Critical Care

COMMENT

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A plea for enhanced monitoring of depth of sedation in patients who are intubated and ventilated

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Introduction

Awareness with recall during surgery and anesthesia occurs when the hypnotic and amnesic components of a general anesthetic fail to sustain disconnected consciousness and ablate memory. This is a rare yet significant complication that occurs in a small percentage (0.1–0.2%) of patients undergoing surgery under general anaesthesia [1]. This phenomenon involves the vivid recollection of sensory experiences during surgery, which can lead to posttraumatic stress disorders. The risk of being aware under general anaesthesia in highest in those patients who are administered muscle relaxants without sufficient hypnotics as they are unable to communicate due to paralysis. This event is frequently associated with a number of dramatic feelings (e.g., patients thinking "they were going to die," sensations of fear and terror, feelings of being unsafe and abandoned or betrayed by doctors and nurses, and pain on being mechanically ventilated).

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Recent data in emergency intubation

An unexpected number of patients suffer awareness after emergency tracheal intubation. Recent research, including a meta-analysis of randomized or nonrandomized studies ($n=941$ patients)[2] revealed that an overall estimate of 12.3% of patients who receive a neuromuscular blocking agent for muscle relaxation before tracheal intubation and during mechanical ventilation in the emergency department (ED) might recover consciousness and encode memories of the intubation manoeuvre, mechanical ventilation, a bronchoscopy, or a combination of these and other painful procedures [2–5]. This occurrence could be underestimated due to factors like patient mortality before extubation, memory loss, or neurological deficits. This concerning incidence of conscious paralysis may result from a combination of factors that include the urgent nature of critical patient conditions, intubation before optimal hypnotic effects, anesthetic under-dosing to avoid hemodynamic collapse, and the lack of sedation-protocolized monitoring during invasive mechanical ventilation. Notably, patients' pharmacogenomics, pharmacokinetics, and pharmacodynamics vary significantly, complicating the dosage-effect relationship of hypnotics and muscle relaxants [6] and clinical sedation assessments before intubation may not guarantee continued unconsciousness due to the complex interplay between hypnotics and painful stimuli.

Strategy to prevent awareness

While adjusting sedative dosages seems logical, it can be challenging in critically ill, paralyzed patients. Hemodynamic vital signs are often used as proxies for sedation,

but they lack precision. Heart rate and blood pressure are unreliable for determining unconsciousness or the degree of sedation or anesthetic depth.

The development and the diffusion of depth-of-anesthesia monitors (DOA) has made intraoperative electroencephalography (EEG) more accessible and practical for detecting excessive light anesthesia, thus reducing the risk of intraoperative awareness. Modern DOA monitors help the physician with the computer processing of raw EEG traces (processed EEG, pEEG) that provide numerical indices on the sedation level (sedation index: from 100, awake patient to 0, totally suppressed EEG) [7–9] (Fig. 1).

Trials that compared pEEG-guided anesthesia with routine care (i.e. clinical signs as a guide for anesthesia management), showed that the risk of awareness was significantly reduced with pEEG monitoring in the overall population of patients and even more in those at higher risk for awareness [10]. A meta-analysis including 52 studies and 41,331 patients showed that pEEG guidance reduces the risk of awareness with paralysis by 64% compared to clinical signs alone, with no evidence of a difference in incidences of intraoperative awareness according to whether anaesthesia was guided by pEEG or by ETAC in a surgical population at unselected or at high risk of awareness [11]. For many reasons (e.g. drug overdose, prevention of post-operative delirium, risk for neurocognitive decline) DOA monitors have frequently been recommended for the management of both anaesthesia depth during surgery (where they are now widely applied to titrate hypnotics) [12, 13] and for the management of sedation in intensive care unit (ICU) patients.

Since sedative titration might be challenging in a critically ill, depth of sedation cannot be clinically assessed in paralyzed patient, and hemodynamic vital signs are unreliable measures of depth of sedation, the risk of awareness in emergency settings can be significantly improved by the use of DOA monitors (Fig. 1). Nowadays, monitoring devices in EDs are often relatively basic, recording only clinical responses (e.g., blood pressure, heart rate, oxygen saturation), while monitoring depth of consciousness/sedation depth is rare or in fact, never monitored. The routine application of a DOA with pEEG in every patient receiving hypnotics and muscle relaxants in every clinical setting may eventually reduce the occurrence of awareness with paralysis and its dramatic consequences, as already observed during anaesthesia and surgery.

Conclusions

Awareness with recall during paralysis occurs in many patients in the ED after tracheal intubation. Emergency physicians and nurses must know the risk of conscious paralysis and strive to detect and eliminate it in all patients receiving paralysis and mechanical ventilation.

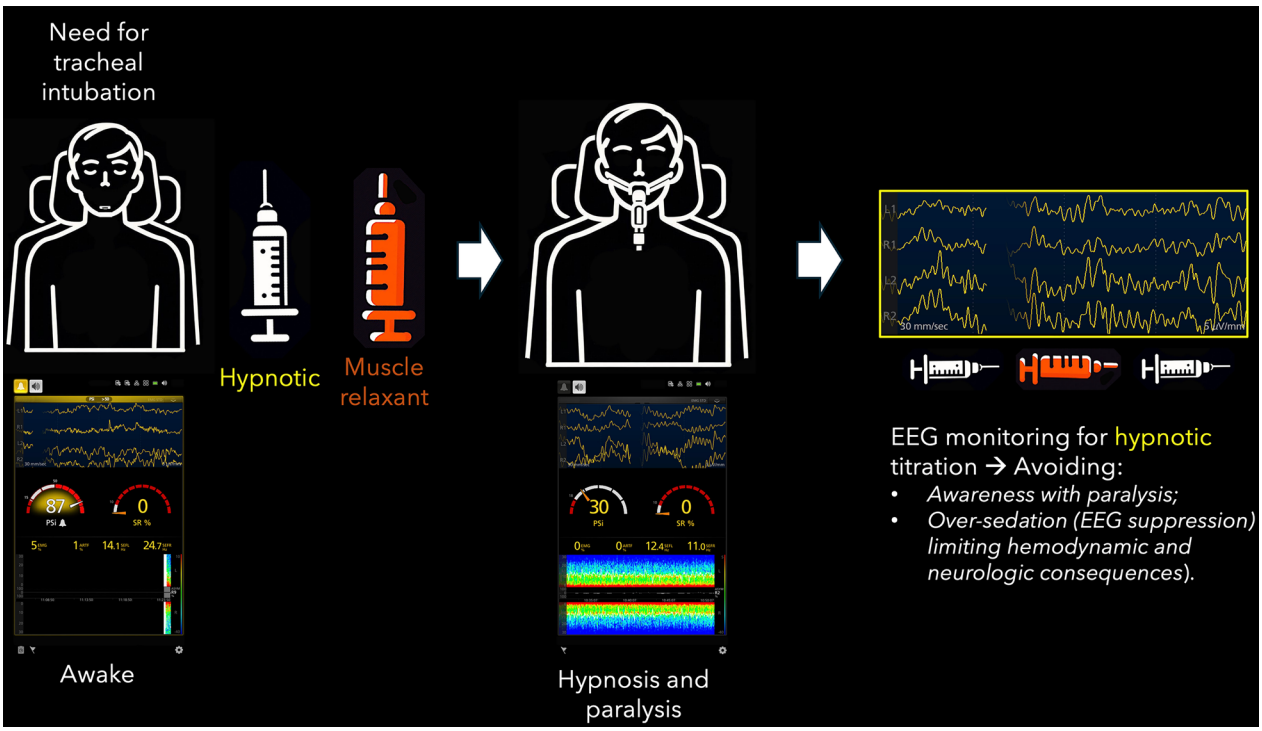

Fig. 1 Intubation, mechanical ventilation and diagnostic procedures frequently occurring in the emergency department

As clinicians, we must consider that the aim of intensive care includes much more than merely the survival of patients. In addition to taking care of physiologic parameters such as blood pressure, tissue perfusion, gas exchange, and urine output, we should also focus on brain health. ICU and ED physicians might consider use of neurological EEG-based monitoring, though further research is needed in ED and ICU settings. Sedation protocols based on pEEG monitors could represent a radical solution for this devastating complication associated with life-saving treatments. It is the responsibility of clinicians to target "zero occurrences" of awareness during paralysis in the ED and during the entire hospital stay of their patients.

Abbreviations

BIS	Bispectral index
DOA	Depth-of-anesthesia monitors
ED	Emergency department
ETAC	End tidal anesthetic-agent concentration
ICU	Intensive care unit
MAC	Minimum alveolar concentration
pEEG	Processed electroencephalography

Author contribution

SR conceived the manuscript, prepared the first draft of the text and figure, and invited the other authors to contribute. BM reviewed the final version of the manuscript as an expert in neuromonitoring. DBE contributed in elaborating the text as expert in the main topic of the paper. EL participated in the manuscript preparation as an expert in neuromonitoring and neurological disorders. All authors contributed to the critical revision of the paper and final approval.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Conflict of interest

SR received grant for congress presentations from Fresenius, Masimo and Medtronic. BM is Global Senior Medical Director—Masimo International Irvine, California, USA; BED and LE declare no conflicts of interest.

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