EEG-Based Monitoring of Anesthetic Depth

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Summary and Conclusions

SBU's appraisal of the evidence

EEG-based monitoring of anesthetic depth is intended to complement traditional monitoring methods during anesthesia. Its primary aim is to adapt anesthesia to individual needs so patients can recover more quickly and be at lower risk for awareness while under anesthesia.

Patients at normal risk of awareness who undergo elective surgery

- EEG-based monitoring of anesthetic depth reduces by a few minutes the *early phase of recovery* after intravenous anesthesia (Evidence Grade 3)*. The time saved has not been shown to have any clinical or economic significance. Whether or not monitoring of anesthetic depth affects the *early phase of recovery* after inhalational anesthesia cannot be determined (Contradictory Scientific Evidence)*.
- Regarding the *later phase of recovery* (eg, time until discharge), scientific evidence on the effects of EEG-based monitoring of anesthetic depth is contradictory*.
- Whether or not EEG-based monitoring of anesthetic depth reduces the risk of *awareness* during anesthesia cannot be assessed (Insufficient Scientific Evidence)*.
- Whether or not EEG-based monitoring of anesthetic depth has any effect on *patient satisfaction*, or on the incidence of post-anesthesia *nausea/vomiting*, cannot be determined (Contradictory Scientific Evidence)*.

Patients at high risk of awareness during anesthesia, or who undergo emergency surgery

- Whether or not EEG-based monitoring of anesthetic depth in risk patients has a positive effect on post-anesthesia *recovery* (Insufficient Scientific Evidence)*, or reduces the risk of *awareness* during anesthesia (Contradictory Scientific Evidence)*, cannot be determined.

In summary, as regards general anesthesia, the scientific evidence is inadequate to support routine use of EEG-based monitoring of anesthetic depth aimed at reducing the incidence of awareness or decisively improving patient recovery.

TECHNOLOGY AND TARGET GROUP General anesthesia is used in surgery and is usually administered as a combination of hypnotics, analgesic drugs, and, when necessary, muscle relaxants. Traditional monitoring during anesthesia takes into account various physical reactions (eg, circulation, respiration, eye-reaction, and movement) to assess anesthetic depth and control medication. Excessively deep anesthesia can lead to reduced circulation, thereby impairing the function of life-sustaining organs and delaying recovery. Excessively shallow anesthesia can lead to biological stress and awareness while the patient is under anesthesia.

Various technical devices have been developed to assess the depth of anesthesia both objectively and quantitatively. Current technology for monitoring anesthetic depth is based mainly on analyzing signals that reflect changes in the electrical activity of the brain (electroencephalography, EEG). The expectation is that EEG-based monitoring of anesthetic depth, as a complement to traditional monitoring, will improve the potential to adapt anesthesia to individual patient needs during the course of surgery.

Post-anesthesia recovery can be divided into an early phase and a late phase. In the early phase, patients regain consciousness, start to breathe on their own, and spontaneously open their eyes. Usually the patient can be extubated, removing the endotracheal tube used to secure the airway. There is no generally accepted signal that would indicate when to extubate. It is done based

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***Criteria for Evidence Grading SBU's Conclusions**

Evidence Grade 1 – Strong Scientific Evidence. The conclusion is corroborated by at least two independent studies with high quality, or a good systematic overview.

Evidence Grade 2 – Moderately Strong Scientific Evidence. The conclusion is corroborated by one study with high quality, and at least two studies with medium quality.

Evidence Grade 3 – Limited Scientific Evidence. The conclusion is corroborated by at least two studies with medium quality.

Insufficient Scientific Evidence – No conclusions can be drawn when there are not any studies that meet the criteria for quality.

Contradictory Scientific Evidence – No conclusions can be drawn when there are studies with the same quality whose findings contradict each other.

on the anesthesiologist's experience and on local routines. In the later recovery phase, the patient's condition is sufficiently stable to discontinue special monitoring. The patient can then leave the post-operative recovery unit. To standardize the assessment of a patient's condition following anesthesia, rating scales have been developed to measure various parameters, eg, awareness, ability to move, circulation, and respiration.

Discomfort and, in severe cases, post-traumatic stress disorder can be associated with awareness resulting from insufficient anesthetic depth. During elective surgery awareness is estimated to occur in 1 to 2 in 1000 patients at normal risk of awareness. The risk of awareness during anesthesia is higher in certain situations, eg, emergency surgery, caesarian section, heart surgery, trauma, or if the patient has circulatory problems. Here, the risk is attributed to using relatively low drug doses for purposes of maintaining circulation.

The potential target group for the method includes all patients given general anesthesia in conjunction with surgical interventions.

PRIMARY QUESTIONS

- Does EEG-based monitoring of anesthetic depth allow patients to recover more quickly and better after anesthesia?
- Does EEG-based monitoring of anesthetic depth reduce the risk of awareness during anesthesia?
- Is EEG-based monitoring of anesthetic depth cost-effective?

The patient group studied primarily includes adult patients administered general anesthesia in conjunction with different types of elective surgery. In addition, patients at high risk for awareness during anesthesia, or who receive emergency surgical procedures, are studied separately.

PATIENT BENEFIT

Patients at normal risk of awareness undergoing elective surgery

EEG-based monitoring of anesthetic depth has a positive effect on early recovery (time until the eyes open and the patient is extubated) after intravenous anesthesia, but scientific evidence on the use of inhalational anesthesia is contradictory. These outcome measures are, however, of limited relevance from the standpoints of both the patient and the health services since the estimated time saved involves a few minutes. Regarding the later phase of recovery (eg, time until discharge), the scientific evidence is contradictory. The results are based on randomized controlled trials (RCT) that compared anesthesia guided by EEG-based monitoring of anesthetic depth versus anesthesia guided by traditional monitoring alone.

The studies evaluated were too small to assess whether EEG-based monitoring of anesthetic depth affects the incidence of awareness during anesthesia.

Scientific evidence is contradictory regarding the effect that EEG-based monitoring of anesthetic depth has on patient satisfaction and on the incidence of nausea/vomiting after anesthesia.

Patients at high risk for awareness during anesthesia or undergoing emergency surgery

Three randomized controlled trials were identified that compared anesthesia guided by EEG-based monitoring of anesthetic depth versus anesthesia guided by traditional monitoring alone. Two of the trials studied patient recovery following anesthesia. No differences between the study groups were observed during either the early or late phases.

Whether or not the use of EEG-based monitoring of anesthetic depth can reduce the incidence of awareness in risk patients while under anesthesia cannot be determined. Findings from two large studies, together including around 4500 patients, are contradictory. A deficiency in both studies concerns the absence of descriptions of those patients in whom awareness could not be fully assessed. The third study was too small to assess the incidence of awareness during anesthesia.

ETHICAL ASPECTS If EEG-based monitoring is used, it should only complement traditional anesthesia monitoring and should not be accorded greater importance than traditional monitoring. The risk for misinterpretation, and the resulting consequences (too deep or too shallow anesthesia), must be considered carefully in each individual case.

ECONOMIC ASPECTS Devices for EEG-based monitoring of anesthetic depth cost between 28 000 and 65 000 Swedish kronor (SEK). In addition, disposable materials, eg, electrodes, cost between SEK 20 and SEK 75 per intervention. It is unclear to what extent the additional costs would be offset by savings generated by the method's potentially positive effects.

Since the scientific evidence offers no solid conclusions regarding patient benefits from EEG-based monitoring of anesthetic depth, it is not possible to assess the method's cost-effectiveness.

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PO Box 5650, SE-114 86 Stockholm, Sweden • alert@sbu.se

This summary is based on a report prepared at SBU in collaboration with **Lennart Christiansson**, MD, PhD, Uppsala University Hospital, Uppsala, and **Per Gannedahl**, MD, PhD, Karolinska University Hospital, Stockholm. It has been reviewed by **Gunilla Barr**, CRNA, PhD, Karolinska University Hospital, Stockholm, and **Ola Stenqvist**, MD, Professor, Sahlgrenska University Hospital, Göteborg. Project manager: **Johan Wallin**, SBU, wallin@sbu.se.

The complete report is available in Swedish.