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The Effectiveness and Safety of Epidural Analgesia, Nitrous Oxide, or Patient-Controlled Analgesia (PCA) for Pain Management during Labor and Delivery: A Literature Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Pain management during labor is an important aspect of obstetric care. Its purpose is to reduce maternal discomfort while ensuring the safety of the mother and newborn. Various pharmacological methods are used to treat labor pain, including epidural analgesia, nitrous oxide inhalation, and patient-controlled analgesia (PCA). Epidural analgesia involves administering local anesthetics and opioids into the epidural space, which effectively relieves pain by blocking nerve conduction. Numerous studies have demonstrated superior pain relief compared to other methods, resulting in

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high patient satisfaction. However, there are concerns about potential side effects such as hypotension, motor block, and prolonged labor. Additionally, the impact of epidural analgesia on the labor process and delivery method remains controversial. Similarly, nitrous oxide, also known as “nitrous oxide,” is an inhaled analgesic that is gaining popularity because of its rapid onset of action and short duration of action. It provides a non-invasive option to reduce pain during labor, allowing women to maintain mobility and control their breathing patterns. Although nitrous oxide is generally considered safe, its effectiveness varies from person to person, and some women report insufficient pain relief. In contrast, PCA allows patients to self-administer a predetermined dose of analgesic medication, that is usually an opioid, via an infusion pump or handheld device. This approach gives women a sense of autonomy and immediate pain relief without the need for repeated injections. Studies have shown that PCA can effectively relieve labor pain while minimizing opioid-related side effects such as respiratory depression and sedation. However, concerns have been raised about the potential for overdose and inadequate pain management if used inappropriately. The choice of pain management method during labor should be individualized based on the woman’s preferences, medical history, and obstetric circumstances. Although epidurals remain the gold standard for effective and lasting pain relief, they do have potential drawbacks. Nitrous oxide and her PCA offer a suitable alternative option for women seeking non-invasive or spontaneous pain relief strategies. This literature review evaluates the effectiveness and safety of these treatments in achieving optimal pain relief and maternal satisfaction while minimizing adverse outcomes.

Keywords: Labor pains; epidural anesthesia; nitrous oxide; patient-controlled anesthesia; pain management; delivery of fetus.

1. INTRODUCTION

Labor pain management is an important aspect of maternal care aimed at improving the birth experience and ensuring the health of both mother and child. During labor, women have access to several pain relief methods, including epidurals, nitrous oxide, and patient-controlled analgesia (PCA) [1].

Assessing the efficacy and safety of these pain management techniques is important for clinical decision-making and optimizing maternal outcomes. Critically reviewing the evidence for these analgesic measures allows healthcare providers to tailor interventions to the individual needs and preferences of childbearing women, ultimately leading to a positive birth experience and maternal satisfaction [2].

The experience of pain during labor varies widely between women, with some women experiencing minimal discomfort and others finding it extremely painful. Factors such as a woman's posture, ease of movement, fear, anxiety, and confidence level during childbirth can influence her perception of pain [3].

A variety of drug and non-drug interventions are available to treat pain during labor. Non-drug interventions such as water immersion, relaxation, acupuncture, and massage can be expected to reduce pain and increase satisfaction with pain relief [4]. Immersion and relaxation can also lead to increased childbirth satisfaction. Additionally, relaxation and acupuncture have been shown to reduce the use of forceps and vent tubes, and acupuncture also reduces the need for cesarean sections. However, there is not enough evidence to determine the effectiveness of hypnosis, biofeedback, sterile water infusion, aromatherapy, and TENS for reducing pain during labor [5]

On the other hand, drug interventions have been studied in more detail. Inhaled nitrous oxide and oxygen (Entonox®) were effective in reducing pain, but some women experienced side effects such as drowsiness, nausea, and vomiting [6]. Non-opioid medications, including sedatives, had analgesic effects and increased satisfaction compared to placebo or no treatment, but satisfaction was lower than opioids [7]. Although epidural anesthesia was effective in reducing pain, it increased the use of forceps and vents and was associated with risks such as hypotension, motor block, fever, and urinary retention. Pain is relieved more quickly with spinal epidural anesthesia, but it is also more likely to cause itching [8].

Nerve blocks with local anesthesia were gratifying but came with side effects such as

dizziness and tingling. Parenteral opioids such as B. Pethidine injections were less effective than epidural injections, but comparative effectiveness compared with other interventions remains unclear [9].

Ultimately, women should be empowered to choose the pain management method that best suits their needs during childbirth. People who choose non-drug interventions should feel comfortable switching to drug interventions if needed [10]. Healthcare providers should provide information to women about the benefits and possible side effects of various pain management methods during pregnancy. However, it is important to note that some important outcomes are often not considered, and there is variation in outcome measurements between studies, such as a sense of control during labor, breastfeeding, mother-infant interaction, costs, and infant outcomes [2].

2. COMPARING THE EFFECTIVENESS OF EPIDURAL ANALGESIA, NITROUS OXIDE, OR PATIENT-CONTROLLED ANALGESIA (PCA) FOR PAIN MANAGEMENT DURING LABOR

Epidural anesthesia is the cornerstone of neuraxial pain management and involves injecting an anesthetic into the epidural space to block sensory and motor spinal nerve roots in various anatomical areas [11]. Its versatility extends beyond procedural anesthesia and has applications in the treatment of chronic pain and muscle spasms, either as a primary anesthetic or as an adjunct to pain management. Epidural anesthesia has a tradition dating back over a century, and clinicians have the flexibility to adapt drug selection and route of administration, whether in intermittent boluses or continuous infusion, to suit different clinical needs [12].

Continuous epidural catheters allow continuous maintenance of labor analgesia, thereby providing sustained pain relief. Intermittent bolus administration by a healthcare provider can provide satisfactory analgesia, but a qualified clinician must always be on hand [13].

In contrast, continuous infusion of low concentrations of local anesthetics provides more consistent analgesic effects and requires medical intervention only in cases of breakthrough pain [14]. Patient-controlled epidural analgesia (PCEA) has emerged as the preferred method for maintaining labor analgesia, especially when dilute solutions of local anesthetics are used, often with lipid-soluble opioids such as fentanyl or sufentanil. It is safe and effective when used in combination with. PCEA allows patients to adjust their analgesic needs within preset parameters, reducing physician intervention, local anesthetic dosage, and lower extremity motor block [15].

Adjusting PCEA settings allows for superior analgesia while minimizing motor block. Bolus doses are usually 4 to 12 ml, with common settings being 5 to 8 ml, but the lockout interval can be adjusted accordingly to account for 10 minutes of analgesia onset. Similarly, a wide range of background infusion rates accommodates patients' individual needs and preferences, ensuring optimal pain management results [16].

Combined spinal-epidural anesthesia (CSE) techniques provide rapid and effective analgesia with minimal impact on ambulatory ability. Typically, a combination of 1 or 2 mg of bupivacaine and 5 to 15 mcg of fentanyl is administered intrathecally, followed by placement of an epidural catheter and immediate or delayed activation with patient-controlled epidural analgesia [17].

This approach results in more rapid deep analgesia than other low-dose neuraxial techniques. Importantly, studies have shown that there are no significant differences in obstetric outcomes, such as the frequency of emergency cesarean sections or duration of labor, when comparing CSE with low concentrations of local anesthetics [18].

Norris et al. conducted a study of 2183 patients to compare the results of CSE and epidural analgesia during labor. Their results showed no difference in the frequency of emergency cesarean sections or the duration of the first or second stage of labor between the two techniques. These results highlight the comparable efficacy of her CSE and epidural analgesia in reducing pain during labor and highlight the clinical utility and safety of the CSE approach [19].

The utilization of nitrous oxide provides an additional pain management option for laboring women who do not have access to or choose not to use, epidural anesthesia [20]. Nitrous oxide provides analgesic effects comparable to paracervical blocks and opioids, without the

associated neonatal side effects seen with injectable opioids [21]. Although some mothers find nitrous oxide to be less effective than epidurals, satisfaction rates for mothers who use nitrous oxide are similar to mothers who receive epidurals, and many indicated their intention to use nitrous oxide in future pregnancies [22].

Administering nitrous oxide is easy, inexpensive, and has no adverse effects on maternal or neonatal health. It does not affect uterine contractions or the normal labor process. Unlike epidurals or injectable opioids, nitrous oxide provides rapid pain relief within a minute of administration, allowing pregnant women to control the amount of pain relief they receive by self-administering the mask [22]. This autonomy may increase the patient's sense of control and reduce pain perception. Nitrous oxide also allows freedom of movement, evokes feelings of joy, relaxation, and reduced anxiety, and reduces pain focus in women during labor [23].

However, nitrous oxide is generally less effective than other pain management methods such as neuraxial analgesia. It has limited analgesic efficacy and requires repeated self-administration, which can be difficult, especially for exhausted pregnant women who find it cumbersome to hold the mask [21]. Reported side effects from using nitrous oxide include excessive drowsiness, nausea, vomiting, lightheadedness, dizziness, feeling of separation, and claustrophobia due to masks. Despite these drawbacks, nitrous oxide remains a valuable option for managing pain during labor, especially for those who do not have access to other forms of pain medication or who wish to avoid pain medication [22].

Both non-pharmacological and pharmacological approaches have shown significant efficacy in relieving labor pain. However, women who give birth in hospitals with high referral rates tend to have better pain control due to access to pharmacological interventions, with epidural anesthesia emerging as the most effective pain relief method [24].

Understanding the multifactorial nature of labor pain is important for promoting acceptance among women and optimizing the use of both pharmacological and non-pharmacological interventions in pain management [4].

The intensity of labor contractions varies from woman to woman and can range from minimal discomfort to unprecedented pain. It is important to realize that although labor pains are intense, they are a unique physiological phenomenon and are not indicative of a medical condition [7].

A review by Anim-Somuah et al. suggests that epidural anesthesia may provide better pain relief and maternal satisfaction compared to non-epidural methods. Although early studies suggested that the use of epidurals increased the incidence of assisted vaginal birth, recent studies have shown that this is not the case, perhaps due to advances in epidural analgesia techniques [25].

Epidural analgesia does not appear to affect the risk of cesarean section or long-term low back pain, nor does it have a direct impact on neonatal outcomes as measured by APGAR scores or neonatal intensive care unit admission. Birth partner preferences strongly influence the choice of analgesic method, and socioeconomic and ethnic factors also influence the use of epidural anesthesia during labor [26].

A study by Lindholm et al. highlights the connections between the most preferred pain relief methods and nitrous oxide, bathing, breathing techniques, epidurals, and massage. Women who chose epidural anesthesia regardless of preference were more likely to report a less positive birth experience, highlighting the influence of preferences and priorities in choosing pain treatment [27]. Conversely, our findings showed that water immersion and physical activity were the most commonly chosen non-pharmacological methods, while nitrous oxide and epidural anesthesia were the preferred pharmacological options [23].

3. CONCLUSION

Effectively treating labor pain requires an elaborate understanding of the various factors that influence pain perception and the availability of different pain relief options. Both pharmacological and non-pharmacological interventions are effective in relieving labor pain, with epidural anesthesia proving to be a particularly effective method. The availability of pharmacological interventions appears to improve intrapartum pain control, especially in hospitals with high referral rates.

It is important to recognize the uniqueness of labor and tailor pain management strategies to individual preferences and needs. Although

epidural anesthesia provides powerful pain relief, it is important to consider the influence of birth partner preferences and socio-economic factors when choosing a method of pain relief.

Further research is needed to consider the optimal use of both pharmacological and non-pharmacological interventions, taking into account factors such as patient preferences, cultural considerations, and healthcare infrastructure. By promoting a comprehensive approach to labor management, healthcare providers can strive to increase maternal satisfaction and optimize a woman's birth experience.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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