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NARRATIVE REVIEW CARDIAC ANESTHESIA

Beyond the incision: exploring acute pain management strategies following cardiac surgeries

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ABSTRACT

This narrative review explores the importance of multimodal pain management options for postoperative cardiac surgery, focusing on maximizing pain alleviation while minimizing opioids usage and adverse consequences. It examines various pharmacological and non-pharmacological techniques, including opioids, NSAIDs, acetaminophen, gabapentinoids, alpha-2 agonists, local anesthetics, and ketamine, to maximize pain relief and improve patient outcomes. The review emphasizes the significance of a multimodal approach, combining different agents for better pain relief and patient outcomes.

Non-pharmacological treatments, such as progressive muscle relaxation, deep breathing exercises, distraction techniques, massage therapy, and transcutaneous electrical nerve stimulation (TENS), also play a role in pain management, promoting comprehensive patient comfort and well-being. These methods are helpful additions to existing pharmaceutical therapies and promote comprehensive patient comfort.

In conclusion, multimodal pain management techniques are crucial in postoperative cardiac surgery, as they provide optimal pain relief, increased patient satisfaction, and overall improvement in outcomes. Healthcare professionals must continuously evaluate, modify, and improve pain management strategies to provide the highest level of care to patients in this high-stakes environment.

Keywords: Postoperative pain Management, Multimodal Analgesia, Opioids, Cardiac Surgery, Acute Pain, Patient-centered care, Interdisciplinary collaboration, Non-pharmacological Pain Relief.

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1. Introduction

Despite the fact that cardiac operations may save patients' lives, they often leave patients in a substantial amount of postoperative discomfort, which can slow down their healing and reduce their overall quality of life. In recent years, medical researchers and practitioners have committed their efforts to look for creative treatments that go beyond the typical incision-based methods of pain management.

Acute pain is a side effect of surgically damaged tissue and should subside as the body recovers. Usually, it takes

three months for pain to be deemed as chronic or persistent.[1] Acute postoperative pain has a wide range of reasons. Tissue damage results after surgery. The pain matrix responds to the surgical injury in a number of ways, including increased sensitivity of the central and peripheral pain pathways and emotions of dread, worry, and frustration.[2] A considerable percentage of patients experience moderate to severe pain during the first few days following cardiac surgeries, which is a common problem.[3]

The first twenty-four hours after surgery are often the most excruciating, and from there on out, the pain will steadily decrease over the course of the next several days. Another factor that contributes to the worsening of postoperative pain is anxiety before to the procedure. This factor affects younger people more strongly than it does elderly people.

2. Epidemiology

Postoperative pain after cardiac surgery is widely reported, however the reported frequency varies substantially, ranging between 49% and 90% for acute pain following cardiac surgery.[4-6]

It has been shown that patients who experience acute postoperative pain that ranges from moderate to severe during the first 72 hours following surgery have a significantly increased risk of experiencing major chronic postoperative pain that disrupts their day-to-day activities and their overall quality of life. This risk is significantly increased when compared to patients who do not experience acute postoperative pain that ranges from moderate to severe during the first 72 hours following surgery.[7] A variety of Numerous patient-related factors, such as demographics, knowledge, beliefs, psychosocial issues, the nature of the operation, and a patient's interactions with their healthcare practitioner, can either help or impede pain management following cardiac surgery.[8]

3. Impact of uncontrolled pain

A number of unfavorable outcomes, including an increased risk of morbidity, a decline in physical function and quality of life, a prolonged use of opioids during and after hospitalization, and an increase in healthcare costs, may result from the improper management of acute pain in surgical patients. A sizable portion of people seem to be predisposed to developing chronic pain as a result of early postoperative discomfort. After surgery, this sort of discomfort might sometimes continue for several months.[9]

Untreated pain may impede efficient wound care, including debridement and dressing changes.[10, 11] It can also impact tissue perfusion and oxygenation, which can slow the healing process of a wound.[12] If a patient's pain is not adequately controlled, it may be difficult for them to move about and may hinder them from taking deep breaths or coughing, all of which may raise the risk of wound complications such as infection , pneumonia and dehiscence.

Pain that remains untreated may have a major and detrimental effect on a person's quality of life, as well as economic, social, psychological, and even bodily consequences. It is possible for immunological and neurological changes to take place if acute pain is not well managed, which may then develop to chronic pain.[13]

The risk of complications such as atelectasis, pneumonia, cardiac ischemia, infarction, and thromboembolic event is increased when postoperative pain is not addressed. Pain makes it difficult to take full breath and to cough, which may result in insufficient ventilation and a reduction in the ability to clear respiratory secretions.[13]

According to the World Health Organization (WHO), people who suffer from uncontrolled acute pain are more than twice as likely to have trouble functioning, and they are four times more likely to have feelings of hopelessness or worry than those who do not.[14] A patient's quality of life may decrease if their pain is not well controlled since it may lead to feelings of worry, despondency, and difficulty sleeping. As a result, you may have a worsening of psychological discomfort and cognitive impairment, as well as an increase in stress, loss of sleep, and weariness. In addition, there may be a worsening of these symptoms. Uncontrolled pain may have a negative impact on a person's ability to communicate socially, participate in everyday activities, and be healthy overall.

4. Physiology of Pain after Cardiac Surgeries:

After cardiac surgery, the likelihood of experiencing acute postoperative pain is correlated with both the presence of a surgical wound and manipulation of tissue or organs. The pericardium, sternum, and blood vessels are among the tissues that are manipulated and cut during surgery. Nociceptors, specialized pain receptors situated in peripheral tissues, are stimulated by mechanical, thermal, and chemical stimuli. This kind of pain gradually gets better as skin and biological tissue recover.[15, 16]

At the site of the injury, tissue damage causes a condition known as neurogenic inflammation. An edematous, red, and painful area surrounds the wound. A number of

inflammatory mediators, including substance P, serotonin, histamine, cytokines, and leukotrienes, as well as potassium ions, bradykinin, prostanoids, and many more are released from the cells that cause these symptoms.[17] Due to the sensitization and activation of peripheral nerve terminals by these inflammatory mediators, pain signaling is amplified.

Peripheral sensitization of sensory afferents, both nociceptive and non-nociceptive, is brought on by inflammation. Due to chemical mediators produced by nociceptors and non-neuronal cells at areas of tissue damage or inflammation, this lowers threshold and boosts responsiveness at the ends of peripheral nerve fibers. The formation of so-called neurogenic inflammation at the trauma site is a result of tissue injury. At the site of the injury, there is significant discomfort, redness, and swelling. These symptoms are brought on by the cells' production of potassium ions, bradykinin, prostanoids, and a variety of inflammatory mediators such as substance P, serotonin, histamine, cytokines, and leukotrienes. Increased pain signaling is a consequence of these inflammatory mediators, which make the nerve terminals of the peripheral nervous system more sensitive and active.[18]

These inflammatory mediators make the nerve terminals in the peripheral nervous system more sensitive, which causes both an increase in the response to generally painless stimuli (allodynia) as well as a heightened sensitivity to painful stimuli (hyperalgesia).[19] Peripheral sensory nerves like A-delta and C fibers carry pain signals produced at the surgical site to the central nervous system.

While C fibers carry sluggish, gradual pain signals, A-delta fibers send acute, rapid pain signals. Peripheral nerves provide pain signals into the spinal cord, where they are carried to higher brain centers.

Numerous processes, including the release of neurotransmitters and the activation of inhibitory channels, are used to control pain signals inside the spinal cord. Enhanced transmission of pain signals to the brain can result from enhanced pain signaling brought on by surgical tissue damage and inflammation.

Central sensitization, or an amplified pain signal inside the CNS, can occur in pain disorders. The process of central sensitization alters the excitability of neurons in the spinal cord and brain, which increases pain sensitivity, lowers pain thresholds, and amplifies existing pain.[20]

In brain parabrachial nucleus, which is primarily right lateralized, transmits pain-related information to the central amygdala from the spinal cord.[21] This circuit is serotoninergic and noradrenergic. The parabrachial nucleus receives opioidergic pain-inhibitory signals from the amygdala as well as somatostatin and corticotropin.[22] Amygdala activity was observed in human meta-analytic studies of pain , supporting the amygdala's role in processing pain,[23]

Additionally, the dopaminergic ventrolateral prefrontal cortex participates in the descending pain inhibitory circuit. Individual pain experiences might vary due to emotional and cognitive aspects that affect how pain is perceived and modulated. Through descending neural pathways, the brain may modify pain signals, enhancing or inhibiting pain transmission.[24]

5. Assessment of Pain after Cardiac Surgeries

The evaluation of post-cardiac surgery pain is essential for efficient pain management and maximizing patient comfort. The impact of pain on patients is assessed using a variety of evaluation methods and instruments. The following are some important techniques for measuring pain following cardiac surgeries:

The numeric rating scale, often known as the NRS, is a screening tool for pain that is widely used to assess the current state of pain using a scale that ranges from 0 to 10, with 0 representing "no pain" and 10 representing "the highest pain imaginable".[25] Regardless of whether or not a person has cognitive impairment, a pain screening approach called a Verbal Descriptor Scale (VDS) may be utilized to evaluate their level of discomfort. The Virtual Diagnostic System (VDS) provides concise explanations of various degrees of pain severity, including "no pain," "mild pain," "moderate pain," "severe pain," "extreme pain," and "the most intense pain imaginable." Person may still be able to react to a VDS even if they have difficulties due to linguistic, cultural, or educational obstacles. A standard method for screening for pain is called the six-category visual analog scale.[26]

For pediatric population the Faces Pain Thermometer (FPT) was created. It has a thermometer with six faces and a scale from 0 to 10.[27]This scale displays a sequence of faces ranging from smiling (no pain) to sobbing (worst agony), allowing patients to express their pain level. It is especially helpful for patients with communication challenges, for example critically ill patients or patient unable to talk. In addition to it, the visual analogue scale (VAS) is an established and apparent assessment that may be used for both acute and chronic pain. The line is 10 centimeters long and illustrates a pain spectrum ranging from "no pain" to "worst pain." The score is tracked by placing a handwritten mark anywhere along the line.[28]

These all were self-reporting scales on which pain can be rated and reported. Furthermore, some other tools are also present for assessment of pain. The Brief Pain Inventory (BPI) is a questionnaire that evaluates the severity and impact of pain on various aspects of a patient's life, including physical functioning, mood, and quality of life.[29] The McGill Pain Questionnaire assesses the sensory, emotional, and evaluative aspects of pain in a patient.[30] Observational and behavioral assessments, such as facial expressions, body movements, vocalizations, and PAINAD Scale, help assess pain intensity in special situations.[31] Additional considerations include assessing physiological signs, patient's reports, and repeated assessments at different intervals to monitor changes in pain intensity and management strategies.

Combining these assessment methods and considering individual patient characteristics is crucial for a comprehensive understanding of pain after cardiac surgeries. Regular and systematic pain assessments enable healthcare providers to tailor pain management strategies and optimize control, improving patient outcomes and post-operative recovery.

6. Pharmacological Pain Management Techniques

At the tail end of the 1960s, it was discovered that high-dose intravenous (IV) morphine was a very hemodynamically stable primary anesthetic medication for a number of patients who were undergoing cardiac surgery. It was during this time that the opioid-based cardiac anesthetic strategy was established.[32] Opioids was the analgesic of choice during cardiac surgery due to the fact that they have a safer hemodynamic profile and sedation. Research is now being conducted to determine ways to enhance patient recovery by using a multimodal strategy that makes use of opiate sparing techniques.[33] It has been shown that early extubation is connected with improved patient outcomes and lower costs associated with cardiac surgery.[34]

Among patients who have undergone cardiac surgery, the following pharmaceutical methods are frequently employed to alleviate pain:

6.1. Opioids:

Opioids were frequently used for early postoperative pain control in ICU, providing analgesia and sedation. However, because fast track extubation is now considered the standard of care for patients undergoing cardiac surgeries due to a number of benefits that have been proven, the use of opioids in the immediate postoperative period has decreased for sedation purposes. However, short acting opioids are still used for pain relief.[35,36] Opioids are strong analgesics used to treat moderate to severe pain, such as morphine, fentanyl, and hydromorphone. They reduce the experience of pain by acting on opioid receptors in the central nervous system. They can be given intravenously, orally, or by PCA apparatus. Sedation, respiratory depression, nausea, constipation, and addiction are some of the side effects.

Following heart surgery, morphine was widely utilized and was regarded as the gold standard. After intravenous (IV) injection, it provides a strong analgesic effect with drowsiness. Pethidine, less potent and popular than morphine, has useful properties like less common histamine release, making it an alternative for patients prone to bronchospasm and controlling shivering in patients.[37]

Newer synthetic opioid agonists such as Fentanyl offer a faster analgesic response than morphine due to its lipo-soluble nature, allowing it to pass through the blood-brain barrier. This may lead to more rapid postoperative pain relief compared to morphine and having shorter duration of action which facilitates fast track extubation.[38-40] Remifentanil offers effective intraoperative protection, rapid onset, and facilitates postoperative recovery. The results of a meta-analysis conducted by Greco et al. reveal that the administration of remifentanil reduces the amount of time patients need mechanical breathing, as well as the release of cardiac troponin and the length of their hospital stays after cardiac surgery.[40]

On the other hand opioids are linked to several harmful side effects, such as delayed intestinal healing following surgery, extended mechanical ventilation, and ICU-associated psychosis/delirium.[41, 42]

There is accumulating data that suggests a multimodal strategy that makes use of opiate-sparing strategies is useful in aiding patient recovery after surgery. There are different regimens for multimodal analgesia techniques comprises of NSAID, Dexamethasone, Acetaminophen , local anesthetists, gabapentinoids, NMDA antagonists and alpha 2 agonists.[43]

6.2. Non-steroidal Anti-Inflammatory Drugs (NSAIDs):

Inhibition of the enzyme cyclooxygenase (COX) is the principal mechanism by which nonsteroidal anti-inflammatory drugs (NSAIDs) function. In order to make thromboxane, prostaglandins, and prostacyclin, arachidonic acid must first be transformed into cyclooxygenase.[44] Following cardiac surgery, NSAIDs have shown opiate sparing effects in many randomized studies.[45-47] Concerns have been raised about the safety of NSAIDs in connection to renal impairment, the danger of bleeding, as well as the fact that they have been

associated to an increased risk of acute myocardial infarction and cardiovascular death.[48]

According to the findings of a prospective randomized double-blind study by Fayaz MK et al. shows that After CABG, diclofenac alone or in combination with paracetamol significantly reduces the need for opioids, resulting in faster extubation and improved oxygenation.[45] In another study the evidence presented by Milo et al. In patients who were previously taking aspirin, postoperative analgesia with ketorolac was related with a lower risk of death after coronary artery bypass graft surgery.[49] Patients who have just had heart surgery may be safely treated postoperatively with a combination of short-term slow-release ibuprofen and lansoprazole, according to the results of another research. This combination does not raise the patients' chance of suffering complications. On the other hand, thorough monitoring of renal function is essential.[50]

6.3. Acetaminophen (Paracetamol):

The activation of descending serotonergic pathways is how paracetamol exerts its central analgesic effect on the body. There is a degree of controversy around the primary mode of action that this compound has, which may include blocking the formation of prostaglandin (PG) or activating cannabinoid receptors through an active metabolite.[51] It was shown that paracetamol administered intravenously was an effective adjuvant in the management of postoperative pain that developed after heart surgery in a study that used a double-blind testing design.[52]

6.4. Gabapentinoids:

It is thought that the way gabapentinoids work to relieve pain is by directly inhibiting voltage-gated Ca2+ channels by attaching to their α2δ-1 subunit. This reduces presynaptic Ca2+ influx and causes the release of excitatory neurotransmitters like glutamate. The acute administration of gabapentinoids does not consistently result in a reduction in calcium currents, refuting this premise.[53] Pregabalin also modifies voltage-gated calcium channels, with a single preoperative dosage of 150 mg and planned dosing of 75 mg twice day after cardiac surgery, had a opioids sparing effect, lowers discomfort, and may even shorten the time it takes to be extubated.[54, 55]

6.5. Alpha-2 Agonists:

Clonidine and dexmedetomidine are examples of alpha-2 agonists, and both of these drugs have analgesic and sedative characteristics. The activation of presynaptic alpha-2 receptors in the central nervous system by alpha-2 agonists is the fundamental mechanism by which these drugs exert their effects. This stimulation of inhibitory neurons leads to a reduction in sympathetic output as a consequence of negative feedback.[56]

In patients who had cardiac surgery, taking dexmedetomidine before to the procedure was associated with a decreased risk of postoperative complications, delirium, and mortality for up to a year after the procedure.[57] Angelina Grest and colleagues conducted a retrospective observational research to demonstrate that both clonidine and dexmedetomidine may be safely supplied to a subgroup of people following cardiac surgery.[58]

Gurbet A et al. in an RCT demonstrates that dexmedetomidine Without increasing the likelihood of adverse effects, particularly respiratory depression, offers adequate preoperative analgesia and decreases the need for opioid analgesics.[59]

6.6. Local Anesthetics:

IV lidocaine, which is best known for its local anesthetic and anti-arrhythmic effects, is becoming more popular as a postoperative analgesic due to its anti-inflammatory and anti-hyperalgesic qualities. This is accomplished by inhibiting sodium, potassium, calcium, G-coupled protein, and n-methyl-d-aspartate receptors. Lidocaine is best known for its local anesthetic and anti-arrhythmic effects.[60, 61]

In patients undergoing off-pump CABG surgery, intraoperative intravenous lidocaine lowered the requirement for remifentanil, in addition to minimizing myocardial damage, which was confirmed by cardiac enzyme release. This was found in the research conducted by Lee et al.[61, 62] According to the findings of Guinot et al., the group that received opioid-free anesthesia needed much less total postoperative morphine (5 mg as opposed to 15 mg) to obtain comparable pain levels. This group also had quicker durations to extubation and a shorter period of time spent in the ICU. They were able to do this by first administering boluses of lidocaine, ketamine, and dexamethasone, and then transitioning to an intraoperative infusion of IV lidocaine that was continuous.[61, 63]

6.7. Ketamine:

Ketamine is a special type of anesthetic that causes amnesia, hypnosis, and analgesia with only mild respiratory and cardiovascular depression. It would appear to be a great option for patients in cardiac surgery who have impaired ventricular function due to its sympathomimetic feature.[64]

There are many distinct sites of action that are accountable for mediating the analgesic, anesthetic, and sympathomimetic effects of ketamine. Antagonizing

activity at N-methyl-D-aspartate (NMDA) receptors is the key neuropharmacological mechanism that underlies its analgesic effects. Racemic ketamine is a combination of the two enantiomers of ketamine known as (S)-ketamine and (R)-ketamine in equal proportions. In terms of both its analgesic and anesthetic efficacy, (S)-ketamine is about three times more powerful than (R)-ketamine. In addition to a quicker clearance rate, an increased ability to manage the anesthetic state is gained with a lower drug load.[65]

According to the findings of study conducted by Piper et al., ketamine improved postoperative patient satisfaction and postoperative recovery, and also cut down on the number of patients who had shivering, nausea, and vomiting after CABG surgery.[66, 67] After cardiac surgery, ketamine have opioid sparing properties and lowers blood pressure fluctuation.[68, 69]

7. Non-pharmacological techniques

Non-pharmacological methods can be useful in pain management following cardiac procedures in addition to pharmaceutical ones. These methods can help alleviate pain, encourage relaxation, and improve general wellbeing in addition to medication-based pain management measure.

7.1. Progressive muscle relaxation technique:

This method includes repeatedly tensing and then releasing various muscle groups in the body (palm, upper arm, shoulder, neck, forehead, scalp, eyebrow, abdomen, thigh, lower leg, feet, and sole muscles) to encourage muscular relaxation and general relaxation. A quasi-experimental research by Mohammed et al. shows patients who underwent cardiac surgery reported less postoperative pain and fatigue because of progressive muscle relaxation technique utilization.[70]

7.2. Deep Breathing Exercises:

Breathing deeply and slowly helps ease tension and lessen the impression of discomfort. Patients are advised to breathe gently by taking deep breaths in through the nose and slowly expelling through the mouth. A study was publish in 2022 by Jarrah MI et al., they analyze the impact of slow deep breathing relaxation exercise on patients' pain tolerance during chest tube removal following coronary artery bypass grafting (CABG) surgery. This study shows that slow deep breathing relaxation exercise a useful method for lowering pain during chest tube removal procedure, helping to reduce the need for analgesics and the side effects that go along with it.[71] So this technique can be postulated to be effective in relieving postoperative pain in general.

7.3. Distraction techniques:

Distraction tactics, such as aromatherapy, music and virtual reality, have been utilized both before and after surgery, with patients with proven benefits.[72, 73] When used with opioids drugs, music therapy has been shown to be effective in reducing anxiety and discomfort. Additionally, listening to music has been associated with less postoperative opioids drug use. Nursing staff and patients can use music as a non-intrusive, well-tolerated, and affordable intervention without the need for professional supervision.[72]

Sendelbach SE et al. conclude in a randomize control trial that with musical intervention for 20 minutes twice day, there were VAS-measured significant decreases in both pain and anxiety.[74] The use of virtual reality as an adjuvant to manage pain while undergoing surgical procedures is becoming more common.[75, 76] Virtual reality (VR) has been used as a method to alleviate the pain and suffering associated with a broad variety of medical procedures. Participants in clinical settings and experimental research who participate in VR report feeling less pain overall, less general discomfort or unpleasantness, and a desire to employ VR again during difficult medical procedures.[77]

In the early stages of patient`s recovery after postoperative cardiac surgery, massage therapy is another non-pharmacological technique that is used if applied once or twice a day for 20 min at body areas chosen by the patient, this treatment was linked to successful pain and anxiety relief.[78]

Another non-pharmacological method to treat acute pain following cardiac surgery is transcutaneous electrical nerve stimulation (TENS). The impact of continuous transcutaneous electrical nerve stimulation (TENS) on postoperative pain after median sternotomy was investigated in a trial that was prospective, randomized, and blinded. The study included 89 patients who were experiencing considerable chest discomfort. VAS scores were utilized both before and after therapy. After 180 minutes, 79% of patients in the active TENS group reported having no more chest discomfort. 5% of patients continued to experience chest discomfort that required drugs and 16% experienced mild pain without them.[79] In the last patients can benefit from emotional support, counseling, and cognitive-behavioral therapy (as a non-pharmacological therapy) can help them manage with pain, lower their levels of intensity and distress, and improve their general psychological health although there is only moderate level of evidence in literature till now.[80]

8. Regional Anesthesia Techniques

Clinical results could be improved by combining general anesthesia with epidural analgesia. The utilization of epidural analgesia during cardiac surgery remains a subject of debate due to the potentially increased risk of hemodynamic instability and epidural hematoma associated with systemic heparinization. But number of studies has showed successful commencement of the procedure without incidence of epidural hematoma formation.[81-83]

Nevertheless, numerous sternal and chest wall blocks are used in patients who have had heart surgery in order to control discomfort after the procedure and speed up the healing process. Pectoralis I and II (also known as PECS I and II) blocks were first used in order to provide pain relief in the upper anterior and lateral chest wall after breast surgery.[84] In a study carried out by Kumar et al., forty patients who were scheduled to have CABG or valve surgery were split into two groups: those who had a postoperative PECS block and those who did not get one. The PECS group was extubated more rapidly, reported less discomfort while coughing and when at rest, and had higher peak inspiratory flow rates than the other group.[85] A patient who was undergoing mitral valve replacement was given 30 milliliters of ropivacaine 0.20% mixed with epinephrine at a ratio of 1:400,000 as a rescue analgesia.[86]

PECS (pectoral nerves) blocks are considered highly safe due to the lack of significant neurovascular structures in the vicinity of the targeted region. Recent data has unequivocally demonstrated that these blocks result in faster extubation and reduced intraoperative narcotic requirements. The serratus anterior plane (SAP) block, introduced in 2013, serves the purpose of blocking the thoracic intercostal nerves and providing analgesia to the lateral cutaneous branches in the T3 to T9 region. This technique has shown promising results in pain management.[87]

There has been a very limited number of researches conducted on the use of the SAP block for sternotomies, despite its widespread use for thoracotomies. Despite this, studies have shown that it may be used in procedures involving the implantation of cardiac devices. Anesthesiologists are able to avoid the need for general anesthesia and the use of perioperative opioids while installing cardiac defibrillators if they make use of a single-shot SAP block, as stated in the research conducted by De Waroux et al. With the exception of one patient whose anxiousness required them to switch to GA, all of the patients went through the procedure without any problems.[88] Magoon et al. conducted a study in which 100 patients undergoing cardiac surgery were randomly allocated to one of three groups: the SAP group, the PECS II group, or the intercostal nerve block group. They found that the SAP and PECS II groups had much lower late mean pain levels but comparable early pain ratings.[89]

The erector spinae plane (ESP) block is utilized for thoracotomies, chest, and abdominal procedures. Unlike fascial plane blocks, the ESP block has the advantage of potentially spreading to the ventral rami, providing coverage for the T2 to T6 intercostal nerves. This characteristic makes it particularly useful for procedures like median sternotomy. The ESP block offers effective pain relief and has found applications in a range of surgical interventions.[90]

In a study conducted by Krishna et al., 106 patients undergoing elective heart surgery with cardiopulmonary bypass (CPB) were randomly assigned to two groups: the erector spinae plane (ESP) group and the acetaminophen and tramadol group. The results showed that patients who received the ESP block reported significantly longer relief from their symptoms and experienced overall reduced pain compared to the other group. This suggests that the ESP block is an effective and promising pain management technique for patients undergoing heart surgery.[91]

A chest wall block known as a paravertebral block (PVB) is often carried out utilizing landmark-based methods. As it becomes more accessible, the ultrasound-guided method is becoming more and more well-liked. The level of injection determines the analgesic impact of PVB, however numerous single shot injections are favored over a single large injection.[92] According to clinical evidence, PVB and GA together result in lower pain ratings, less need for morphine equivalents, and shorter stays in the intensive care unit.[93]

El Shora et al. conducted a study in which they randomly allocated 145 cardiac surgeries to either bilateral PVB with GA or thoracic epidural with GA. They found that both methods resulted in identical levels of pain, but the thoracic epidural + GA method resulted in shorter stays in the intensive care unit as well as lower rates of vomiting and urine retention.[94]

The transversus thoracic muscle plane block (TTPM) involves the administration of local anesthetic between the transversus thoracic muscle and internal intercostal muscles. This technique was initially introduced in 2015.[95] In a study conducted by Aydin et al., patients who received a preoperative TTPM block with 20 mL of 0.75% bupivacaine on each side reported experiencing less pain, required lower opioid consumption, and had reduced instances of nausea and pruritus.[96] These findings suggest that the TTPM block can be an effective

approach in managing pain and improving postoperative outcomes in patients.

In order to improve patient outcomes, ERAS procedures use a multidisciplinary strategy that includes adopting evidence-based treatments all during the perioperative phase.

To reduce the need of opioids and improve recovery, these guidelines emphasize early mobilization, optimized hydration management, and multimodal pain management techniques.[97] By injecting local anesthetic between the pectoral major and the intercostal muscles, close to the sternum, the parasternal block. The block must be applied bilaterally with a spread from the II to the VI intercostal regions in order to get an adequate analgesic cover.

Numerous researches have looked at the parasternal block in cardiac patients to determine how it affects both intraoperative pain and postoperative pain.[98, 99]

In a randomized controlled study conducted by Althea M. Barr and colleagues, it was concluded that the use of ropivacaine parasternal intercostal block after adult cardiac surgery is a safe and effective method to improve pain management. This approach was found to reduce the need for narcotic analgesics while providing speedy pain relief.[100] In another study by Nilgun Kavrut Ozturk and colleagues, a comparison was made between parasternal block and transcutaneous electrical nerve stimulation (TENS) in patients who had undergone heart surgery with a median sternotomy. The researchers found that the parasternal block was more effective in managing early postoperative pain and significantly reduced the requirement for opioids.[101] These findings highlight the potential benefits of using parasternal blocks as a superior pain management option in patients undergoing heart surgery.

9. Multimodal pain management strategies

Optimizing pain management while minimizing reliance on any one modality or medication is the aim of multimodal pain management. It incorporates a variety of therapies and strategies. It seeks to effectively relieve pain while minimizing the dangers and negative effects related to high-dose opioids.[102]

Adults who get multimodal analgesics after Cardiac Surgery had shorter hospital stays, lower costs, and fewer postoperative complications however the ideal mix of multimodal analgesic administration is uncertain.[103-105]

10. Role of nursing care

The nursing care is crucial to the efficient treatment of postoperative pain since it is their job to evaluate pain and act quickly.[106] Nurses should be aware on how to care for patients who are in pain since they are always around patients who are suffering some level of discomfort. Reducing postoperative pain leads to earlier hospital release, a shorter stay, cheaper medical costs, and more patient satisfaction.[107]

Nurses administer pain medications safely and accurately, monitoring patient reactions and assessing side effects. Nurses play a vital role in informing patients about proper medication dosage, how frequently to take it, and the potential side effects. Additionally, they employ various non-pharmacological pain management techniques as part of their nursing care. These techniques involve physical methods like massage, movement restriction or rest, repositioning, and the application of cold and heat. These approaches have proven to be highly effective in providing relief from pain.[108] For the successful management of non-pharmacological pain, it is essential to utilize cognitive behavioral and psychological therapies. These therapeutic approaches encompass patient education, breathing exercises, and relaxation techniques. Implementing these methods can lead to effective pain relief and improved overall well-being.[109]

11. Barriers to implement effective pain control practices

Following cardiac surgery, it can be difficult to deploy appropriate pain management techniques. These challenges may affect the standard of care and patient outcomes. Recognizing these obstacles and using the right techniques, however, can aid in their removal.

These obstacles or barriers can be classified as Patient related barriers, Professional barriers, barriers in assessing pain, barriers in Communication with other health care professionals, barriers may be at organizational level, lack of Accountability and Local policies may be a major hindrance in implementation of an effective pain control practice.

When we discuss patient related barriers two significant categories may be made out of it. The first is concerned with anxiety, how it connects to pain perception, and the risk factors that keep patients from reporting their discomfort. The degree of pain is known to be affected by high levels of anxiety.[110] According to Wickstrom et al., many patients who are having surgery at a hospital anticipate discomfort and frequently have low expectations for pain treatment.[111] Anxiety might be increased by prior experiences and tales from relatives

and friends. These elevated anxiety levels frequently persist in hospitals and are made worse with time.

Studies have shown shortcomings in acute pain management in hospitals, making pain management in clinical practice an issue that has existed for almost 30 y. Professionals frequently lack information, make poor assessments, fail to document, and refuse to give pain priority. Professional hurdles to effective pain treatment are created by these deficiencies, and they may get worse during the perioperative phase when patients may find it difficult to speak. In order to address these difficulties, effective communication with other health professions is essential. The goal of this part is to remove these obstacles and discuss how pain is assessed in clinical settings.

For pain management and intervention decision-making, pain assessment is essential. However, assessing pain continues to be difficult in clinical practice. It is crucial to create tools appropriate for perioperative patients and include them into clinical algorithms in order to solve this. It's crucial to use pain evaluation instruments created especially for the patient population. For instance, critical care nurses employ the pain assessment and intervention notation (PAIN) tool, which was created for those who cannot communicate orally.[112] For patients complaining of pain to receive a clinical assessment and therapy, effective communication is essential. To maintain continuity of treatment, the staff's ability to relay information about pain and communicate patients' requirements must be further improved.[113]

The organization that oversees pain treatment frequently sets a variety of limitations that may unintentionally make it more difficult to manage pain effectively. Pain management is influenced by factors such as accountability, local culture, trust, hospital policies, and available resources. National policies can restrict prescribing and service provision, while global barriers, like opioid importation, can impact pain management. These policies have gained attention as they reduce quality of life for many people, including those in European countries.[114]

12. CONCLUSION

Optimizing pain management procedures for cardiac surgery patients necessitates a diverse strategy that takes into account numerous obstacles and puts in place efficient tactics. A patient-centered approach, the use of multimodal pain management, tailoring care to individual needs, improving communication and collaboration, allocating adequate resources, encouraging responsible opioid use, and ensuring safe medication practices are all ways that healthcare providers can improve pain management. To find areas for development and improve pain management techniques, continuous review and improvement are crucial. Healthcare professionals may obtain the best pain alleviation and accelerated healing by removing obstacles, encouraging teamwork, and empowering patients.

13. Conflict of interests

The authors declare that there are no conflicts of interest regarding the research conducted and the results presented in this study. We have no financial or personal relationships with any individuals or organizations that could potentially bias or influence the findings and conclusions of this review article.

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15. Authors' contribution

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