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Management of Acute Surgical Pain in Plastic and Reconstructive Surgery

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Short running head Acute pain management in plastic surgery

Abstract (max 250 words)

Less than half of all patients undergoing surgery report adequate postoperative pain relief. Poorly managed postoperative pain can lead to complications, increased hospital stays, prolonged rehabilitation and a decreased quality of life. Pain rating scales are commonly used to identify, manage and track the perceived intensity of pain. Changes in perceived pain severity and intensity are a key indicator for course of treatment. Postoperative pain is best treated with multimodal management, which is the use of a variety of analgesic medication and techniques that target different receptors and mechanisms of action in the peripheral and central nervous system. This includes systemic analgesia, regional analgesia, local analgesia (e.g. topical and tumescent analgesia), and non-pharmacological modalities. It is recommended that this approach is individually tailored and discussed through a shared decision-making approach. This review provides an overview of the multimodal management for acute postoperative pain related to plastic surgery procedures. To increase patient satisfaction and provide effective pain control, it is recommended to educate patients on expectations of pain, multimodal options for pain control (including peripheral nerve blocks), complications of unrelieved pain, tracking and monitoring of pain by self-reporting and how to safely reduce the use of opioid-based pain medication.

1. Introduction

Pain is described as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage" by the Subcommittee on Taxonomy and adopted by the International Association for the Study of Pain (IASP) Council in 1979. [1] The effective relief of pain in a surgical patient after a procedure is of great importance. Poorly managed postoperative pain can lead to complications, prolonged rehabilitation and a decreased quality of life. [2,3] Eighty percent of patients who undergo surgery in the United States report postoperative pain, with 88% of these patients reporting moderate, severe, or extreme pain levels. [4] Uncontrolled postsurgical pain has been linked to the development of persistent postsurgical pain (PPSP) caused by maladaptive neuronal plasticity. [5,6] The use of both opioid and non-opioid medications as part of postoperative pain treatment has increased significantly over the past decades. [7,8] Appropriate pain relief leads to shortened hospital stays, reduced hospital costs and increased patient satisfaction. [2,3]

The incidence of pain levels varies by analgesic technique. [9] Predictive factors of the severity of acute postoperative pain include younger age, female sex, preoperative pain, anxiety/mood, and incision size. [10] This emphasizes the importance of patient-individualized treatment and a treatment-specific approach for each type of plastic surgical procedure. In this review, we will focus on the management of acute postoperative pain and provide an overview of the different modalities. The physiology of pain will be described and recommendations for acute postoperative pain management based on patient specific factors will be discussed.

2. Physiology of pain

The pain pathway is comprised of four steps: transduction, transmission, modulation and perception. Nociceptors are receptors in tissues which are activated specifically by painful stimuli and cause nociceptive pain. These receptors transduce an electrical signal from the periphery to

the central nervous system along axons. [11,12] Nociceptive pain describes pain from physical damage and responds well to treatment with opioids. [13] Neuropathic pain is often associated with damage to the neurological system and is described as a shooting pain or burning sensation. Pain transmission is strictly dependent on the balance of the excitatory and inhibitory influences that act on the neuron circuits of the somatosensory system. [14] Melzack and Wall's gate control theory of pain describes modulation as the mechanism by which the descending pathway of the brain alters the intensity of the pain signal, depending on the circumstance that initiates the nociceptive signal. [15,16] This theory has been a breakthrough and explains why rubbing a painful area soothes the pain. Moreover, it is the foundation of how transcutaneous electrical nerve stimulation (TENS) units work. [17] TENS is a therapy which involves the use of low-voltage electric currents to treat pain. The effectiveness of TENS treatment for people with a variety of pain conditions remains controversial. [17] Numerous theories have been postulated to describe mechanisms underlying pain perception. The most accepted theory states that the more intense a noxious stimulus is, the more unpleasant it will be. However, the perception of pain could be modulated by affective-motivational components of pain to alter the perception (i.e. cognitive modulation of pain). [18]

3. Assessment of pain

3.1 Validated pain rating scales

Pain rating scales are commonly used to identify, manage and track the perceived intensity of pain. Changes in pain severity and intensity are a key indicator for course of treatment. [19] Commonly used and validated scales are the Visual Analogue Scale (VAS), the Numerical Rating Scale (NRS), the Verbal Rating Scale (VRS) and the Faces Pain Scale-Revised (FPS-R) (Figure 1). [20] The VAS is presented as a 10-cm line, visualizing a scale ranging from ‘no pain’ to ‘worst imaginable pain’. The patient is asked to physically mark a score that fits best with the situation.

[21-23] The NRS is a numerical 11 or 21-point scale where the end points indicate the extremes of 'no pain' and 'worst possible pain'. The VRS is comprised of 5-7 word categories, i.e., 'no / mild / moderate / severe / worst possible pain'. This forces the patient to translate the sensation into words, however, does not necessarily reflect the intensity of the pain. [24] While the NRS, VAS and VRS are commonly used in adults, the FPS-R is proven effective with children and elderly. This scale shows six facial expressions which can be matched with numerical pain intensity scores. The faces are depicted without smiles or tears to avoid confusion between pain intensity and distress. [25-30]

3.2 Implication of pain rating scales

Accurately measuring pain intensity is difficult as pain is subjective, [31] self-reported, [32] and multifaceted including cognitive, physical, sensory, behavioral and sociocultural factors. [33] When comparing pain rating scales in adults, numerous studies show that the NRS is preferred due to ease of use, higher compliance rates, better responsiveness and good applicability compared to the VAS and VRS. [34] The VRS and FPS-R are reported to be more influenced by pain catastrophizing and interference, i.e. the social consequences of pain, and emotional distress. [35] Furthermore, the intensity of pain is influenced by the meaning of pain to the patient and its expected duration. [36] Acute or chronic pain can result in altered behavior, dysfunction or disabilities. While acute pain can be measured reliably by common pain rating scales, the accuracy of the perceived intensity of chronic pain is more likely to be influenced by anxiety and fear. [36,37]

4. Management of acute postoperative pain

Managing acute postoperative pain plays an essential role in facilitating the recovery of the patient to normal function. [38] Research suggests that less than half of all patients undergoing surgery report adequate postoperative pain relief. [39] It is key to reduce the incidence of adverse physiologic and

psychological effects associated with inadequately controlled pain. [38] Thus, it is recommended that managing postoperative pain commences preoperatively. Clinicians can provide individually tailored education and pain management plans to the patient through a shared decision-making approach and discussing treatment options. Preoperatively, education points should include the expectation of pain and the options for pain management including local, topical, regional (e.g. use nerve blocks) and systemic anesthesia. Individually tailored education preoperatively is proven to result in beneficial effects including less preoperative anxiety, fewer requests for sedative medications, reduced postoperative opioid consumption and reduced length of stay after surgery. [38,40,41]

Preoperative consultation should also aim at assessing medical and psychiatric comorbidities, concomitant medication, history of chronic pain, substance abuse and response to previous postoperative treatment. Postoperatively, education should focus on how to adequately manage and document the pain. Obesity poses a challenge in opioid administration as this patient population is at increased risk for respiratory depression or sleep apnea. Therefore, in this population, regional anesthesia techniques and avoiding sedative analgesics are preferred. [41,42] Predisposing risk factors for persistent opioid use are suggested to be patients that are female, adolescents or older than 50 years and patients that have a pre-existing history of depression, illicit drug, alcohol, antidepressant or benzodiazepine use. [41,43] Postoperatively, pain should be assessed and re-assessed in rest as well as movement, to assure a patient's ability to participate in post-surgical rehabilitation. [41]

After discharge, patients should again be reminded on how to track and manage their pain by self-reporting, including the use of mobile applications. Furthermore, education points include when and whom to contact in case of questions, how to adequately reduce the use of pain medication

and the process of disposal of unused opioids. [41,44] It has been suggested that dissemination of an educational brochure significantly improves the disposal of unused opioids after surgery, decreasing the amount of excess opioids circulating in our communities. [45]

5. Multimodal postoperative analgesia

Postoperative pain is best treated with multimodal analgesia (MMA), which is defined as the use of a variety of analgesic medication and techniques that target different receptors and mechanisms of action in the peripheral and central nervous system. MMA protocols are used to potentiate the effects of opioids. Compared to single-modality interventions, using MMA may result in additive or synergistic effects, superior pain relief and reduced reliance on opioid medications. [41,46-51] However, different side effects of each modality and interference with other treatments should be monitored. [41,47] An overview of the multimodal management for the postoperative pain patient is depicted in Figure 2 and will be discussed in detail below. [52]

5.1 Acute postoperative pain management

Systemic analgesia

Despite an ongoing opioid epidemic, opioids remain the cornerstone of perioperative pain management including in the treatment of acute postoperative pain. [53,54] Opioids should be coupled with multimodal analgesic options, tailored to the type of pain a patient is experiencing with a goal of using the lowest amount of opioid possible. [55] Personalized opioid prescription models could be used to accurately estimate post-discharge opioid consumption and decrease the risk of developing persistent opioid use. [56] Opioids are associated with severe side effects, which are discussed below. Nonsteroidal anti-inflammatory drugs (NSAID) act by inhibiting the enzyme cyclooxygenase (COX) and are associated with side effects including peptic ulcer disease, gastrointestinal (GI) hemorrhage, renal dysfunction, platelet dysfunction and altered liver function. [57] For patients with

a previous history of GI injury, prolonged use of NSAIDs, advanced age, concurrent use of aspirin or corticosteroids, the risk of GI complications such as upper GI bleeding is increased. In these cases, gastroprotective agents or alternative NSAID formulations such as COX-2 inhibitors are preferred. [58,59] Lumiracoxib has the highest degree of selectivity for COX-2. Meloxicam is preferred over COX-1 inhibitors as it has greater affinity to COX-2 inhibition compared with COX-1 inhibition, similar to celecoxib and diclofenac. [60] These drugs, together with acetaminophen are more potent than naproxen, ibuprofen and indomethacin. [61]

The use of gabapentinoids in acute postoperative pain management remains controversial. [62,63] It is imperative that the use of gabapentinoids will be tailored to the type of surgery and limited to patients that are at high risk of developing neuropathic pain from surgery. For patients that underwent abdominal wall reconstruction, postoperative gabapentin administration was not associated with an increase in adverse effects in patients, thus safe to use. [52] While its effect on neuropathic pain can take up to two weeks to work, gabapentinoids should be provided as part of the MMA protocol to ensure that pain is controlled in the acute setting as well.

Table 1 provides an overview of the pharmacotherapeutic MMA regimen including indications and considerations. [6,60,64] Alternative medication options are also provided. Patients with allergies to the medications should either not be given these medications or should be provided alternative medications within the same drug class, depending on the allergy severity. [60]

Regional analgesia

Regional anesthesia is effective, safe, economical and results in fewer systemic side effects. Moreover, it allows for faster postoperative recovery and prevention of general anesthesia complications in patients with sleep apnea, chronic obstructive pulmonary disease (COPD) or coronary artery disease. [65] Epidural analgesia distributes the drug in the epidural space and

potentially provides full pain blockade below the level of insertion. [66] It is superior to systemically administrated drugs due to its higher potency, explained by its proximity to the opioid and alpha agonist receptors in the dorsal horn. [67] Peri- and postoperative epidural analgesia could be used in plastic surgery patients undergoing abdominal wall reconstruction, liposuction or breast surgery. [68] Patients undergoing breast surgery could also benefit from regional nerve blocks such as paravertebral, intercostal, serratus anterior, erector spinae plane or pectoralis blocks. Transversus abdominis plane (TAP) blocks could be used in abdominoplasty and abdominal-based flap reconstruction (e.g. breast and abdominal wall reconstruction), amongst others. [68-70] For hand and shoulder surgery, brachial plexus blocks can be applied to achieve successful neural blockade. The axillary approach, infraclavicular approach, and supraclavicular approach are commonly used for the hand, whereas the interscalene approach is used for shoulder and upper arm surgery. Axillary, supraclavicular, and infraclavicular approaches have similar success rates when performed with ultrasound guidance. [71] Kettner et al. demonstrated superior pain control with regional blocks compared with opioid-based analgesia in a meta-analysis, [72] which has also been corroborated by others. [73]

Local and topical analgesia

Local anesthetic infiltration is often used for wrist or digital nerve blocks in hand surgery. Especially carpal tunnel release, Dupuytren's release, trigger finger release and tendon repair are performed under local anesthesia without tourniquet. [74] This is called "wide-awake local anesthesia no tourniquet" hand and wrist surgery (WALANT). [75] Patient satisfaction is increased when using the WALANT technique in an office-based setting compared to the ambulatory day surgery setting. Furthermore, WALANT anesthesia improved patient satisfaction when compared to sedation and monitoring techniques, irrespective of the surgical setting and location. [76] Local

analgesia typically involves subcutaneous injection of 1% lidocaine, which interrupts axon depolarization by preventing Na^+ influx into the neuron, combined with 1:100,000 epinephrine, to provide vasoconstriction. The vasoconstrictive property decreases the anesthetic dissolution into the blood stream and ultimately allows a higher maximum anesthetic dose. [77] Besides hand surgery, a trend toward increased use of local anesthetics is seen in cosmetic surgery of the head and neck. [78] For abdominal surgery, surgical site infiltration techniques provide excellent postoperative pain relief. In peritoneal, musculofascial, and subdermal tissues, where pain foci originate, 1-1.5 mL is injected every 1 to 2 cm of surgical incision per layer using a 22-gauge, 1.5-inch needle (i.e. continuous motion fanning technique) at the time of incision closure. [79] Liposomal bupivacaine as part of MMA significantly decreases the mean length of stay (5.8 days versus 9.2 days in control; $p = 0.004$), lowers costs and 30-day readmission rates. [80]

Tumescent analgesia (TA) is a method of infiltrating a very dilute solution of a local anesthetic, commonly lidocaine, combined with epinephrine and sodium bicarbonate into tissue until it becomes firm and tense (i.e. tumescent). This technique was first described by Klein in the late 1980s. [81] An upper limit of 35 mg/kg lidocaine has been proven to be safe and effective. [82-84] TA could be used for breast, body, face, and combined with other modalities of MMA. [82-85]

Topical anesthetic creams in plastic surgery are used when injections are avoided or to reduce the pain, needle anxiety and edema at the surgical site prior to injection. Commonly used creams are topicaine (4% lidocaine gel), EMLA cream (2.5% lidocaine and 2.5% prilocaine) and TAC (0.5% tetracaine, 1:2,000 adrenaline and 11.8% cocaine). With the use of topical creams, children and patients over the age of 65 years can undergo minor procedures without general anesthesia. [86] Non-pharmacological interventions include physical therapy, acupuncture, cognitive behavioral therapy

(CBT) and TENS. These supportive therapeutic modalities are often combined with pharmacological therapy. [87]

An algorithm for acute pain management based on clinical indication is provided in Figure 3. [66,69,80,82,88,89]

5.2 Opioids: guidelines and side effects

Opioids act primarily on mu opioid receptors in the central nervous system, [90] and can modify afferent pain signals by binding to opiate receptors resulting in the reduction of pain perception. [91] It is recommended that opioids are administered orally as opposed to intravenously when possible. [38] Although oral administration results in a slower time of onset, it generates a more steady and long-lasting analgesic effect. [92] Other routes of administration are sublingual, transdermal or neuraxial. [57] Parenteral routes include intramuscular (IM), intravenous (IV) or subcutaneous (SC) administration of drugs. Parenteral administration provides a faster onset of action of the drug and bypasses the liver first pass effect. In some cases of moderate to severe pain, the use of PCA devices in the hospital is recommended without routine basal infusion of opioids.[38] PCA devices increase the patient's autonomy by allowing self-administration of low doses of opioids and reduce the nursing burden, resulting in greater effectiveness and patient satisfaction. Administration by proxy should be avoided in adults with proper monitoring, especially when patients are sleeping. [38,93] However, its use is associated with increased side effects and should not be combined with epidural analgesia. [93] Well known side events include nausea, vomiting, pruritus, sedation, constipation, respiratory depression, and opioid-induced hyperalgesia. [88,94] Furthermore, opioids rapidly lose their potency resulting in tolerance. [66,95]

Patients who have been prescribed opioids postoperatively have the potential to become persistent opioid users, even if they were previously opioid naïve, [96,97] ranging from 5% to 14%, due to its well-established addictive potential. [98-100] Recent studies found that outpatient plastic surgery patients only use half of the prescribed opioids, which indicates an opportunity to reduce opioid prescription. [101-103] Eighty-three percent of patients do not store opioids in a locked location, and 64% do not dispose opioids after one month, as recommended by the manufacturer. [103] Moreover, another study showed that the majority of plastic surgery patients does not expect postoperative opioids and prefers non-narcotic postoperative treatment. [104] Overprescribing by surgeons is proven to result in unintended distribution of unused opioids into society, or its redirection for illicit abuse. [105,106] When opioids are prescribed for acute pain, it is recommended by the Center for Disease Control (CDC) to prescribe the lowest effective dose of immediate-release opioids for a maximum of three days. Clinicians should review the patient's history of controlled substance prescriptions using the state prescription drug monitoring program (PDMP) data to perform a risk assessment and determine the patient's opioid use prior to prescribing opioids.

Using patient satisfaction as an indicator of pain control has limited validity. If patients are not fully educated on the complications of unrelieved pain, this may lead to chronic pain. In ambulatory surgery patients, pain is the leading reason why patients cannot be transferred from phase I to phase II recovery in under 50 minutes from surgery. Pain scores were reported lower when using MMA, [95,107] resulting in increased efficiency and compliance across the healthcare system and decreased costs. [50,64] Plastic surgery patients should specifically be routinely educated on the medical risks of opioids, regarding postoperative side effects and potential for abuse, the purpose and importance of MMA and alternatives to opioids, as well as proper use of medication. [64] A national survey reported that only two thirds of patients were provided education on pain

management prior to surgery. Overall, nurses were more likely than other health care professionals to educate patients about their pain management. [108]

6. New pain treatments

The Food and Drug Administration (FDA) has recently approved Seglentis® (celecoxib and tramadol hydrochloride) for the management of acute pain in adults that is severe enough to require an opioid analgesic and for which alternative treatments are inadequate. This drug combines a NSAID and opioid agonist, and could be administered orally at an initial dose of two tablets every 12 hours as needed for the relief of pain. Side effects include respiratory depression, addiction, increased risk of cardiovascular thrombotic events, nausea, vomiting and GI adverse events. [109] The integration of pharmacological sciences with bioengineering has been a step towards achieving a steady or pulsatile delivery in a controlled fashion, with fewer side effects. Pharmacoplastic surgery is an emerging concept that describes the use of a device with pharmacologic components to augment the safety and/or efficacy of a certain device in the field of plastic surgery. [110] Drug-eluting biomaterials, such as sutures, provide better wound healing, tissue healing and a sustained drug delivery system to wound sites. [110]

Conclusions

To increase patient satisfaction and effective pain control, it is recommended to commence managing postoperative pain preoperatively and educate patients on the complications of unrelieved pain, how to track and monitor their pain by self-reporting and how to adequately reduce the use of pain medication. Multimodal pain therapy combines various approaches (e.g. systemic analgesia, regional analgesia, local analgesia and non-pharmacological interventions), resulting in increased patient satisfaction and a reduced opioid use. The use of local analgesia (e.g. topical or tumescent analgesia) leads to shortened hospital stays, reduced hospital costs and

effective pain control. Individually tailored education on pain management is of importance to set expectations, decrease complications and provide early rehabilitation. Clinicians can provide these plans to the patient through a shared decision-making approach, discussing treatment options, expectations and documenting pain treatment goals.

References

1. Raja SN, Carr DB, Cohen M, et al. The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. *Pain*. Sep 1 2020;161(9):1976-1982. doi:10.1097/j.pain.0000000000001939

2. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. *Lancet*. May 13 2006;367(9522):1618-25. doi:10.1016/S0140-6736(06)68700-X

3. Kehlet H, Holte K. Effect of postoperative analgesia on surgical outcome. *Br J Anaesth*. Jul 2001;87(1):62-72. doi:10.1093/bja/87.1.62

4. Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research. *Mil Med*. May 2016;181(5):397-9. doi:10.7205/MILMED-D-16-00012

5. Beloeil H, Sulpice L. Peri-operative pain and its consequences. *J Visc Surg*. Dec 2016;153(6S):S15-S18. doi:10.1016/j.jviscsurg.2016.09.004

6. Schoenbrunner AR, Janis JE. Pain Management in Plastic Surgery. *Clin Plast Surg*. Apr 2020;47(2):191-201. doi:10.1016/j.cps.2019.12.001

7. Sullivan MD, Howe CQ. Opioid therapy for chronic pain in the United States: promises and perils. *Pain*. Dec 2013;154 Suppl 1:S94-S100. doi:10.1016/j.pain.2013.09.009

8. Kaye AD, Cornett EM, Hart B, et al. Novel Pharmacological Nonopioid Therapies in Chronic Pain. *Curr Pain Headache Rep*. Apr 3 2018;22(4):31. doi:10.1007/s11916-018-0674-8

9. Dolin SJ, Cashman JN, Bland JM. Effectiveness of acute postoperative pain management: I. Evidence from published data. *Br J Anaesth*. Sep 2002;89(3):409-23.

10. Gan TJ. Poorly controlled postoperative pain: prevalence, consequences, and prevention. *J Pain Res*. 2017;10:2287-2298. doi:10.2147/JPR.S144066

11. Basbaum AI, Bautista DM, Scherrer G, Julius D. Cellular and molecular mechanisms of pain. *Cell*. Oct 16 2009;139(2):267-84. doi:10.1016/j.cell.2009.09.028

12. Chen JS, Kandle PF, Murray I, Fitzgerald LA, Sehdev JS. Physiology, Pain. *StatPearls*. 2022.

13. Gupta A, Kaur K, Sharma S, Goyal S, Arora S, Murthy RS. Clinical aspects of acute post-operative pain management & its assessment. *J Adv Pharm Technol Res*. Apr 2010;1(2):97-108.

14. Yam MF, Loh YC, Tan CS, Khadijah Adam S, Abdul Manan N, Basir R. General Pathways of Pain Sensation and the Major Neurotransmitters Involved in Pain Regulation. *Int J Mol Sci*. Jul 24 2018;19(8)doi:10.3390/ijms19082164

15. Bourne S, Machado AG, Nagel SJ. Basic anatomy and physiology of pain pathways. *Neurosurg Clin N Am*. Oct 2014;25(4):629-38. doi:10.1016/j.nec.2014.06.001

16. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science*. Nov 19 1965;150(3699):971-9. doi:10.1126/science.150.3699.971

17. Melzack R, Wall PD. Acupuncture and transcutaneous electrical nerve stimulation. *Postgrad Med J*. Dec 1984;60(710):893-6. doi:10.1136/pgmj.60.710.893

18. Villemure C, Bushnell CM. Cognitive modulation of pain: how do attention and emotion influence pain processing? *Pain*. Feb 2002;95(3):195-199. doi:10.1016/S0304-3959(02)00007-6

19. Chang VT, Janjan N, Jain S, Chau C. Update in cancer pain syndromes. *Journal of palliative medicine*. 2006;9(6):1414-1434.

20. Falch C, Vicente D, Haberle H, et al. Treatment of acute abdominal pain in the emergency room: a systematic review of the literature. *Eur J Pain*. Aug 2014;18(7):902-13. doi:10.1002/j.1532-2149.2014.00456.x

21. Kremer E, Atkinson JH, Ignelzi RJ. Measurement of pain: patient preference does not confound pain measurement. *Pain*. 1981;10(2):241-248.

22. Dixon J. Agreement between horizontal and vertical visual analogue scales. *Rheumatology*. 1986;25(4):415b-415b.

23. Jensen MP, Karoly P. Self-report scales and procedures for assessing pain in adults. 2011;

24. Ohnhaus EE, Adler R. Methodological problems in the measurement of pain: a comparison between the verbal rating scale and the visual analogue scale. *Pain*. 1975;1(4):379-384.

25. Hicks CL, von Baeyer CL, Spafford PA, van Korlaar I, Goodenough B. The Faces Pain Scale–Revised: toward a common metric in pediatric pain measurement. *Pain*. 2001;93(2):173-183.

26. Tomlinson D, Von Baeyer CL, Stinson JN, Sung L. A systematic review of faces scales for the self-report of pain intensity in children. *Pediatrics*. 2010;126(5):e1168-e1198.

27. Miró J, De la Vega R, Gertz KJ, Thong IS, Jensen MP, Engel JM. Do commonly used measures of pain intensity only reflect pain intensity in youths with bothersome pain and a physical disability? *Frontiers in Pediatrics*. 2019;7:229.

28. von Baeyer CL. Children's self-reports of pain intensity: scale selection, limitations and interpretation. *Pain Research and Management*. 2006;11(3):157-162.

29. Von Baeyer CL, Spagrud LJ. Systematic review of observational (behavioral) measures of pain for children and adolescents aged 3 to 18 years. *Pain*. 2007;127(1-2):140-150.

30. Kim EJ, Buschmann MT. Reliability and validity of the Faces Pain Scale with older adults. *International Journal of Nursing Studies*. 2006;43(4):447-456.

31. Ferrell B, Grant M, Padilla G, Vemuri S, Rhiner M. The experience of pain and perceptions of quality of life: validation of a conceptual model. *The Hospice Journal*. 1991;7(3):9-24.

32. McCaffery M. *Nursing practice theories related to cognition, bodily pain, and man-environment interactions*. University of California Print. Office; 1968.

33. McGuire DB. Comprehensive and multidimensional assessment and measurement of pain. *Journal of pain and symptom management*. 1992;7(5):312-319.

34. Hjermstad MJ, Fayers PM, Haugen DF, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. *Journal of pain and symptom management*. 2011;41(6):1073-1093.

35. Thong IS, Jensen MP, Miró J, Tan G. The validity of pain intensity measures: what do the NRS, VAS, VRS, and FPS-R measure? *Scandinavian journal of pain*. 2018;18(1):99-107.

36. Turk DC, Melzack R. The measurement of pain and the assessment of people experiencing pain. 2011;

37. Breivik H. Patients' subjective acute pain rating scales (VAS, NRS) are fine; more elaborate evaluations needed for chronic pain, especially in the elderly and demented patients. *Scandinavian Journal of Pain*. 2017;15(1):73-74.

38. Chou R, Gordon DB, de Leon-Casasola OA, et al. Management of Postoperative Pain: a clinical practice guideline from the American pain society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' committee on regional anesthesia, executive committee, and administrative council. *The journal of pain*. 2016;17(2):131-157.

39. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: results from a national survey suggest postoperative pain continues to be undermanaged. *Anesthesia & Analgesia*. 2003;97(2):534-540.

40. Agarwal A, Gautam S, Gupta D, Agarwal S, Singh P, Singh U. Evaluation of a single preoperative dose of pregabalin for attenuation of postoperative pain after laparoscopic cholecystectomy. *British journal of anaesthesia*. 2008;101(5):700-704.

41. Horn R, Kramer J. Postoperative pain control. 2019;

42. Garimella V, Cellini C. Postoperative pain control. *Clinics in colon and rectal surgery*. 2013;26(03):191-196.

43. Lespasio MJ, Guarino A, Sodhi N, Mont MA. Pain management associated with total joint arthroplasty: a primer. *The Permanente Journal*. 2019;23

44. Ali SM, Lau WJ, McBeth J, Dixon WG, van der Veer SN. Digital manikins to self-report pain on a smartphone: A systematic review of mobile apps. *European Journal of Pain*. 2021;25(2):327-338.

45. Hasak JM, Roth Bettlach CL, Santosa KB, Larson EL, Stroud J, Mackinnon SE. Empowering Post-Surgical Patients to Improve Opioid Disposal: A Before and After Quality Improvement Study. *J Am Coll Surg*. Mar 2018;226(3):235-240.e3. doi:10.1016/j.jamcollsurg.2017.11.023

46. Elia N, Lysakowski C, Tramer MR. Does multimodal analgesia with acetaminophen, nonsteroidal antiinflammatory drugs, or selective cyclooxygenase-2 inhibitors and patient-controlled analgesia morphine offer advantages over morphine alone? Meta-analyses of randomized trials. *The Journal of the American Society of Anesthesiologists*. 2005;103(6):1296-1304.

47. McDaid C, Maund E, Rice S, Wright K, Jenkins B, Woolacott N. Paracetamol and selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs) for the reduction of morphine-

related side effects after major surgery: a systematic review. *Health Technol Assess*. 2010;14(17):1-153.

48. Rawal N, Viscusi E, Buvanendran A, Kehlet H. Multimodal minus reuben. *Anesthesiol News*. 2009;35

49. Joshi GP. Putting it all together: recommendations for improving pain management in plastic surgical procedures. *Plast Reconstr Surg*. Oct 2014;134(4 Suppl 2):94S-100S. doi:10.1097/PRS.0000000000000677

50. Barker JC, DiBartola K, Wee C, et al. Preoperative Multimodal Analgesia Decreases Postanesthesia Care Unit Narcotic Use and Pain Scores in Outpatient Breast Surgery. *Plast Reconstr Surg*. Oct 2018;142(4):443e-450e. doi:10.1097/prs.0000000000004804

51. Zelcer S, Kolesnikov Y, Kovalyshyn I, Pasternak DA, Pasternak GW. Selective potentiation of opioid analgesia by nonsteroidal anti-inflammatory drugs. *Brain Res*. Apr 8 2005;1040(1-2):151-6. doi:10.1016/j.brainres.2005.01.070

52. Sarac BA, Schoenbrunner AR, Brower KI, Joshi GP, Janis JE. Analysis of Adverse Effects of Multimodal Gabapentin in Abdominal Wall Reconstruction. *Plast Reconstr Surg*. Jan 18 2022;doi:10.1097/PRS.0000000000008836

53. Levy B, Paulozzi L, Mack KA, Jones CM. Trends in opioid analgesic–prescribing rates by specialty, US, 2007–2012. *American journal of preventive medicine*. 2015;49(3):409-413.

54. Waljee JF, Li L, Brummett CM, Englesbe MJ. Iatrogenic opioid dependence in the United States: are surgeons the gatekeepers? *Annals of surgery*. 2017;265(4):728-730.

55. Faucher L, Furukawa K. Practice guidelines for the management of pain. *J Burn Care Res*. Sep-Oct 2006;27(5):659-68. doi:10.1097/01.BCR.0000238117.41490.00

56. Zhang K, Blum, K., Chu, J.J, Zewdu, A., Janse, S., Skoracki, R., Janis, J.E., Barker, J.C. . A Personalized Opioid Prescription Model for Predicting Postoperative Discharge Opioid Needs. . *Accepted to Plastic and Reconstructive Surgery*. 2021;

57. Ramsay MA. Acute postoperative pain management. *Proc (Bayl Univ Med Cent)*. Jul 2000;13(3):244-7. doi:10.1080/08998280.2000.11927683

58. Goldstein JL, Cryer B. Gastrointestinal injury associated with NSAID use: a case study and review of risk factors and preventative strategies. *Drug Healthc Patient Saf*. 2015;7:31-41. doi:10.2147/DHPS.S71976

59. Goldstein JL. Challenges in managing NSAID-associated gastrointestinal tract injury. *Digestion*. 2004;69 Suppl 1:25-33. doi:10.1159/000076554

60. Schoenbrunner AR, Joshi GP, Janis JE. Multimodal Analgesia in the Aesthetic Plastic Surgery: Concepts and Strategies. *Plast Reconstr Surg Glob Open*. May 2022;10(5):e4310. doi:10.1097/GOX.0000000000004310

61. McGettigan P, Henry D. Current problems with non-specific COX inhibitors. *Curr Pharm Des*. Nov 2000;6(17):1693-724. doi:10.2174/1381612003398690

62. Chang CY, Challa CK, Shah J, Eloy JD. Gabapentin in acute postoperative pain management. *Biomed Res Int*. 2014;2014:631756. doi:10.1155/2014/631756

63. Verret M, Lauzier F, Zarychanski R, et al. Perioperative Use of Gabapentinoids for the Management of Postoperative Acute Pain: A Systematic Review and Meta-analysis. *Anesthesiology*. 2020;133(2):265-279. doi:10.1097/aln.0000000000003428

64. Barker JC, Joshi GP, Janis JE. Basics and best practices of multimodal pain management for the plastic surgeon. *Plastic and Reconstructive Surgery Global Open*. 2020;8(5)

65. Hausman MS, Jr., Jewell ES, Engoren M. Regional versus general anesthesia in surgical patients with chronic obstructive pulmonary disease: does avoiding general anesthesia reduce the risk of postoperative complications? *Anesth Analg*. Jun 2015;120(6):1405-12. doi:10.1213/ANE.0000000000000574

66. Khansa I, Jefferson R, Khansa L, Janis JE. Optimal Pain Control in Abdominal Wall Reconstruction. *Plast Reconstr Surg*. Sep 2018;142(3 Suppl):142S-148S. doi:10.1097/PRS.0000000000004870

67. Wu CL, Cohen SR, Richman JM, et al. Efficacy of postoperative patient-controlled and continuous infusion epidural analgesia versus intravenous patient-controlled analgesia with opioids: a meta-analysis. *Anesthesiology*. Nov 2005;103(5):1079-88; quiz 1109-10. doi:10.1097/00000542-200511000-00023

68. Farias-Eisner G, Kao K, Pan J, Festekjian J, Gassman A. Intraoperative Techniques for the Plastic Surgeon to Improve Pain Control in Breast Surgery. *Plast Reconstr Surg Glob Open*. Nov 2017;5(11):e1522. doi:10.1097/GOX.0000000000001522

69. ElHawary H, Joshi GP, Janis JE. Practical Review of Abdominal and Breast Regional Analgesia for Plastic Surgeons: Evidence and Techniques. *Plast Reconstr Surg Glob Open*. Dec 2020;8(12):e3224. doi:10.1097/GOX.0000000000003224

70. ElHawary H, Abdelhamid K, Meng F, Janis JE. Erector Spinae Plane Block Decreases Pain and Opioid Consumption in Breast Surgery: Systematic Review. *Plast Reconstr Surg Glob Open*. Nov 2019;7(11):e2525. doi:10.1097/GOX.0000000000002525

71. Albrecht E, Mermoud J, Fournier N, Kern C, Kirkham KR. A systematic review of ultrasound-guided methods for brachial plexus blockade. *Anaesthesia*. Feb 2016;71(2):213-27. doi:10.1111/anae.13347

72. Kettner SC, Willschke H, Marhofer P. Does regional anaesthesia really improve outcome? *British Journal of Anaesthesia*. 2011/12/01/ 2011;107:i90-i95. doi:https://doi.org/10.1093/bja/aer340

73. Levene JL, Weinstein EJ, Cohen MS, et al. Local anesthetics and regional anesthesia versus conventional analgesia for preventing persistent postoperative pain in adults and children: A Cochrane systematic review and meta-analysis update. *J Clin Anesth*. Aug 2019;55:116-127. doi:10.1016/j.jclinane.2018.12.043

74. Lalonde D, Eaton C, Amadio P, Jupiter J. Wide-awake Hand and Wrist Surgery: A New Horizon in Outpatient Surgery. *Instr Course Lect*. 2015;64:249-59.

75. Lalonde D. Wide awake local anaesthesia no tourniquet technique (WALANT). Springer; 2015:1-2.

76. Moscato L, Helmi A, Kouyoumdjian P, Lalonde D, Mares O. The impact of WALANT anesthesia and office-based settings on patient satisfaction after carpal tunnel release: a patient reported outcome study. *Orthop Traumatol Surg Res*. Oct 26 2021:103134. doi:10.1016/j.otsr.2021.103134

77. Gordley KP, Basu CB. *Optimal Use of Local Anesthetics and Tumescence*. Semin Plast Surg. 2006 Nov;20(4):219-24. doi: 10.1055/s-2006-951579.

78. Koeppe T, Constantinescu MA, Schneider J, Gubisch W. Current trends in local anesthesia in cosmetic plastic surgery of the head and neck: results of a German national survey and observations on the use of ropivacaine. *Plast Reconstr Surg*. May 2005;115(6):1723-30. doi:10.1097/01.prs.0000161671.34502.40

79. Joshi GP, Janis JE, Haas EM, Ramshaw BJ, Nihira MA, Dunkin BJ. Surgical Site Infiltration for Abdominal Surgery: A Novel Neuroanatomical-based Approach. *Plast Reconstr Surg Glob Open*. Dec 2016;4(12):e1181. doi:10.1097/GOX.0000000000001181

80. Little A, Brower K, Keller D, Ramshaw B, Janis JE. A Cost-Minimization Analysis Evaluating the Use of Liposomal Bupivacaine in Reconstructive Plastic Surgery Procedures. *Plast Reconstr Surg*. Apr 2019;143(4):1269-1274. doi:10.1097/PRS.0000000000005435

81. Klein JA. Tumescent technique chronicles. Local anesthesia, liposuction, and beyond. *Dermatol Surg*. May 1995;21(5):449-57.

82. Rohrich RJ, Kenkel JM, Janis JE, Beran SJ, Fodor PB. An update on the role of subcutaneous infiltration in suction-assisted lipoplasty. *Plast Reconstr Surg*. Feb 2003;111(2):926-7; discussion 928. doi:10.1097/01.PRS.0000039396.69495.C5

83. Gutowski KA. Tumescent analgesia in plastic surgery. *Plast Reconstr Surg*. Oct 2014;134(4 Suppl 2):50S-57S. doi:10.1097/PRS.0000000000000678

84. Conroy PH, O'Rourke J. Tumescent anaesthesia. *Surgeon*. Aug 2013;11(4):210-21. doi:10.1016/j.surge.2012.12.009

85. Hardwicke JT, Jordan RW, Skillman JM. Infiltration of epinephrine in reduction mammaplasty: a systematic review of the literature. *Plast Reconstr Surg*. Oct 2012;130(4):773-778. doi:10.1097/PRS.0b013e318262f085

86. Kaweski S, Committee PSEFTA. Topical Anesthetic Creams. *Plastic and Reconstructive Surgery*. 2008;121(6):2161-2165. doi:10.1097/PRS.0b013e318170a7a4

87. Huang N, Cunningham F, Laurito CE, Chen C. Can we do better with postoperative pain management? *The American Journal of Surgery*. 2001/11/01/ 2001;182(5):440-448. doi:https://doi.org/10.1016/S0002-9610(01)00766-8

88. Joshi GP, Kehlet H. Postoperative pain management in the era of ERAS: an overview. *Best Practice & Research Clinical Anaesthesiology*. 2019;33(3):259-267.

89. Saranteas T, Koliantzaki I, Savvidou O, et al. Acute pain management in trauma: anatomy, ultrasound-guided peripheral nerve blocks and special considerations. *Minerva Anestesiol*. Jul 2019;85(7):763-773. doi:10.23736/S0375-9393.19.13145-8

90. Pasternak GW. Opiate pharmacology and relief of pain. *Journal of Clinical Oncology*. 2014;32(16):1655.

91. Trescot AM, Datta S, Lee M, Hansen H. Opioid pharmacology. *Pain physician*. 2008;11(2 Suppl):S133-53.

92. Glare P, Walsh T. Clinical pharmacokinetics of morphine. *Therapeutic drug monitoring*. 1991;13(1):1-23.

93. Roberts GW, Bekker TB, Carlsen HH, Moffatt CH, Slattery PJ, McClure AF. Postoperative nausea and vomiting are strongly influenced by postoperative opioid use in a dose-related manner. *Anesthesia & Analgesia*. 2005;101(5):1343-1348.

94. Alexander JC, Patel B, Joshi GP. Perioperative use of opioids: current controversies and concerns. *Best Practice & Research Clinical Anaesthesiology*. 2019;33(3):341-351.

95. Pavlin DJ, Chen C, Penaloza DA, Polissar NL, Buckley FP. Pain as a factor complicating recovery and discharge after ambulatory surgery. *Anesth Analg*. Sep 2002;95(3):627-34, table of contents. doi:10.1097/00000539-200209000-00025

96. Cramer JD, Wisler B, Gouveia CJ. Opioid stewardship in otolaryngology: state of the art review. *Otolaryngology–Head and Neck Surgery*. 2018;158(5):817-827.

97. Alam A, Gomes T, Zheng H, Mamdani MM, Juurlink DN, Bell CM. Long-term analgesic use after low-risk surgery: a retrospective cohort study. *Archives of internal medicine*. 2012;172(5):425-430.

98. Brummett CM, Waljee JF, Goesling J, et al. New persistent opioid use after minor and major surgical procedures in US adults. *JAMA surgery*. 2017;152(6):e170504-e170504.

99. Johnson SP, Chung KC, Zhong L, et al. Risk of prolonged opioid use among opioid-naïve patients following common hand surgery procedures. *The Journal of hand surgery*. 2016;41(10):947-957. e3.

100. Jiang X, Orton M, Feng R, et al. Chronic opioid usage in surgical patients in a large academic center. *Annals of surgery*. 2017;265(4):722.

101. Rose KR, Christie BM, Block LM, Rao VK, Michelotti BF. Opioid prescribing and consumption patterns following outpatient plastic surgery procedures. *Plastic and Reconstructive Surgery*. 2019;143(3):929-938.

102. Hart AM, Broecker JS, Kao L, Losken A. Opioid use following outpatient breast surgery: are physicians part of the problem? *Plastic and reconstructive surgery*. 2018;142(3):611-620.

103. Chu JJ, Janis JE, Skoracki R, Barker JC. Opioid Overprescribing and Procedure-Specific Opioid Consumption Patterns for Plastic and Reconstructive Surgery Patients. *Plast Reconstr Surg*. Apr 1 2021;147(4):669e-679e. doi:10.1097/PRS.0000000000007782

104. Long EA, Johnson SP, Valmadrid A, Wormer BA, Drolet BC, Perdikis G. Plastic surgery patient expectations for postoperative opioid prescriptions. *Annals of Plastic Surgery*. 2020;84(6S):S437-S440.

105. Bartels K, Mayes LM, Dingmann C, Bullard KJ, Hopfer CJ, Binswanger IA. Opioid use and storage patterns by patients after hospital discharge following surgery. *PloS one*. 2016;11(1):e0147972.

106. Compton WM, Jones CM, Baldwin GT. Relationship between nonmedical prescription-opioid use and heroin use. *New England Journal of Medicine*. 2016;374(2):154-163.

107. Pavlin DJ, Chen C, Penaloza DA, Buckley FP. A survey of pain and other symptoms that affect the recovery process after discharge from an ambulatory surgery unit. *J Clin Anesth*. May 2004;16(3):200-6. doi:10.1016/j.jclinane.2003.08.004

108. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: results from a national survey suggest postoperative pain continues to be undermanaged. *Anesth Analg*. Aug 2003;97(2):534-540. doi:10.1213/01.ANE.0000068822.10113.9E

109. Medscape: https://reference.medscape.com/drug/seglentis-celecoxib-tramadol-4000087.

110. Klifto KM, Tuffaha SH, Cooney DS, Hultman CS. Pharmacoplastic Surgery: Emerging Concepts. *Plast Reconstr Surg*. Nov 2020;146(5):703e-706e. doi:10.1097/PRS.0000000000007308

Figure and table legends

Figure 1: Validated pain rating scales

Commonly used and validated scales are the Visual Analogue Scale (VAS), the Numerical Rating Scale (NRS), the Verbal Rating Scale (VRS) and the Faces Pain Scale-Revised (FPS-R). Copyrighted, used and reprinted with permission of Saffari T.M. and colleagues; all rights reserved.

Figure 2: Multimodal management (MMA) for the postoperative pain patient

A schematic overview of the multimodal pain management is depicted. To manage pain, step 1 of the MMA includes non-opioid treatment e.g. acetaminophen, nonsteroidal anti-inflammatory drugs (NSAID), cyclooxygenase (COX)-inhibitors and gabapentinoids (gabapentin and pregabalin to prevent central sensitization). If insufficient, opioids will be added to the management (i.e. step 2 weak opioids and step 3 strong opioids). Step 4 of the MMA ladder includes local, topical and regional anesthesia. Peri- and postoperative epidural analgesia and peripheral nerve blocks are part of the regional analgesia, which are used for a variety of surgical procedures in both inpatient and outpatient settings. Non-pharmacological treatments such as physical therapy, cognitive behavioral therapy (CBT) and transcutaneous electrical nerve stimulation (TENS) could aid in managing postoperative pain when combined with other modalities. Topical anesthetic creams include topicaine (4% lidocaine gel), EMLA (2.5% lidocaine and 2.5% prilocaine) and TAC (0.5% tetracaine, 1:2000 adrenaline and 11.8% cocaine). Local analgesia (1% lidocaine with or without 1:100000 epinephrine) is often used in hand surgery or cosmetic surgery. Copyrighted, used and reprinted with permission of Saffari T.M. and colleagues; all rights reserved.

Figure 3: Algorithm for acute pain management based on clinical indication

In this flowchart, an overview of the acute pain management per clinical indication is provided. The ambulatory surgery category includes same-day surgical care that does not require hospitalization, also called outpatient surgery. Regional nerve blocks for abdominal surgery include blocks in the transversus abdominis plane (TAP) or liposomal bupivacaine. For breast surgery, regional anesthesia includes paravertebral, intercostal, serratus anterior plane (SAP), pectoralis (PECS) and erector spinae plane (ESP) nerve blocks. If the pain for any of the categories is not managed, additional analgesics according to the multimodal management (MMA) ladder (described in Figure 2) are provided. CTR: carpal tunnel release. NSAID: nonsteroidal anti-inflammatory drugs. Copyrighted, used and reprinted with permission of Saffari T.M. and colleagues; all rights reserved.

Table 1: Medications used in multimodal management for surgical patient

COX-inhibitor: cyclooxygenase (COX)-inhibitor. FDA: Food and Drug Administration. GI: gastrointestinal. IV: intravenous MMA: multimodal analgesia. NSAID: nonsteroidal anti-inflammatory drugs (NSAID). PO: per os. PRN: pro re nata (i.e. as needed). TID: three times daily

Table 1

Multimodal agent	Indications	Dosage	Contraindications and important considerations	Side effects
Acetaminophen	Base of MMA, recommended in all patients unless contraindicated	Preoperatively: 1000 mg PO/PR/IV x1 Postoperatively: 650-1000 mg q6h	• Hepatoxicity when used above the maximum dosage of 4 g per 24 hours • Avoid in patients with known liver disease	Most commonly experienced with long-term use: • Nausea and vomiting • Fatigue • Anorexia
NSAIDs	Base of MMA, recommended in all patients unless contraindicated	Intraoperatively: Ketorolac 15–30 mg IV x1 Postoperatively: Ketorolac PRN • IV: 30 mg as single dose or 30 mg q6h; not to exceed 120 mg/day • IM: 60 mg as single dose or 30 mg q6h; not to exceed 120 mg/day • PO: intended as a continuation of IV or IM therapy. 20 mg to start, then 10 mg q4-6h; not to exceed 40 mg/day Ibuprofen 600-800 mg PO q6-8h PRN Naproxen 500 mg PO q12h	Increased risk of GI complications in case of: • Previous history of GI injury • Advanced age • Concurrent use of aspirin or corticosteroids • Avoid in patients with acute or chronic renal disease and iatrogenic acute renal injury Ketorolac: • Duration of Ketorolac therapy should not exceed 5 days • Risk for acute renal failure and hyperkalemia with prolonged use	• Stomach ulcers or reflux • Headache • Allergic reaction
COX-2 specific inhibitors (celecoxib)	When NSAIDs are contraindicated	Preoperatively: Celecoxib 400 mg PO x1 Postoperatively:	• Contraindicated in preexisting coronary artery disease due to association with higher rates of cardiac events	• Constipation • Nausea and vomiting

		Celecoxib 200 mg PO TID	• Avoid in patients with acute or chronic renal disease and iatrogenic acute renal injury	
Opioids	Second step of acute pain management when non-opioid treatment is not sufficient	Oral options: • Oxycodone 5 mg q4h PRN • Morphine 7.5-15 mg q4h PRN • Hydromorphone 2-4 mg q4h PRN Intravenous options: • Hydromorphone 0.5-1 mg q3-4h PRN • Morphine 2-4 mg q3-4h PRN Alternative in case of allergies: • Fentanyl 25-50 mcg q1-2h PRN	<u>Caution in patients with:</u> • Abuse history or potential • History of alcohol consumption • Obstructive sleep apnea • Advanced age • Concurrent use of other sedative medications	• Addiction • Respiratory depression • Constipation
Gabapentinoids (e.g. gabapentin and pregabalin)	Useful in patients with higher risk for persistent postoperative pain	Preoperatively: Gabapentin: 300-1200 mg Postoperatively: Gabapentin 300-600 mg TID	<u>Caution in patients with:</u> • Advanced age, morbidly obese • Reduced lung function, obstructive sleep apnea Dose adjustment in patients with renal impairment	• Dizziness • Somnolence • Respiratory depression
Dexamethasone	Reduce postoperative pain through anti-inflammatory mechanisms	Intraoperatively: 0.1-0.2 mg/kg, most commonly 8 mg	• Problematic for patients with hyperglycemia or insulin usage, but this is not a strong contraindication	<u>Surgical side effects include:</u> • Delayed wound healing • Increased surgical site infections • Hyperglycemia

Muscle relaxants (e.g. cyclobenzaprine)	As adjuncts in MMA treatment when pain is not controlled with standard MMA and operation involves high likelihood of muscle spasm or tension	Cyclobenzaprine 5-10 mg TID Methocarbamol 500-750 mg q6h Tizanidine 2 mg TID	Caution in elderly patients due to increased risk of fall due to sedation/delirium	• Seizures • Drowsiness • Dizziness, dry mouth, fatigue

Figure 1

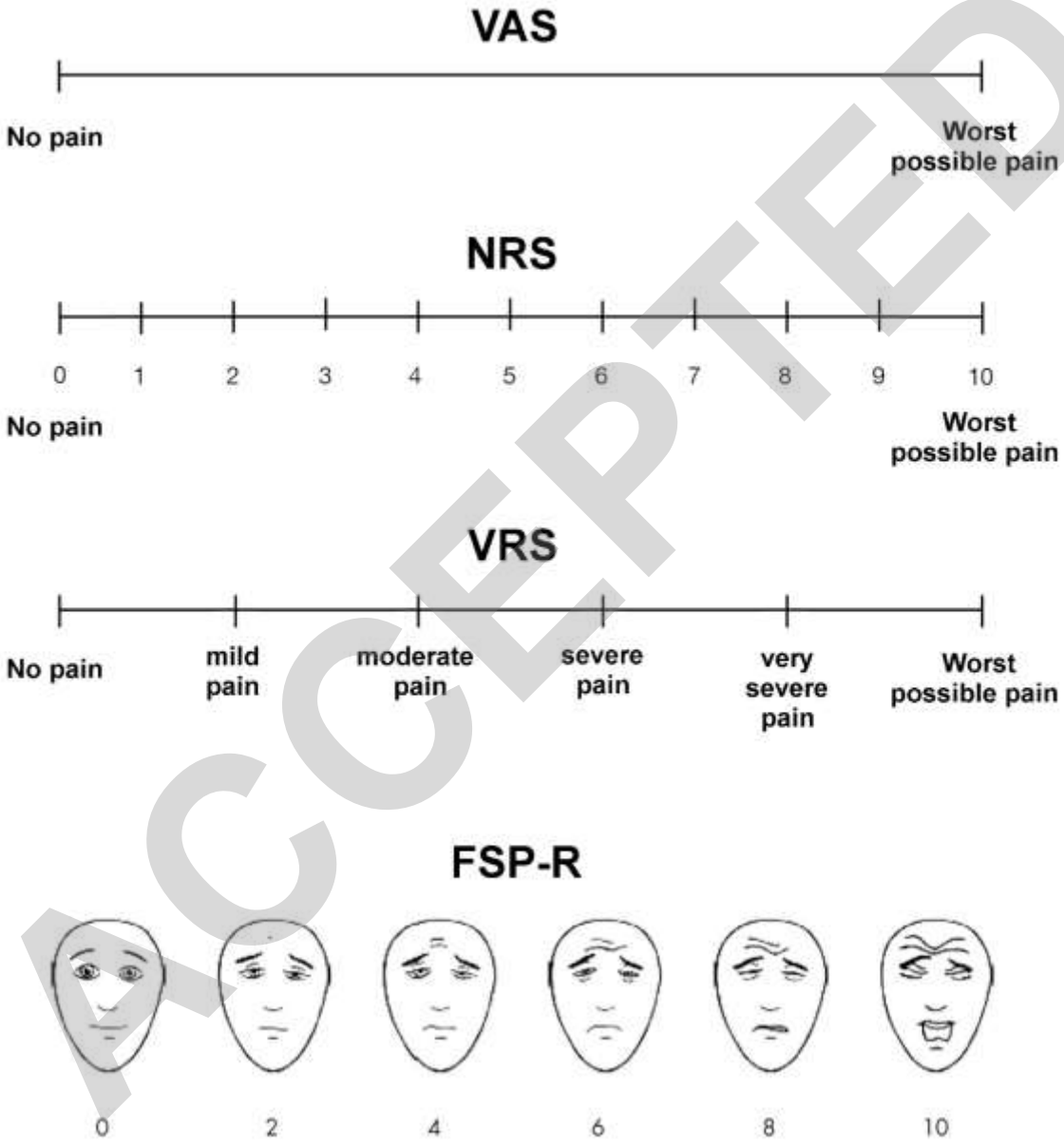

Figure 2

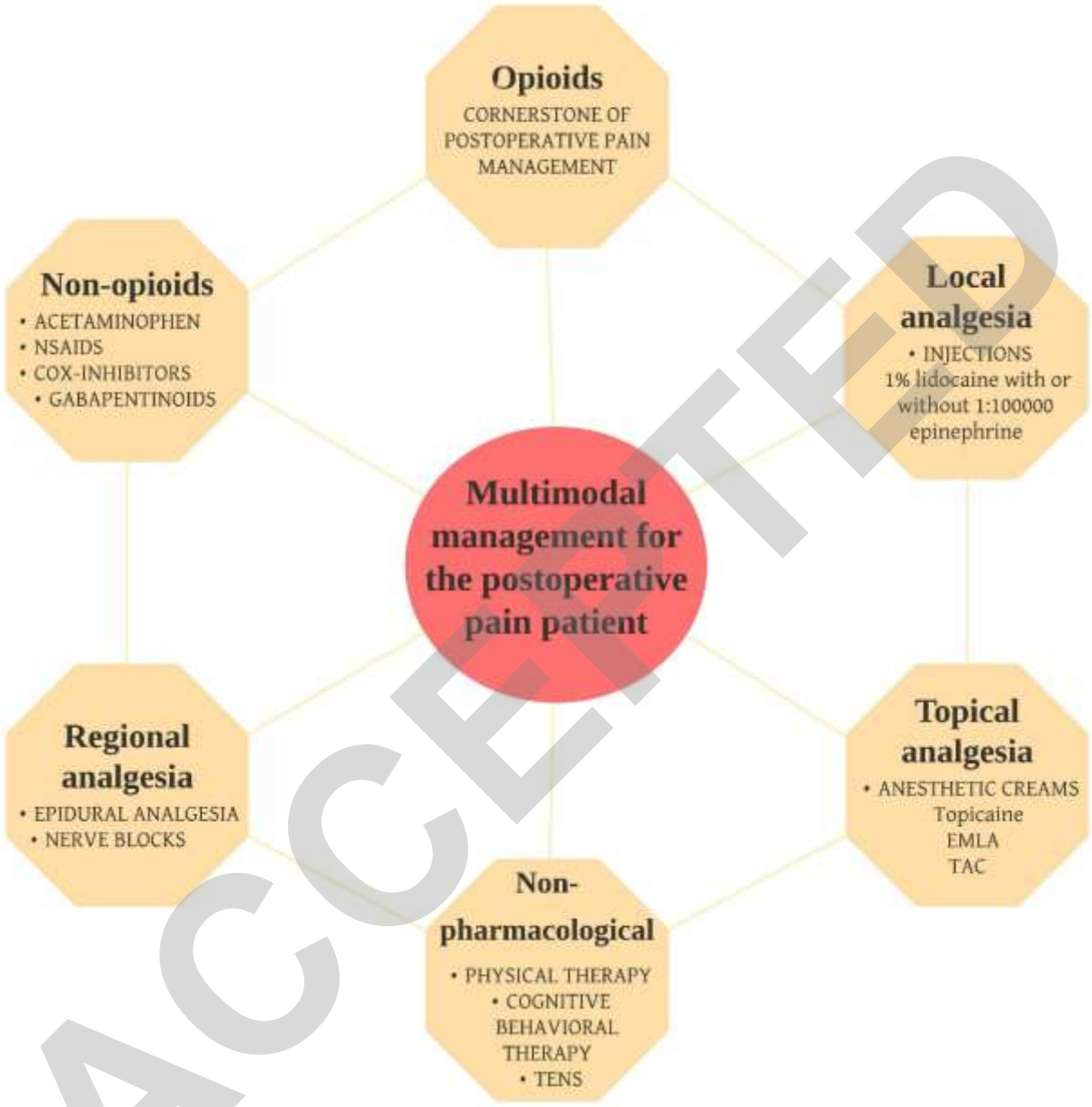

Figure 3