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ORIGINAL ARTICLE

Emergence agitation in adults undergoing abdominal surgery under general anaesthesia: predictors from a two-centre prospective observational study

Mirza Kovacevic[1,2†*], Amir Hakanovic[3†], Alma Jahic[4], Ismeta Karic Heric[5], Selma Sijercic[6,7], Ferid Krupic[8,9]

[1]Department of Anaesthesiology, Resuscitation and Intensive Care, Cantonal Hospital Zenica, Zenica, Bosnia and Herzegovina; [2]School of Medicine, University of Zenica, Zenica, Bosnia and Herzegovina; [3]Kardiologie Mittelland, Aarau, Switzerland; [4]General Hospital "Prim. dr. Abdulah Nakaš", Sarajevo, Bosnia and Herzegovina; [5]Cantonal Hospital "Dr. Safet Mujić", Mostar, Bosnia and Herzegovina; [6]Clinic of Anaesthesiology, University Clinical Centre Tuzla, Tuzla, Bosnia and Herzegovina; [7]School of Medicine, University of Tuzla, Tuzla, Bosnia and Herzegovina; [8]Department of Orthopaedics, University of Gothenburg, Gothenburg, Sweden; [9]Department of Anaesthesiology, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden;

ABSTRACT

Aim To identify factors associated with emergence agitation (EA) in adults undergoing abdominal surgery under general anaesthesia.

Methods This prospective two-centered study included 107 patients (≥18 years) who underwent abdominal surgery at two hospital centres between February 2025 and September 2025. Collected variables included demographics, American Society of Anesthesiologists (ASA) classification, education level, smoking and alcohol use, comorbidities, fasting status, urgency and type of surgery, and anaesthesia duration. Hemodynamic parameters were recorded before induction, before endotracheal intubation (ETI), and before extubation. EA was assessed using the Richmond Agitation-Sedation Scale (RASS) and the Sedation-Agitation Scale (SAS) before (T1) and 10 minutes after extubation (T2).

Results At T2, EA incidence was 22% (23 patients) according to SAS and 41% (44 patients) according to RASS. SAS-defined EA at T1 was associated with ASA status ≥ III (aOR 2.35, 95% CI 1.05–5.25; p = 0.028) and lower blood pressure before extubation (aOR 0.62, 95% CI 0.50–0.96; p = 0.016). SAS-defined EA at T2 was associated with higher body weight (aOR 1.20, 95% CI 1.03–1.40; p = 0.017) and higher heart rate before extubation (aOR 1.45, 95% CI 1.25–1.80; p = 0.022). According to RASS, lower blood pressure before induction was associated with EA at T1 (aOR 0.88, 95% CI 0.78–0.99; p = 0.045), while nasogastric tube presence was associated with EA at T2 (aOR 2.10, 95% CI 1.06–4.15; p = 0.034).

Conclusion EA after general anaesthesia in adults undergoing abdominal surgery is common. Identification of associated factors may improve perioperative risk assessment and early recognition.

Keywords: hospital, incidence, patients, risk assessment

INTRODUCTION

Emergence agitation (EA) is a transient disturbance in behaviour and cognition during recovery from general anaesthesia. It manifests as restlessness, confusion, and disorientation, sometimes escalating to aggressive actions. Although often short-lived, EA may lead to accidental removal of tubes or catheters, self-injury, bleeding, and hemodynamic instability, while also increasing the burden on recovery staff (1). The reported incidence of EA in adults ranges from 5% to 20%, reflecting differences in surgical type, anaesthetic techniques, and diagnostic tools. In abdominal surgery, the risk may be higher due to postoperative pain, airway irritation, and the frequent use of invasive devices (2). A recent retrospective study in abdominal procedures confirmed associations between age, American Society of Anesthesiologists (ASA) classification, type and duration of surgery, catheter placement, pain, smoking, and EA (3).

The mechanisms underlying EA are not fully understood. Proposed contributors include rapid awakening from volatile anaesthetics, neurotransmitter imbalance, perioperative stress, and inadequate pain control. Intraoperative hemodynamic fluctuations, high ASA physical status, obesity, alcohol use, and

*Corresponding author:
Mirza Kovacevic
Department of Anaesthesiology, Resuscitation and Intensive Care, Cantonal Hospital Zenica, Zenica, Bosnia and Herzegovina
E-mail: kovacevic.mirza@hotmail.com
ORCID ID: 0000-0002-3492-4100
†These authors contributed equally to this work and share first authorship.

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preoperative anxiety have also been linked to increased risk (4). Procedure-related variables, such as sevoflurane anaesthesia, the presence of a tracheal tube and/or urinary catheter, and postoperative pain of Numeric Rating Scale (NRS) ≥ 5, may further influence outcomes (5). Reliable measurement is critical for accurate diagnosis. The Sedation-Agitation Scale (SAS) (6) and the Richmond Agitation-Sedation Scale (RASS) (7) are widely used, both showing strong validity and reliability in perioperative and intensive care settings. SAS primarily grades agitation severity, while RASS captures both agitation and sedation, which may explain discrepancies in reported incidence (8). Preventive strategies are essential. Pharmacologic interventions, such as remimazolam and remifentanil, have reduced EA in randomized controlled trials (9,10), while non-drug measures include techniques to educate patients on mouth breathing and interventions aimed at reducing secretion during extubation (11). Combining these strategies with careful risk assessment may improve safety and recovery, as EA—also referred to as post-anaesthetic excitement—is increasingly recognized in the literature as a well-documented phenomenon occurring in both children and adults during the immediate postoperative period, and typically lasts 5–15 minutes (12). A preliminary review of the literature revealed limited prospective data on anaesthetic emergence outcomes, risk factors, and management in specific adult patient cohorts, with potential variability depending on the measurement scale (13). Focused studies on abdominal surgery patients are therefore needed to clarify incidence, predictors, and preventive strategies.

The present study aimed to identify predictors of EA in adults undergoing abdominal surgery under general anaesthesia using two validated scales (SAS and RASS) in a prospective two-centre design.

PATIENTS AND METHODS

Patients and study design

This prospective observational study was conducted at two hospital centres (Cantonal Hospital Zenica and Cantonal Hospital "Dr. Safet Mujic", Mostar) between February 2025 and September 2025.

A total of 107 adult patients (≥ 18 years) scheduled for abdominal surgery under general anaesthesia were enrolled. Inclusion criteria encompassed adults aged 18 years or older undergoing appendectomy, herniorrhaphy, or cholecystectomy, classified as ASA physical status I–III, with planned operative duration of two hours or less. Patients were required to be hemodynamically stable at the time of preoperative evaluation and capable of providing informed consent and completing the psychological assessment. Exclusion criteria included pregnancy or lactation, a history of diagnosed psychiatric or neurocognitive disorders (such as depression, anxiety disorders, psychosis, dementia, or cognitive impairment), current hospitalization in or transfer from the Intensive Care Unit or other inpatient wards, use of haloperidol, risperidone, quetiapine or other sedative/antipsychotic agents within 48 hours prior to surgery, ASA physical status IV or higher, anticipated operative time exceeding two hours, and refusal or inability to participate.

Written informed consent was obtained from all participants.

The Ethics Committees of the Cantonal Hospital Zenica and Cantonal Hospital "Dr. Safet Mujic", Mostar approved the study (Centre 1: No. 00-03-18-8/25; Centre 2: No. 00-12-1/25, approval date: January 30, 2025).

Methods

All patients received standardized general anaesthesia. Induction was performed with intravenous propofol (1.5–2.5 mg/kg) and fentanyl (1–2 μg/kg), followed by neuromuscular blockade with rocuronium (0.6–1 mg/kg) to facilitate tracheal intubation. Anaesthesia was maintained with sevoflurane in a mixture of oxygen and air, titrated to maintain an age-adjusted minimum alveolar concentration and stable hemodynamics. No benzodiazepines were administered during induction or maintenance, and flumazenil was not used in any case. Mechanical ventilation was delivered in volume-controlled mode, with end-tidal CO_2 maintained between 35–45 mmHg and peripheral oxygen saturation (SpO_2) > 94%. Intraoperative records were reviewed for potential confounding physiological disturbances, transient hypotension (mean arterial pressure <65 mmHg) was corrected with fluid boluses and, when required, a single vasopressor dose. No episodes of perioperative hypoxemia (SpO_2 < 90%) or ventilation-related hypercapnia ($EtCO_2$ > 50 mmHg) were observed. Agitation was defined as a state of mental excitement with purposeless motor activity, ranging from mild restlessness to severe uncoordinated movements (14).

The collected preoperative variables included age, gender, body weight, body mass index (BMI), ASA classification (I-III), smoking and alcohol status, education level (primary, secondary, or tertiary), comorbidities, previous hospitalizations or ICU stays, fasting duration, and type of surgery (elective vs. urgent).

Intraoperative variables included: surgical approach (laparoscopic vs. open), duration of surgery and anaesthesia, use of nasogastric tube, urinary catheter, or central venous line. Hemodynamic monitoring included blood pressure (BP) and heart rate (HR) at three time points: before induction, before endotracheal intubation, and before extubation.

Postoperative variables included: emergence agitation was assessed using the RASS and SAS at two time intervals: immediately before extubation during standardized emergence after discontinuation of anaesthetic agents and when patients demonstrated responsiveness to verbal stimulation (T1) and 10 minutes post-extubation in the operating room (T2). These assessments were performed by two attending anaesthesiologists trained in the use of both scales. All assessors received standardized instruction prior to study initiation.

The SAS is a 7-point scale ranging from dangerous agitation (score 7) to unarousable (score 1). The RASS is a 10-point scale from +4 (combative) to –5 (unarousable) (15). For this study, emergence agitation was defined as SAS ≥ 5 or RASS ≥ +1 (Figure 1).

Statistical analysis

Continuous variables were presented as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution, while categorical variables were expressed as counts and percentages (n, %). Normality of continuous variables was assessed using the Shapiro–Wilk test. Emergence agitation (EA) was defined as a binary outcome based on predefined thresholds (SAS ≥ 5; RASS ≥ +1). Analyses were conducted separately for each scale (SAS and RASS) and for each time point (T1: pre-extubation; T2: post-extubation). Univariable logistic regression analysis was performed to evaluate the association between each predictor and EA. Results are reported as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) and corresponding p-values. Continuous predictors were modelled

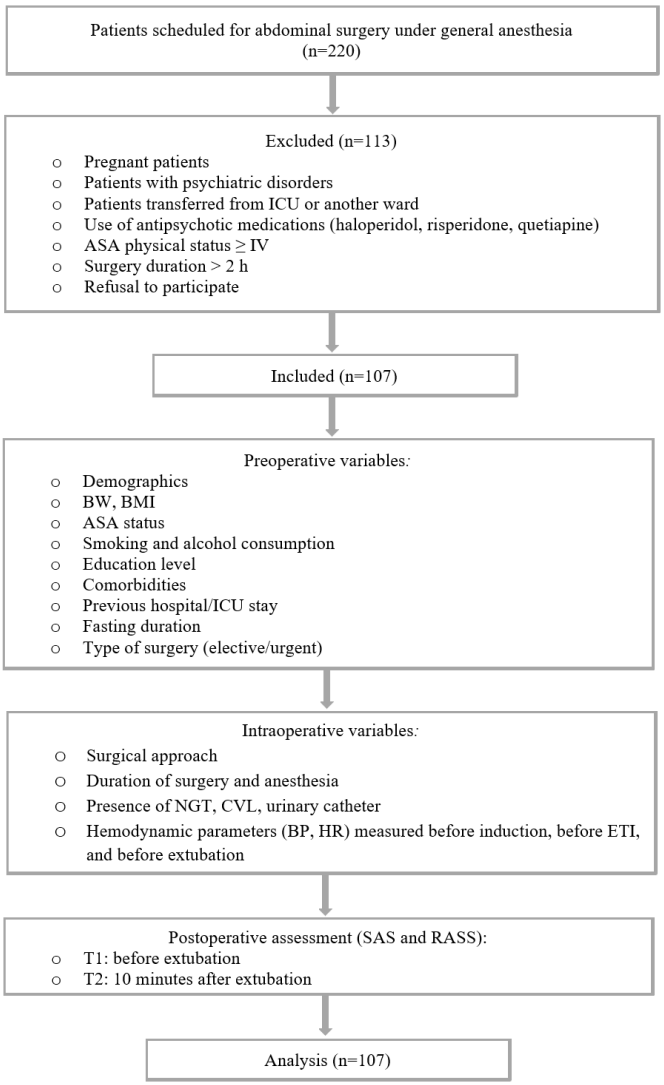

Figure 1. Flowchart of the study protocol

ICU, Intensive Care Unit; BW, body weight; BMI, body mass index; ASA, American Society of Anesthesiologists; NGT, nasogastric tube; CVL, central venous line; ETI, endotracheal intubation; SAS, Sedation–Agitation Scale; RASS, Richmond Agitation–Sedation Scale.

per clinically meaningful increments (age per 10 years, body weight per 10 kg, blood pressure per 10 mmHg, and heart rate per 10 beats/min). Categorical variables were analysed using predefined reference categories (e.g., ASA I–II as the reference; absence of a nasogastric tube as the reference).

Variables with $p < 0.05$ in univariable analysis and/or variables considered clinically relevant a priori were entered into multivariable logistic regression models to identify factors independently associated with EA. Adjusted odds ratios (aORs) with 95% CIs and p-values are reported. Given the relatively limited number of EA events in some subgroup analyses, the number of predictors included in multivariable models was restricted to reduce the risk of model overfitting. Multicollinearity among predictors was assessed using variance inflation factors (VIF), and no significant multicollinearity was identified. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test. For descriptive purposes only, group comparisons were additionally performed using Student's t-test or Mann–Whitney U test for continuous variables and χ^2 or Fisher's exact test for categorical variables, as appropriate. No imputation procedures were performed, and analyses were conducted using complete-case data. Given the exploratory nature of the study and the number of comparisons performed, p-values were interpreted cautiously. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

A total of 107 patients were included in the analysis. The mean age of the patients was 54.00 ± 17.12 years, with 43 (40.2%) males and 64 (59.8%) females (Table 1).

According to the SAS, emergence agitation (EA) was observed in 35 (32.7%) patients at T1 and 23 (21.5%) at T2. Based on the RASS, EA was observed in 58 (54.2%) patients at T1 and 44 (41.1%) at T2. When stratified by type of surgery, the presented proportions reflect the distribution of surgical procedures among the patients who developed EA, rather than the incidence of EA within each surgical subgroup. Among the patients with EA at T1 according to SAS, 17 (48.6%) underwent appendectomy, 13 (37.1%) herniorrhaphy, and five (14.3%) cholecystectomy, while at T2 the corresponding proportions were four (17.4%), six (26.1%), and 13 (56.5%), respectively. Similarly, among the patients with EA at T1 according to RASS, 27 (46.6%) patients underwent appendectomy, 25 (43.1%) herniorrhaphy, and six (10.3%) cholecystectomy, whereas at T2 the corresponding proportions were 10 (22.7%), 10 (22.7%), and 24 (54.5%), respectively.

At T1 according to SAS, ASA physical status ≥ III was associated with an increased likelihood of EA (OR 2.10, 95% CI 1.16–3.81; p = 0.006). Cardiovascular disease (OR 2.41, 95% CI 1.19–3.92; p = 0.036), previous ICU stay (OR 1.32, 95% CI 1.12–2.27; p = 0.019) and NGT presence (OR 1.37, 95% CI 1.20-1.88; p = 0.049) were also significantly associated with higher odds of EA. Hemodynamic parameters demonstrated significant associations, with blood pressure before induction (OR 0.49 per 10 mmHg increase, 95% CI 0.21–0.85; p = 0.033), before endotracheal intubation (OR 0.24 per 10 mmHg increase, 95% CI 0.02–0.78; p = 0.018), and before extubation (OR 0.64 per 10 mmHg increase, 95% CI 0.41–0.87; p = 0.023) being inversely associated with EA (Table 2).

At T2, according to SAS, higher body weight was associated with higher odds of EA (OR 1.62 per 10 kg increase, 95% CI 1.03–2.83; p = 0.035), as was higher heart rate before extubation (OR 1.25 per 10 beats/min increase, 95% CI 1.05–1.72; p = 0.034). According to RASS, previous hospital stay (OR 1.40, 95% CI 1.10–1.86; p = 0.030), presence of NGT (OR 2.35, 95% CI 1.27–3.86; p = 0.012) were associated with higher odds of EA. In addition, blood pressure before extubation was inversely associated with EA (OR 0.32 per 10 mmHg increase, 95% CI 0.19–0.83; p = 0.045), and heart rate before endotracheal intubation was also inversely associated with EA (OR 0.43 per 10 beats/min increase, 95% CI 0.21–0.75; p = 0.030) (Table 3).

In multivariable logistic regression analysis for SAS at T1, ASA physical status ≥ III (adjusted OR 2.35, 95% CI 1.05–5.25; p = 0.028) and lower blood pressure before extubation (adjusted OR 0.62 per 10 mmHg increase, 95% CI 0.50–0.96; p = 0.016) were independently associated with EA. For SAS at T2, higher body weight (adjusted OR 1.20 per 10 kg increase, 95% CI 1.03–1.40; p = 0.017) and higher heart rate before extubation (adjusted OR 1.45 per 10 beats/min increase, 95% CI 1.25–1.80; p = 0.022) were independently associated with EA.

According to RASS, lower blood pressure before induction was independently associated with EA at T1 (adjusted OR 0.88 per 10 mmHg increase, 95% CI 0.78–0.99; p = 0.045), while

Table 1. Baseline characteristics of the study population (N = 107)

Variable		Value
Age (years) (Mean±SD)		54.00±17.12
Gender (No, %)	Female	64 (59.8)
	Male	43 (40.2)
BW (kg) (Mean±SD)		79.40±12.21
BMI (kg/m^2) (Mean±SD)		32.00±6.01
		No (%) of patients
ASA status	I	19 (17.8)
	II	76 (71)
	III	12 (11.2)
Education	Primary	25 (23.3)
	Secondary	50 (46.7)
	Tertiary	32 (29.9)
Smoking		43 (40.2)
Alcohol consumption		12 (11.2)
Comorbidities	COPD	3 (2.8)
	CVD	13 (12.4)
	HTN	67 (62.6)
	DM	14 (13.1)
Previous hospital stay		55 (51.4)
Previous ICU stay		19 (17.8)
Fasting duration (hours) (Mean±SD)		7.15±1.23
Type of surgery	Elective	63 (58.9)
	Urgent	44 (41.1)
Surgical approach	Open	46 (43)
	Laparoscopic	61 (57)
NGT presence		19 (17.8)
Urinary catheter		7 (6.5)
CVL presence		5 (4.6)
		Mean ± SD
Surgery duration (min)		57.13±26.83
Anaesthesia duration (min)		66.53±26.75
Hemodynamic parameters		
BP (mmHg)	before induction	149.34±28.18
	before ETI	144.46±27.57
	before extubation	142.12±25.38
HR (bpm)	before induction	85.90±15.38
	before ETI	87.75±18.56
	before extubation	82.44±20.80

BW, body weight; BMI, body mass index; ASA, American Society of Anaesthesiologists; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; HTN, hypertension; DM, diabetes mellitus; ICU, Intensive Care Unit; NGT, nasogastric tube; CVL, central venous line; BP, blood pressure; HR, heart rate; bpm, beats per minute; ETI, endotracheal intubation.

the presence of a nasogastric tube remained independently associated with EA at T2 (adjusted OR 2.10, 95% CI 1.06–4.15; p = 0.034). The results of the multivariable logistic regression analysis are presented in Table 4.

DISCUSSION

In this prospective two-centre study, the post-extubation incidence of EA in adult patients undergoing abdominal surgery was 22% when assessed using the SAS, and 41% when using the RASS. This discrepancy underscores an important methodological point: the choice of assessment tool strongly influences the reported incidence of EA. The SAS focuses on grading agitation severity, whereas the RASS captures both agitation and sedation, which may explain the higher rates observed with the latter (16). Our findings add to the growing body of literature recognizing EA in adults as a clinically relevant phenomenon (17). In recent years, adult EA has gained increasing attention, particularly because of its impact on patient safety and postoperative care (18). In our study, perioperative hemodynamic fluctuations were associated with EA, whereas anaesthesia and surgery duration were not consistently associated with agitation. Patient and surgery-related characteristics also showed significant associations. In our study, higher ASA physical status, body weight, and the presence of nasogastric tubes were associated with EA. These findings align with a recent systematic review that summarized predictors across adult populations, identifying obesity, cognitive impairment, and the use of invasive devices such as endotracheal tubes, urinary catheters and nasogastric tubes as major contributors (19). The consistency between our results and prior evidence supports the relevance of

Table 2. Univariable logistic regression analysis of risk factors for EA before extubation T1

Variable		SAS	RASS
		OR (95% CI); p-value	OR (95% CI); p-value
Age (per 10 years increase)		0.951 (0.491–1.236); 0.470	0.956 (0.642–1.158); 0.091
Gender	Female	ref.	ref.
	Male	1.221 (0.432–1.755); 0.239	0.833 (0.532–1.601); 0.281
BW (per 10 kg)		0.342 (0.221–1.453); 0.372	0.633 (0.415–1.056); 0.313
BMI (per 1 unit increase)		1.210 (0.887–2.971); 0.452	0.665 (0.532–2.643); 0.881
			No (%) of patients
ASA $\geq$ **III** (yes vs no)		2.108 (1.169–3.814); **0.006**	1.311 (0.687–2.301); 0.332
Education	Primary	ref.	ref.
	Secondary	0.990 (0.667–1.881); 0.442	1.010 (0.487–1.671); 0.252
	Tertiary	0.522 (0.398–1.497); 0.482	0.422 (0.147–1.671); 0.199
Smoking		0.832 (0.569–1.756); 0.798	0.577 (0.098–1.224); 0.091
Alcohol consumption		1.341 (0.545–2.145); 0.265	1.382 (0.837–1.728); 0.532
Comorbidities	COPD	0.971 (0.292–1.904); 0.209	0.681 (0.089–1.412); 0.443
	CVD	2.415 (1.198–3.924); **0.036**	2.433 (0.941–4.168); 0.123
	HTN	2.487 (0.894–3.902); 0.318	1.874 (0.691–2.745); 0.244
	DM	0.884 (0.521–1.900); 0.790	1.887 (0.943–2.331); 0.101
Previous hospital stay		1.248 (0.786–1.827); 0.401	1.352 (0.602–1.841); 0.332
Previous ICU stay		1.328 (1.122–2.276); **0.019**	0.928 (0.834–1.050); 0.831
Fasting duration (hours)		0.943 (0.721–1.254); 0.594	1.115 (0.482–1.451); 0.327
Type of surgery	Elective	ref.	ref.
	Urgent	0.897 (0.284–1.135); 0.125	0.855 (0.192–1.199); 0.152
Surgical approach	Open	ref.	ref.
	Laparoscopic	0.501 (0.072–1.281); 0.202	0.622 (0.469–1.294); 0.150
NGT presence		1.372 (1.201–1.886); **0.049**	1.332 (0.653–1.861); 0.787
Urinary catheter		0.965 (0.228–1.820); 0.622	0.887 (0.467–1.234); 0.192
CVL presence		0.881 (0.362–1.532); 0.795	1.281 (0.056–1.964); 0.202
Surgery length (per 10 min)		0.736 (0.215–1.145); 0.697	0.698 (0.061–1.170); 0.677
Anaesthesia length (per 10 min)		0.687 (0.237–1.110); 0.246	0.499 (0.272–1.185); 0.888
Hemodynamic parameters			
BP (per 10 mmHg increase)	before induction	0.497 (0.213–0.855); **0.033**	0.773 (0.266–1.148); 0.651
	before ETI	0.248 (0.021–0.782); **0.018**	0.391 (0.147–1.134); 0.378
	before extubation	0.643 (0.418–0.873); **0.023**	0.542 (0.043–1.084); 0.483
HR (per 10 bpm increase)	before induction	0.432 (0.312–1.063); 0.102	0.562 (0.051–1.075); 0.702
	before ETI	0.334 (0.026–1.051); 0.391	0.633 (0.423–1.061); 0.126
	before extubation	0.752 (0.448–1.061); 0.081	0.640 (0.231–1.052); 0.356

EA, emergence agitation (SAS $\geq$ 5; RASS $\geq$ +1); SAS, Sedation-Agitation Scale; RASS, Richmond Agitation-Sedation Scale; CI, confidence interval; BW, body weight; BMI, body mass index; ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; HTN, hypertension; DM, diabetes mellitus; NGT, nasogastric tube; CVL, central venous line; BP, blood pressure; HR, heart rate; bpm, beats per minute; ETI, endotracheal intubation. Reference categories: female sex; ASA I–II; elective surgery; open approach; absence of nasogastric tube.

these variables in the perioperative context. Another key determinant identified in our analysis was hemodynamic instability during surgery. Fluctuations in blood pressure and heart rate were associated with agitation both before and after extubation. This is consistent with prior evidence showing that rapid physiological changes during emergence in the postoperative period may be related to agitation (20). In a randomized controlled trial, repeated verbal orientation reminders during emergence significantly reduced EA incidence from 66.7% to 28.1% and eliminated episodes of severe agitation (21). However, such findings should be interpreted within the context of the respective study design. The simplicity of this approach makes it highly practical for implementation in recovery units. Our findings regarding the influence of education level and prior hospitalization experience may reflect the potential role of psychological preparedness and reassurance in recovery quality (22).

The present study adds to the evidence by focusing specifically on abdominal surgery, a field in which EA has not been systematically studied. While most prior research has examined neurosurgical procedures (23), our findings suggest that abdominal surgery patients may also be vulnerable, particularly when invasive devices and postoperative pain are present. Given the observed association between nasogastric tube use and emergence agitation, this factor may be relevant in perioperative decision-making; however, causality cannot be established. Identifying patients at higher risk of EA—those with higher ASA class, obesity, comorbidities, prolonged surgery, or invasive devices—may help clinicians better recognize these cases in the perioperative setting (24). These strategies may be relevant in the perioperative setting; if validated, they may also reduce staff workload, as EA has been associated with increased nursing interventions and, in severe cases, the need for physical restraint.

Our study has several limitations. First, the sample size was

Table 3. Univariable logistic regression analysis of risk factors for EA after extubation T2

Variable		SAS	RASS
		OR (95% CI); p-value	OR (95% CI); p-value
Age (per 10 years increase)		0.615 (0.100–1.243); 0.413	1.023 (0.440–1.654); 0.600
Gender	Female	ref.	ref.
	Male	1.254 (0.881–1.654); 0.110	0.302 (0.096–1.671); 0.151
BW (per 10 kg)		1.625 (1.030–2.832); **0.035**	0.718 (0.210–1.027); 0.382
BMI (per 1 unit increase)		0.855 (0.550–2.068); 0.668	0.771 (0.544–1.011); 0.443
		No (%) of patients	No (%) of patients
ASA $\geq$ **III** (yes vs no)		1.543 (0.738–2.550); 0.366	1.285 (0.694–2.016); 0.223
Education	Primary	ref.	ref.
	Secondary	0.955 (0.750–2.158); 0.788	0.435 (0.150–1.268); 0.288
	Tertiary	0.886 (0.453–1.534); 0.057	0.928 (0.686–1.975); 0.532
Smoking		1.034 (0.450–2.207); 0.791	0.611 (0.308–1.133); 0.288
Alcohol consumption		0.827 (0.374–1.764); 0.673	0.879 (0.465–1.395); 0.332
Comorbidities	COPD	0.832 (0.544–1.294); 0.633	0.870 (0.664–1.692); 0.253
	CVD	0.946 (0.545–1.674); 0.410	0.687 (0.523–1.189); 0.173
	HTN	0.758 (0.354–1.520); 0.422	1.537 (0.403–2.101); 0.192
	DM	0.833 (0.599–1.527); 0.244	0.981 (0.529–1.841); 0.299
Previous hospital stay		0.787 (0.486–1.355); 0.451	1.402 (1.107–1.864); **0.030**
Previous ICU stay		0.631 (0.194–1.517); 0.524	0.876 (0.315–1.042); 0.302
Fasting duration (hours)		0.843 (0.618–1.671); 0.533	0.631 (0.439–1.241); 0.485
Type of surgery	Elective	ref.	ref.
	Urgent	0.818 (0.483–1.205); 0.278	0.701 (0.487–1.534); 0.693
Surgical approach	Open	ref.	ref.
	Laparoscopic	0.882 (0.692–1.091); 0.251	0.782 (0.488–1.140); 0.672
NGT presence		1.721 (0.934–2.072); 0.093	2.351 (1.277–3.865); 0.012
Urinary catheter		0.997 (0.641–1.290); 0.357	0.980 (0.840–1.108); 0.802
CVL presence		0.998 (0.461–1.408); 0.100	0.722 (0.259–1.325); 0.331
Surgery length (per 10 min)		0.677 (0.340–1.399); 0.398	0.548 (0.142–1.054); 0.342
Anaesthesia length (per 10 min)		0.653 (0.246–1.488); 0.537	0.550 (0.244–1.256); 0.403
Hemodynamic parameters			
BP (per 10 mmHg increase)	before induction	0.685 (0.442–1.146); 0.425	0.666 (0.338–1.108); 0.244
	before ETI	0.499 (0.242–1.139); 0.241	0.512 (0.100–1.013); 0.152
	before extubation	0.497 (0.150–1.254); 0.260	0.326 (0.193–0.837); **0.045**
HR (per 10 bpm increase)	before induction	0.476 (0.180–1.285); 0.298	0.638 (0.201–1.047); 0.056
	before ETI	0.517 (0.265–1.235); 0.279	0.433 (0.215–0.753); **0.030**
	before extubation	1.255 (1.057–1.724); **0.034**	0.514 (0.309–1.321); 0.467

EA, emergence agitation (SAS $\geq$ 5; RASS $\geq$ +1); SAS, Sedation-Agitation Scale; RASS, Richmond Agitation-Sedation Scale; CI, confidence interval; BW, body weight; BMI, body mass index; ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; HTN, hypertension; DM, diabetes mellitus; NGT, nasogastric tube; CVL, central venous line; BP, blood pressure; HR, heart rate; bpm, beats per minute; ETI, endotracheal intubation. Reference categories: female sex; ASA I–II; elective surgery; open approach; absence of nasogastric tube.

modest, and only three types of abdominal procedures were included, which may limit the generalizability of the findings. In addition, the relatively limited number of EA events in some subgroup analyses may have increased the risk of model overfitting and reduced the stability of multivariable estimates. Second, intraoperative anaesthetic depth and postoperative pain scores were not systematically assessed, which is common in clinical practice, especially during urgent procedures; however, but both may represent potential confounders for emergence agitation. Third, this was a two-center study, and center-specific perioperative practices and patient management strategies may have influenced the observed associations. Furthermore, multiple statistical comparisons were performed, which may have increased the risk of type I error. Finally, long-term outcomes, such as the relationship between EA and postoperative delirium or cognitive decline, were not assessed.

Despite these limitations, the prospective design and the use of two validated agitation scales strengthen the reliability of our findings.

Future research should aim to develop predictive models or nomograms that integrate demographic, clinical, and perioperative factors to stratify EA risk more accurately. Large multicentre studies are needed to validate such models across different surgical populations. In addition, randomized controlled trials should investigate bundled interventions that combine pharmacological and non-pharmacological approaches.

EA appears to be a relatively common phenomenon following abdominal surgery under general anaesthesia. Our findings suggest that several patient-related and perioperative factors may be associated with its occurrence. The scientific novelty of this study lies in the simultaneous assessment of EA using both the SAS and the RASS at different peri-extubation time points in adult abdominal surgery patients. This approach demonstrated variability in EA incidence depending on the assessment instru-

Table 4. Multivariable logistic regression analysis of risk factors for EA¶

Variable	Timepoint	SAS	RASS
		Adjusted-OR (95% CI); p-value	Adjusted-OR (95% CI); p-value
ASA ≥III (yes vs no)	T1	2.351 (1.054–5.250); **0.028**	
BP before induction¶ (per 10 mmHg increase)	T1		0.883 (0.788–0.994); **0.045**
BP before extubation¶ (per 10 mmHg increase)	T1	0.623 (0.501–0.960); **0.016**	
BW (per 10 kg increase)	T2	1.201 (1.036–1.402); **0.017**	
HR before extubation¶ (per 10 bpm increase)	T2	1.457 (1.255–1.801); **0.022**	
NGT presence (yes vs no)	T2		2.103 (1.066–4.152); **0.034**

EA, emergence agitation (SAS ≥5; RASS ≥ +1); SAS, Sedation-Agitation Scale; RASS, Richmond Agitation-Sedation Scale; BP, blood pressure; OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; BW, body weight; bpm, beats per minute; HR, heart rate; NGT, nasogastric tube. Reference categories: ASA I–II; absence of nasogastric tube. Due to the limited number of EA events in some subgroup analyses, the number of predictors included in multivariable models was restricted to reduce the risk of model overfitting.

ment used, highlighting the potential impact of methodological differences on reported findings. However, given the observational design and relatively limited sample size, these findings should be interpreted with caution. Further larger multicentre studies are needed to better clarify these associations and their potential clinical implications.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ETHICS STATEMENT

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Cantonal Hospital Zenica and Cantonal Hospital "Dr. Safet Mujic", Mostar (Centre 1: No. 00-03-18-8/25; Centre 2: No. 00-12-1/25, approval date: January 30, 2025). Written informed consent was obtained from all participants prior to inclusion in the study.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request and with permission of the institution.

AUTHOR CONTRIBUTIONS (CRediT)

Conceptualization: M.K.; **Data curation:** M.K., A.H., A.J.; **Formal analysis:** M.K., I.K. H.; **Investigation:** M.K., A.H., A.J.; **Methodology:** M.K., A.H.; **Supervision:** S.S., F.K.; **Validation:** I.K. H.; **Writing – original draft:** M.K.; **Writing – review & editing:** M.K., A.H., A.J., I.K. H., S.S., F.K. All authors have read and agreed to the published version of the manuscript.

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