

Classification Research on Intraoperative Neuromonitoring

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Citation: Mortazavi SH. (2023) Classification Research on Intraoperative Neuromonitoring. *J Neurol Sci Res.* 3(1):1-5.

Received: March 06, 2023 | **Published:** March 27, 2023

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Abstract

This classification research provides an overview of the current research on Intraoperative Neuromonitoring (IONM) and classifies the articles based on their focus and methodology. IONM is a technique used to monitor the function of the nervous system during surgical procedures, and it has become an essential tool for the safety and success of many surgeries, especially those involving the central nervous system. The study conducted a literature search using electronic databases including PubMed, MEDLINE, and Google Scholar. A total of 75 articles were included and classified based on their focus into four categories: Techniques of IONM, Clinical applications of IONM, IONM in specific surgical specialties, and IONM safety and ethics. The majority of articles focused on the clinical applications of IONM, followed by articles focused on the techniques of IONM, indicating the importance of technical knowledge and proficiency in utilizing IONM during surgical procedures. This study highlights the growing interest in the clinical applications and effectiveness of IONM in reducing surgical complications and improving patient outcomes. It also emphasizes the importance of technical proficiency, ongoing education, and ethical and safety considerations surrounding its use.

Introduction

Intraoperative neuromonitoring (IONM) is a technique that involves monitoring the function of the nervous system during surgical procedures. This technique has become an essential tool for the safety and success of many surgeries, especially those involving the central nervous system. This classification research aims to provide an overview of the current research on IONM and classify the articles based on their focus and methodology. Intraoperative neuromonitoring (IONM) has revolutionized the field of surgery by providing real-time information about the function of the nervous system during surgical procedures. This technique involves the use of various modalities such as electromyography (EMG), somatosensory evoked potentials (SSEPs), and electroencephalography (EEG) to monitor the function of nerves, muscles, and the brain during surgery. By detecting any changes in nerve function, IONM can help surgeons identify and avoid potential complications, such as nerve damage, paralysis, or loss of sensory function. Over the past few decades, IONM has become an essential tool for the safety and success of many surgeries, particularly those involving the central nervous system. The technique has been used in a wide range of surgical specialties, including neurosurgery, orthopedic surgery, cardiovascular surgery, and more. With advancements in technology, new modalities, such as transcranial magnetic stimulation (TMS) and near-infrared spectroscopy (NIRS), are being developed and incorporated into IONM practices. Given its importance, there has been a significant amount of research conducted on IONM over the years. This classification research aims to provide an overview of the current research on IONM and classify the articles based on their focus and methodology. By understanding the different categories of IONM research, healthcare professionals can stay up-to-date with the latest advancements and best practices in the field.

Methodology

A literature search was conducted using electronic databases including PubMed, MEDLINE, and Google Scholar. The search terms included “intraoperative neuromonitoring,” “surgical procedures,” “nervous system function,” “electrophysiology,” and “safety”. The articles were screened based on their relevance to the topic and publication date (from 2010 to 2023). The articles were then classified based on their focus and methodology. After conducting the literature search and screening process, the articles were then analyzed and classified based on their methodology. The classification was based on the type of study design and methodology used in each article. The following categories were used:

- 1. Case reports and case series:** These articles describe individual cases or a small group of cases that underwent IONM during surgery. They provide detailed descriptions of the surgical procedure and the monitoring techniques used, as well as the outcomes and complications associated with the procedure.
- 2. Retrospective studies:** These articles analyze data from past cases in which IONM was used during surgery. They may compare the outcomes of surgeries with IONM to surgeries without IONM, or analyze the factors associated with improved outcomes or complications.

3. Prospective studies: These articles involve the collection of data during ongoing surgeries in which IONM is used. They may compare the outcomes of surgeries with IONM to surgeries without IONM, or analyze the factors associated with improved outcomes or complications. **4. Review articles:** These articles provide a comprehensive overview of the current state of research on IONM, including a summary of the techniques and clinical applications of IONM, as well as the safety and ethical considerations.

The articles were classified based on the type of study design and methodology used. This allowed for a comprehensive overview of the different types of studies conducted in the field of IONM and provided insights into the strengths and limitations of each type of study design.

Results

A total of 75 articles were included in this classification research. The articles were classified based on their focus into four categories: (1) Techniques of IONM, (2) Clinical applications of IONM, (3) IONM in specific surgical specialties, and (4) IONM safety and ethics. Further analysis of the results revealed that the majority of the articles (n=32) focused on the clinical applications of IONM, indicating a strong interest in the effectiveness of IONM in reducing the risk of neurological complications during surgery and improving patient outcomes. This was followed by articles focused on the techniques of IONM (n=24), which reflect the importance of technical knowledge and proficiency in utilizing IONM during surgical procedures.

The category of IONM in specific surgical specialties had a relatively smaller number of articles (n=12), indicating that while the technique is widely used, there is still much to learn about its application in different surgical contexts. Lastly, the IONM safety and ethics category had the smallest number of articles (n=7), suggesting that ethical considerations and safety protocols surrounding IONM may not be receiving as much attention as other aspects of the technique.

Overall, the results of this classification research suggest a growing interest in the clinical applications and effectiveness of IONM in reducing surgical complications and improving patient outcomes. Additionally, it highlights the importance of technical proficiency and ongoing education in the field of IONM, as well as the need to consider ethical and safety considerations surrounding its use.

1. Techniques of IONM: This category includes articles that focus on the technical aspects of IONM, including the different modalities used for monitoring, such as electromyography (EMG), somatosensory evoked potentials (SSEPs), and electroencephalography (EEG). Several articles in this category also discuss the use of new technologies, such as transcranial magnetic stimulation (TMS) and near-infrared spectroscopy (NIRS), for IONM. In the category of Techniques of IONM, the articles focus on the technical aspects of IONM. These articles provide detailed information on the different modalities used for monitoring nerve function during surgery. Electromyography (EMG) is a common modality used to monitor muscle activity during surgery. Articles in this category also discuss the use of somatosensory evoked potentials (SSEPs) and electroencephalography (EEG) for monitoring sensory and brain function,

respectively. Moreover, several articles in this category discuss the use of new technologies, such as transcranial magnetic stimulation (TMS) and near-infrared spectroscopy (NIRS), for IONM. TMS is a noninvasive technique that can stimulate different areas of the brain, providing information on the integrity of the neural pathways. NIRS is a technique that uses near-infrared light to measure changes in blood oxygenation, providing information on the cerebral oxygenation and metabolism during surgery. Overall, the articles in this category provide valuable information on the technical aspects of IONM and the different modalities and technologies available for monitoring nerve function during surgery.

2. Clinical applications of IONM: This category includes articles that discuss the use of IONM in various surgical procedures, such as spine surgery, brain surgery, and peripheral nerve surgery. Many articles in this category focus on the effectiveness of IONM in reducing the risk of neurological complications during surgery and improving patient outcomes. This category of articles focuses on the clinical applications of IONM and its impact on patient outcomes. Many studies have investigated the effectiveness of IONM in reducing the risk of neurological complications during surgical procedures. For instance, in spinal surgery, IONM is used to monitor the integrity of the spinal cord and nerve roots during the operation, allowing the surgeon to adjust their approach and avoid potential damage to the nervous system. Similarly, in brain surgery, IONM is used to monitor the brain's response to the surgery and to ensure the preservation of critical brain functions such as speech, motor control, and vision. In peripheral nerve surgery, IONM is used to monitor the function of the peripheral nerves during surgery, such as nerve conduction velocity (NCV), latency, and amplitude, which can indicate whether the nerve is intact or damaged. The clinical applications of IONM have been studied in various surgical procedures, including spine, brain, and peripheral nerve surgery. Many articles in this category have investigated the effectiveness of IONM in reducing the risk of neurological complications during surgery and improving patient outcomes. Some studies have reported a reduction in the rate of postoperative complications and improved patient outcomes, such as decreased hospital length of stay and improved functional outcomes. However, the efficacy of IONM in some surgical procedures is still being studied, and further research is needed to determine its full potential in improving patient outcomes.

3. IONM in specific surgical specialties: This category includes articles that focus on the use of IONM in specific surgical specialties, such as neurosurgery, orthopedic surgery, and cardiovascular surgery. These articles discuss the unique challenges and considerations for IONM in each specialty. Studies in this category examine the use of IONM in specific surgical specialties and discuss the challenges and considerations that may arise in those specialties. For example, one article may focus on the use of IONM in orthopedic surgery, discussing the specific challenges of monitoring nerve function during joint replacement procedures. Another article may examine the use of IONM in cardiovascular surgery, discussing the challenges of monitoring nerve function in a rapidly changing environment and the potential benefits of IONM in reducing the risk of neurological complications. Overall, these articles provide valuable insights into how IONM can be tailored to meet the unique needs of each surgical specialty, improving patient outcomes and ensuring the safety of nerve function during surgery.

4. IONM safety and ethics: This category includes articles that discuss the ethical and safety considerations of IONM, including patient consent, adverse events, and the role of the IONM team in

ensuring patient safety. The articles in this category highlight the importance of safety and ethical considerations in the use of IONM. They discuss the potential risks associated with IONM, such as nerve damage or interference with the surgical procedure, and the steps that can be taken to mitigate these risks. The role of the IONM team in ensuring patient safety is also emphasized, including the need for proper training and communication among team members. Several articles in this category also discuss the ethical considerations of IONM, such as patient autonomy and informed consent. They emphasize the importance of providing patients with clear and accurate information about the risks and benefits of IONM, as well as their right to make informed decisions about their care. The articles also discuss the potential for conflicts of interest and the need for transparency in the use of IONM. Overall, the articles in this category emphasize the importance of considering safety and ethical considerations in the use of IONM, and provide guidance on how to ensure that patients receive the highest quality of care.

Category	Number of Articles	Examples of Articles
Techniques of IONM	24	[1-3]
Clinical applications of IONM	32	[4-6]
IONM in specific surgical specialties	12	[7-9]
IONM safety and ethics	7	[10-12]

Table: The following table summarizes the articles included in this classification research.

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