TITLE: Intraoperative Monitoring During Spinal or Neurological Surgeries: Clinical Effectiveness and Guidelines

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RESEARCH QUESTIONS

1. What is the clinical effectiveness of intraoperative monitoring during spinal or neurological surgeries?

2. What are the clinical benefits and harms associated with the use of intraoperative monitoring during spinal or neurological surgeries?

3. What are the evidence-based guidelines for the use of intraoperative monitoring during spinal or neurological surgeries?

KEY MESSAGE

One systematic review, 14 prospective non-randomized studies, and two evidence-based guidelines were identified regarding the use of intraoperative monitoring during spinal or neurological surgeries.

METHODS

A focused search (with main concepts appearing in title, abstract or major subject heading) was conducted on key resources including PubMed, The Cochrane Library (2013, Issue 7), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies and guidelines. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2008 and July 25, 2013. Internet links were provided, where available.

The summary of findings was prepared from the abstracts of the relevant information. Please note that data contained in abstracts may not always be an accurate reflection of the data contained within the full article.

RESULTS

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials, non-randomized studies, and evidence-based guidelines.

One systematic review, 14 prospective non-randomized studies, and two evidence-based guidelines were identified regarding the use of intraoperative monitoring during spinal or neurological surgeries. Due to the large volume of relevant literature, retrospective non-randomized studies have been included in the appendix.

Additional references of potential interest are provided in the appendix.

OVERALL SUMMARY OF FINDINGS

One systematic review[1] determined that intraoperative neurological monitoring is both sensitive and specific for the detection of neurological complications during spinal surgery. The authors recommended that intraoperative monitoring be used, particularly when spinal cord or nerve roots are deemed to be at risk. Fourteen prospective non-randomized studies[2-15] were identified regarding intraoperative neurological monitoring and are summarized in Table 1. None of the included studies reported any serious harms associated with the use of intraoperative monitoring during spinal or neurological surgeries.

One American guideline[16] concluded that "intraoperative monitoring is established as effective to predict an increased risk of the adverse outcomes of paraparesis, paraplegia, and quadriplegia in spinal surgery." A second American guideline[17] recommended electrophysiological monitoring should not be used routinely during routine surgery for cervical spondylotic myelopathy or cervical radiculopathy. Changes in transcranial motor-evoked potentials may be sensitive for the diagnosis of potential neurological injury but worsening of electrophysiological monitoring does not always indicate a change in clinical outcome or prevent neurological complications.

Table 1: Summary of Included Prospective Non-Randomized Studies

Author and Year	Type of Monitoring and Surgery	Authors' Conclusions
Zielinski et al. 2013[2]	NIOM vs no monitoring spinal canal surgery	NIOM could decrease the risk of neurological complications for patients undergoing intramedullary, but not extramedullary, spinal canal surgery.
Pankowski et al. 2012[3]	SEP and MEP scoliosis	Intraoperative monitoring should be used to avoid neurological complications resulting from scoliosis correction.
Senft et al. 2012[4]	multimodal neurophysiological	The combination of neurophysiological monitoring and intraoperative MRI allowed for

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	monitoring glioma resection	more complete glioma resection without an increase in neurological complications.
Motoyama et al. 2011[5]	transcranial and direct cortical MEP unruptured cerebral aneurysm	Transcranial MEPs could be obtained when direct MEP measurement is not possible and during craniotomy and closure of the dura when direct MEPs cannot be recorded. Combined transcranial and direct MEP recording may improve both reliability and feasibility of monitoring during these surgeries.
Park et al. 2011[6]	multimodal neurophysiological monitoring cervical or cervicothoracic kyphosis	SEPs, transcranial MEPs, and electromyography activity demonstrated high specificity and negative predictive value. The authors suggested that transcranial MEP monitoring may allow successful intervention in some cases; however, larger prospective trials are needed to establish whether intraoperative monitoring decreases the risk of neurological complications.
Beyazova et al. 2011[7]	multimodal neurophysiological monitoring tethered cord syndrome	MEPs and SEPs did not change during surgery for any patient and no neurological complications were recorded. The authors recommend direct nerve root/rootlet stimulation should be included as a component of multimodal neurophysiological monitoring.
Neuloh et al. 2010[8]	continuous MEP monitoring intraceable focal epilepsy	MEP reflects motor functioning similar to localizing motor mapping results. The authors suggest that continuous MEP monitoring is both feasible and safe in this population and was correlated with seizure control and positive neurological outcomes.
Voulgaris et al. 2010[9]	continuous intraoperative electromyographic and transcranial MEP spinal stenosis surgery	The authors suggest that intraoperative monitoring may allow for the identification of potential neural structure damage as it is happening and can possibly be avoided through corrective measures by the surgeon.
Castellon et al. 2009[10]	intraoperative neurophysiologic monitoring thoracolumbar burst fractures	Patients were monitored throughout surgery using SEP, transcranial MEP, electromyography. No significant changes in spinal cord function were observed.
Chung et al. 2009[11]	upper-limb SEP lumbosacral spine	SEP was monitored in the upper limbs and SEP and electromyography were monitored in lower limbs. No postoperative upper extremity

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Author and Year	**Type of Monitoring and Surgery**	**Authors' Conclusions**
	surgery	paralysis was reported. The authors concluded that upper limb SEP monitoring was able to detect position-related ulnar neuropathy in 5.2% of study patients.
Hyun et al. 2009[12]	combine SEP and MEP monitoring intramedullary spinal cord tumor	The authors concluded that combined monitoring with both SEP and MEP resulted in higher sensitivity, and positive and negative predictive value than single monitoring techniques.
Mavrogenis et al. 2009[13]	intraoperative neurophysiological monitoring pedicle screw placement	No neurological complications were reported and no revision surgery was required. A cut-off current threshold value of 7 mA had a greater than 95% positive predictive value for accurate screw placement.
Quraishi et al. 2009[14]	intraoperative neurophysiological monitoring spinal deformity correction	The authors concluded that useful neurophysiological data was obtained and monitoring was feasible in this population. Overall, there was recorded sensitivity of 100% and specificity of 84.3%.
Kelleher et al. 2008[15]	intraoperative neurophysiological monitoring cervical spine surgery	The authors calculated positive and negative predictive value, sensitivity, and specificity for SEP, MEP, and electromyography in the study population. They determined that the combined use of SEP and electromyography, with occasional use of MEP, could be useful for the prediction and prevention of neurological complications.

NIOM = neurophysiological intraoperative monitoring; mA = milliampere; MEP = motor evoked potential; SEP = somatosensory evoked potential; vs = versus

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Health Technology Assessments
No literature identified.

Systematic Reviews and Meta-analyses

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Randomized Controlled Trials
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Non-Randomized Studies - prospective

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APPENDIX – FURTHER INFORMATION:

Non-Randomized Studies – retrospective

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