced incidence of laryngospasm; reliable clearance of hypnotic agents; reduced postoperative nausea and vomiting; and maintained anesthesia during protracted airway manipulation.

Currently, pharmacokinetic models for propofol are not validated in obese patients who were excluded from initial development of these models. To minimise the risk of accidental awareness, the use of processed EEG-based depth of anesthesia monitoring, continuous clinical observation and interpretation of vital signs should guide titration of drug infusion targets and rates.

Using volatile agents with a rapid offset of action (low blood:gas partition coefficient) such as desflurane and sevoflurane may limit absorption into adipose tissue, reducing the risk of re-sedation, deteriorating respiratory function and airway obstruction at emergence.

A 2015 consensus document, produced by expert members of a Working Party, established by the Association of Anaesthetists of Great Britain and Ireland and the Society for Obesity and Bariatric Anaesthesia provided recommendations for anesthetic management of the obese surgical patient (Nightingale CE, 2015). There are several recommendations related to analgesia considerations and nociception monitoring, including always considering sleep-disordered breathing and its consequences in obese patients, basing drug dosage according to lean body weight and titrating to effect, rather than dosing to total body weight, and avoiding the use of long-acting opioids and sedatives. Depth of anesthesia monitoring should be considered, especially when total intravenous anesthesia is used in conjunction with neuromuscular blocks.

The recently updated ERAS guidelines for bariatric surgery (ERABS) (Stenberg E, 2022) note that patients with obesity generally show an increased sensitivity towards opioid sedative effects and consequently higher susceptibility towards respiratory depression. In an effort to reduce the incidence and severity of postsurgical pain, multimodal analgesia using limited doses of opioids has been advocated. Lidocaine, dexmedetomidine, ketamine and magnesium, when used as part of opioid-free anesthesia, may have better anti-inflammatory effects than classical opioid-based anesthesia and may therefore be preferable. In addition, appropriate use of nonsteroidal anti-inflammatory drugs (NSAIDs) reduces opioid consumption. One limitation of most NSAIDs is that they are "low-ceiling" analgesics. Paracetamol is free of bleeding, gastric and renal side effects that limit the use of NSAIDs.

Regional anesthetic techniques have been demonstrated to be highly efficient in reducing opioid requirements. Epidural analgesia for postoperative pain is effective, but is not required in laparoscopic surgery. Ultrasound-guided transversus abdominis plane block can decrease pain scores and opioid requirement, and improve ambulation after bariatric surgery. Infiltration of bupivacaine 0.5% before incision results in a reduction in opioid consumption and postoperative pain. Other promising strategies are intraperitoneal instillation of bupivacaine and erector spinae plane block.
Although current evidence does not allow recommending of specific anesthetic agents or techniques, there is high level of evidence in support of using multimodal, opioid-sparing analgesia approaches to improve postoperative recovery

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Opioid-Free Anesthesia

The opioid-free anesthesia (OFA) technique has been recently reported in the literature for the bariatric surgery population and is popular in certain parts of Europe, demonstrating good outcomes. OFA involves avoidance of opioids by all routes, including by intravenous and neuraxial routes, in the intraoperative period and has the benefits of reduced postoperative nausea and vomiting (PONV) and reduction of postoperative respiratory depression, particularly in patients with obstructive sleep apnea. This typically involves sympatholysis and amnesia with dexmedetomidine and anesthesia maintenance with desflurane monitored and titrated with bispectral index monitoring; co-analgesia with ketamine, magnesium and intravenous lignocaine infusion; and deep neuromuscular blockade maintained until the end of the operation. Intravenous nonsteroidal anti-inflammatory drugs, high dose paracetamol, dexamethasone and gabapentin may be added with routine use of local anesthetic infiltration. The OFA technique has not been adopted widely to date because of the lack of robust evidence (Shinde P, 2020).

The Role of Nociception Monitoring in the Obese Patient

In both opioid sparing and opioid free approaches, nociception monitoring can offer significant value by providing a continuous, objective indication of the level of nociception throughout surgery. When using combinations of multiple types of drugs to provide analgesia in obese patients for whom the known PkPd models may be less valid - an objective tool helps personalize the dosing according to the patient's actual requirements which may change during the procedure. This helps the clinicians assess the analgesic effectiveness of the combination of drugs used to spare or eliminate the use of opioid analgesics, whilst preventing hemodynamic instability and preventing opioid related complications during recovery, in particular opioid induced respiratory depression (OIRD).

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Nociception Monitoring - NOL® Technology Overview

The PMD-200 system consists of a proprietary monitoring unit, and a unique sensor platform which consists of a reusable non-invasive finger probe and a single-use sensor.

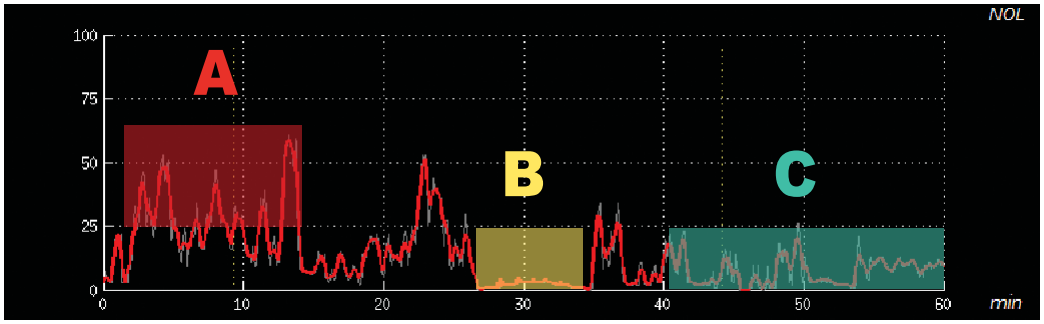
The finger probe and single-use sensor continuously acquire physiological signals through the following four sensors:

- Photoplethysmograph (PPG)
- Galvanic Skin Response (GSR)
- Peripheral Temperature (Temp)
- Accelerometer (ACC)

The NOL algorithm extracts and analyses the following nociception-related physiological parameters: pulse rate, pulse rate variability, pulse wave amplitude, skin conductance level, skin temperature, movement, and their various derivatives.

Using advanced AI algorithms, the system analyzes multiple nociception-related physiological parameters and their various derivatives, which correspond with the autonomic nervous system's response to noxious stimuli, characterizing the patient's pain signature. The monitor displays the NOL index - a relative measure with a range of 0–100, where 0 represents no pain/nociceptive response and 100 represents extreme pain/nociceptive response.

NOL Index Range & Suggested Thresholds



The NOL index and trend are intended to support clinical decisions concerning the administration of analgesic medications. Clinical evidence suggests the following guidelines for surgical procedures under general anesthesia:

A. NOL trend above 25 for more than one minute may indicate the patient requires additional analgesic therapy. Higher values indicate a stronger nociceptive response.

B. NOL below 10 for more than one minute **during a painful stimulation** may indicate excessive anti-nociception and reduction of analgesics may be considered (when using short acting opioids).

C. NOL between 0-25 represents an appropriately suppressed physiological response to noxious stimuli and indicates adequate analgesia.

The NOL index cannot anticipate noxious stimuli and thus a minimal level of analgesics should always be maintained.

Meet the Experts - Carmel Medical Center, Haifa, Israel

Dr. Zeev Goldik,
Head of Anaesthesia, Intesnive Care & Pain Service,
Past President – ESAIC,

Dr. Michael Grach,
Anaesthesiologist & Pain Specialist – Head of Pain Unit

Carmel Hospital is a 477 bed general hospital located in the north of Israel, affiliated with the Rappaport Faculty of Medicine of the Technion. More than 20,000 surgical procedures are performed annually throughout 13 operating rooms. The hospital recently introduced NOL monitoring in major surgeries. A particular focus area for NOL has been in spine surgeries.

Using NOL in Clinical Practice - Anesthesia Insights

NOL technology provides us with a continuous objective measurement of the nociception-anti nociception balance, an important tool that we did not have at our disposal until now. Our team has found NOL simple to use and to integrate into our clinical reasoning and it takes away some of the guesswork, allowing us to personalize analgesia to patient's actual needs. We see that we are able to reduce the amounts of opioids we have been giving in bariatric surgery by employing opioid sparing approaches or even opioid free approaches, with patients experiencing a more comfortable recovery with less pain but also less side effects associated with excessive opioids such as respiratory depression and PONV.

To learn more about the clinical implementation of NOL in bariatric surgery, the reader is invited to watch the following video presented by Dr. Goldik: ***https://youtu.be/7mMndYHGSPg***

Personalizing anesthesia with NOL guided bariatric surgery

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