



Original Article

Incidence and Risk Factors for Postoperative Delirium in Elderly for Abdominal Surgeries Under General Anaesthesia

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ABSTRACT

Background: Postoperative delirium (POD) remains a critical concern for healthcare professionals, influenced by multiple factors; can occur within 5 days after surgery and is influenced by preoperative status of patient, different type, site and emergency nature of surgeries and type of anaesthesia administered. It significantly influences the prognosis and outcome after any surgery. By identifying modifiable risk factors, targeted prevention strategies can be developed to reduce its occurrence. Therefore, this study aims to investigate the incidence and risk factors of postoperative delirium (POD) in elderly patients undergoing abdominal surgeries under general anaesthesia to address a critical gap in existing research. **Methodology:** In this prospective observational study, after written informed consent, 147 elderly patients fulfilling inclusion and exclusion criteria undergoing abdominal surgeries under general anaesthesia were enrolled. Surgery was conducted as per established hospital protocol and relevant preoperative, intraoperative and postoperative data was collected. Confusion Assessment Method Score was used to evaluate Postoperative delirium. **Results:** The postoperative delirium was present in 28.57% patients (95% CI=21.80 to 36.46). Male gender was major factor for incidence of postoperative delirium; other factors included were 7uimHb level, longer surgery duration, inhalational agent used (isoflurane, sevoflurane, desflurane), greater intraoperative blood loss (mean 600 ml), hemodynamic instability ($p<0.001$), those who required RBC or plasma transfusion, those admitted to ICU (71.43%), post operative infection (82.3%), inadequate sleep and requirement of more post operative analgesia. **Conclusion:** Postoperative delirium remains a significant problem, in elderly undergoing major abdominal surgery. The most consistent variables correlated with delirium included lower haemoglobin levels, longer surgeries, haemodynamic instability, blood transfusions, inadequate sleep, and postoperative infections. In logistic regression, patients who did not receive RBC transfusion were less likely to develop POD.

Keywords: Postoperative delirium, Incidence, Elderly, Abdominal surgery, General anaesthesia.

INTRODUCTION

Postoperative delirium (POD) is influenced by factors such as age, frailty, preexisting conditions, the severity of illness, the type of surgery, and can occur within 5 days after surgery [1,2]. It has been seen that acute surgical procedures have even higher incidence (upto 55%) of POD, when compared with elective surgeries[3]. Advancing age, frailty[4], baseline cognitive status, chronic pain, comorbid medical conditions (cerebrovascular including stroke, cardiovascular, peripheral vascular diseases, diabetes, anemia, and sleep apnea), comorbid psychiatric disorder (Parkinson's disease, depression,

anxiety disorders, and alcohol use disorder) can predispose towards developing POD[5,6]. American Society of Anesthesiologists(ASA) score of ≥ 3 and preoperative fluid fasting and hydration status also predisposes POD[6]. Site of surgery, whether it is abdominal or cardiothoracic has been implicated as one of the significant intraoperative risk factor[6]. Appropriate pain management and adequate use of sedatives/analgesics are considered modifiable factors for perioperative delirium[7].

The neurobiology involved in the development of delirium is multifactorial. One such factor is inflammation mediated neuronal injury. Surgical procedures trigger inflammatory mediators (CRP, IL-6,8) and cortisol,[8,9] which activates microglial cells, leading to increased production of pro-inflammatory cytokines, cognitive disturbances, and neuronal apoptosis[8,10]. Neurotransmitter imbalances, especially reduced acetylcholine and elevated dopamine, serotonin, and norepinephrine levels, contribute to delirium[8,11,12].

POD significantly increases the risk of long-term mortality particularly in the elderly[13,14,15]. It is also linked to longer hospitalizations, increased mechanical ventilation time, and longer ICU stays, increased care costs, higher readmission rates, prolonged cognitive impairment, and increased mortality.

The existing research regarding the incidence, duration, and risk factors associated with postoperative delirium in India remains insufficient. By identifying modifiable risk factors, such as preoperative comorbidities, anaesthetic choices, and postoperative complications, we can develop targeted prevention strategies to reduce its occurrence. Therefore, this study aims to investigate the incidence and risk factors of postoperative delirium in elderly patients undergoing abdominal surgeries under general anaesthesia to address a critical gap in existing research.

MATERIALS AND METHODS

This prospective observational study, was conducted in the Department of Anaesthesiology and Critical Care in a tertiary hospital of India over a period of 18 months. This study was approved from Institutional ethical committee with reference number: IRBGMC/ANESTH 181, dated: July 20, 2023.

Inclusion criteria

1. Elderly participants, aged ≥ 65 years
2. Following Abdominal surgeries under General Anaesthesia
3. Written informed consent by guardian or immediate family member

Exclusion criteria

1. Pre-operative history of Schizophrenia, Epilepsy, Parkinsonism, Dementia, Delirium, Brain Injury or Neurosurgery
2. Communication and Hearing Impairment
3. Hepatic Insufficiency or serious Renal Insufficiency (undergoing dialysis before Surgery)
4. Pre-operative Cognitive Impairment

SAMPLE SIZE CALCULATION

Considering an expected incidence of postoperative delirium of 25% [16,17], absolute error of 7.5%, the minimum sample size required for the study at 95% confidence interval level

$$= \frac{4 \times 25 \times (100-25)}{(7.5)^2}$$
$$= 133.3$$

We included 147 cases in our study over a period of 18 months according to inclusion criteria.

METHODOLOGY

In this prospective observational study, 147 elderly patients fulfilling inclusion and exclusion criteria and had undergone abdominal surgeries under general anaesthesia were enrolled. Surgical procedures and post operative treatment protocols were based on clinical guidelines for Surgery. Guardians or immediate family member providing consent, were informed about the study's purpose, procedures, and potential risks, and written informed consent was obtained. They were also given the option to withdraw their consent and leave the study at any time without any impact on patient's ongoing treatment.

After collecting pre-operative data, operation theater was prepared, as per standard guidelines. Patient was received in operation theater and standard monitoring was obtained through multi-channel monitor. General Anesthesia was used in accordance to the standard protocols. Intra-operative data was collected during this period.

Postoperative delirium was evaluated twice daily for the first three post-operative days using Confusion Assessment Method (CAM) Score, and post-operative data variables were collected.

Data Collection

Socio-demographic details and Pre-Operative data: Ambulatory status, Co-morbidities – Hypertension, Diabetes, Thyroid status, Cardiovascular disorder, Cerebrovascular disorder, Pulmonary, Substance use (Alcohol or Nicotine), Medication history, Past surgical history, Laboratory Examinations, Duration of hospitalization to surgery; **Intra-Operative Variable:** Indication of surgery, Type of surgery, Inhalation used, Duration of surgery, Blood loss during surgery, Hemodynamics Status, Red Blood Cell transfusion usage, Plasma transfusion usage, Analgesic used; **Post-Operative:** Sleep status, Infection (if any), ICU admission (if any), Confusion Assessment Method

Measurement

Confusion Assessment Method (CAM) [18]:

CAM is an assessment tool for diagnosing delirium; It assess on nine headings of acute onset, inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbances, psychomotor agitation or retardation, and altered sleep-wake cycle. To establish a diagnosis of delirium, feature 1 and 2 should be present, and either of 3 or 4.

STATISTICAL ANALYSIS

Continuous variables were summarized as mean, standard deviation (SD), median and interquartile range (IQR). Categorical variables were summarized as frequency and percentages. The relationship of delirium with categorical variables was analyzed using chi-square test. Fischer's exact test was used when Cochran's criteria were not met. The relationship of delirium with continuous variable was analyzed using unpaired t-test. Variables found to be significant on univariate analysis were used to fit a multivariate logistic regression model. P-value <0.05 was considered statistically significant.

RESULTS

A total of 147 patients underwent this study after meeting inclusion and exclusion criteria. We had the maximum participation from the 65-69 year age group (51.02%) followed by 70-74 year age group (21.77%); Majority of our participants were Male (54.4%) (Table 1). Maximum patients (98.6%) were ambulatory (Table 1). Among comorbidity, majority (50.3%) patients were hypertensive followed by Diabetes mellitus (12.2%), hypothyroidism (14.3%), Cerebrovascular disorders (3.4%), and pulmonary disorders (12.9%) (Fig.1). Among Laboratory parameters, the mean±SD of haemoglobin was 11.41±1.85 g/dl, serum urea was 31.56±7.50 mg/dl, serum creatinine was 0.87±0.21 mg/dl, serum albumin was 3.29±0.62 g/dl, and platelet count was 157.62±62.73 ($\times 10^3/\text{mm}^3$) (Table 1).

Age group (in years)	Frequency	Percentage (%)
65-69	75	51.02
70-74	32	21.77
75-79	23	15.65
80-84	15	10.20
85-89	1	0.68
90-94	1	0.68
Gender	Frequency	Percentage (%)
Male	80	54.4
Female	67	45.6
Ambulatory Status	Frequency	Percentage (%)
Ambulatory	145	98.6
With support	2	1.4
Laboratory Parameters	Mean	SD
Hemoglobin	11.41	1.85
Urea	31.56	7.50
Creatinine	0.87	0.21
Albumin	3.29	0.62
Platelet	157.62	62.73

INTRAOPERATIVE DETAILS:	
Fasting hours, Mean (SD)	13.86 (1.55)
Duration of surgery, in minutes, Mean (SD)	191.44 (92.64)
Type of Inhalational agent used, N (%)	
• Isoflurane	114 (77.6%)

• Desflurane	13 (8.8%)
• Sevoflurane	20 (13.6%)
Blood loss, ml, <i>Mean (SD)</i>	350.95 (288.94)
Haemodynamics, <i>N (%)</i>	
• Stable	131 (89.1%)
• Unstable	16 (10.9%)
RBC Transfusion, <i>N (%)</i>	15 (10.2%)
Plasma Transfusion, <i>N (%)</i>	6 (4.1%)
POSTOPERATIVE DETAILS	
ICU admission, <i>N (%)</i>	
Yes	7 (4.8%)
No	140 (95.2%)
Postoperative Infection, <i>N (%)</i>	
Present	17 (11.6%)
Absent	130 (88.4%)
Analgesic used, <i>N (%)</i>	
Paracetamol	98 (66.7%)
Paracetamol and Diclofenac	4 (2.7%)
Paracetamol and Epidural	44 (29.9%)
Paracetamol and Epidural and Diclofenac	1 (0.7%)
Sleep, <i>N (%)</i>	
Adequate	124 (84.4%)
Inadequate	(15.6%)

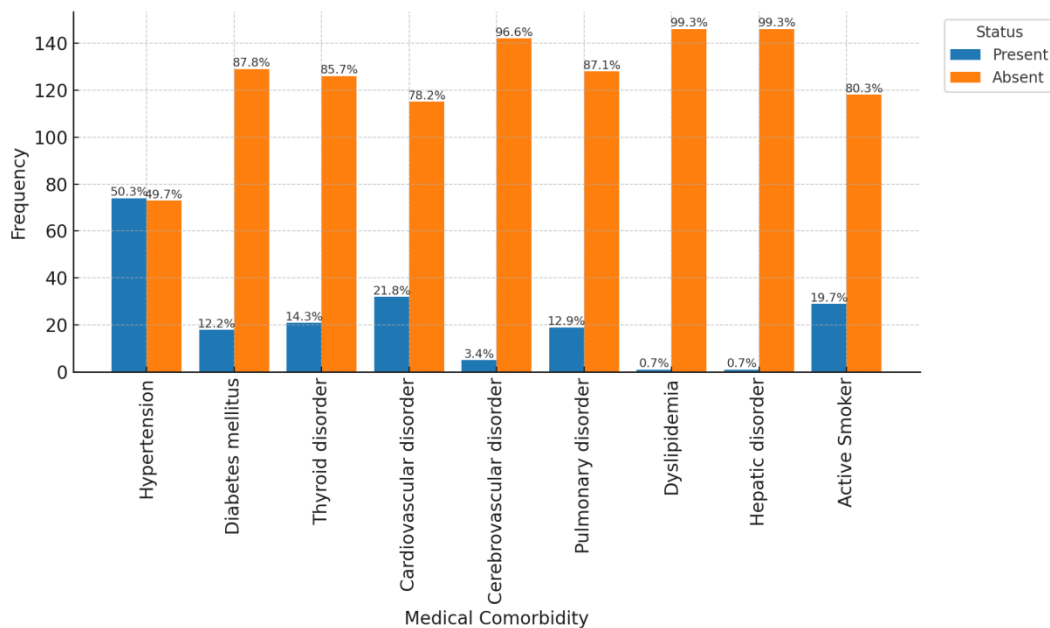


Figure 1: BAR GRAPH SHOWING MEDICAL COMORBIDITIES OF PARTICIPANTS

Variables	POD		P Value
	Present	Absent	
Age, <i>Mean (SD)</i>	70.74 (6.47)	69.88 (5.35)	0.45
Gender			
Male, <i>N (%)</i>	33 (41.25)	47 (58.75)	<0.001
Female, <i>N (%)</i>	9 (13.43)	58 (86.57)	
Ambulatory			
Yes, <i>N (%)</i>	42 (28.97)	103 (71.03)	>0.999
No, <i>N (%)</i>	0 (0.00)	2 (100.00)	
Hypertension			
Present, <i>N (%)</i>	20 (27.03)	54 (72.97)	0.71

Absent, <i>N (%)</i>	22 (30.14)	51 (69.86)	
Diabetics			
Present, <i>N (%)</i>	6 (33.33)	12 (66.67)	0.59
Absent, <i>N (%)</i>	36 (27.91)	93 (72.09)	
Thyroid status			
Hypothyroid, <i>N (%)</i>	3 (14.29)	18 (85.71)	0.19
Euthyroid, <i>N (%)</i>	39 (30.95)	87 (69.05)	
Cardiovascular disorder			
Present, <i>N (%)</i>	10 (31.25)	22 (68.75)	0.82
Absent, <i>N (%)</i>	32 (27.83)	83 (72.17)	
Cerebrovascular disorder			
Present, <i>N (%)</i>	2 (40.00)	3 (60.00)	0.62
Absent, <i>N (%)</i>	40 (28.17)	102 (71.83)	
Pulmonary disorder			
Present, <i>N (%)</i>	9 (47.37)	10 (52.63)	0.06
Absent, <i>N (%)</i>	33 (25.78)	95 (74.22)	
Dyslipidemia			
Present, <i>N (%)</i>	0 (0.00)	1 (100.00)	>0.999
Absent, <i>N (%)</i>	42 (28.77)	104 (71.23)	
Hepatic disorder			
Absent, <i>N (%)</i>	42 (28.77)	104 (71.23)	>0.999
Hepatitis C, <i>N (%)</i>	0 (0.00)	1 (100.00)	
Smoker			
Present, <i>N (%)</i>	15 (51.72)	14 (48.28)	>0.999
Absent, <i>N (%)</i>	27 (22.88)	91 (77.12)	

The most common indication for surgery was Gall Stone Disease (53.06%) followed by Gastric Carcinoma (17.01%). Other indications included Pancreatic Head Mass (1.36%), Periampullary Carcinoma, Rectosigmoid Growth and Ascending Colon Carcinoma (2.04% each). Hydatid Liver, Gall Bladder Mass, Hepatic Flexure Growth and Gastric Outlet Obstruction (1.36% each). The most common surgical procedure performed included Laparoscopic Cholecystectomy (53.74%) followed by Gastrectomy (11.56%), Staging Laparoscopy (4.08%), Whipple's Procedure and Diagnostic Laparoscopy (3.40% each), Low Anterior Resection, Exploratory Laparotomy and Hemicolectomy (2.72% each). Less frequently performed surgeries included Subtotal Colectomy, Exploratory Laparotomy with Gastrectomy, and Hydatid Cystectomy (1.36% each).

The postoperative delirium was present in 28.57% patients (95% CI=21.80 to 36.46) (Fig. 2). The association of POD with demographic and clinical variables showed that male gender was major factors for incidence of postoperative delirium (Table 3); other factors included were Hemoglobin level, longer surgery duration, inhalational agent used (isoflurane, sevoflurane, desflurane), greater intraoperative blood loss (mean 600 ml), hemodynamic instability ($p < 0.001$), those who required RBC or plasma transfusion, those required postoperative ICU (71.43%), post operative infections (82.3%), inadequate sleep and requirement of more post operative analgesia (Table 4).

Table 4: Univariate analysis of association of POD with laboratory and operative variables

Variables	POD		p-value
	Present	Absent	
Haemoglobin, <i>Mean (SD)</i>	10.76 (1.87)	11.67 (1.78)	0.006
Urea, <i>Mean (SD)</i>	32.47 (6.65)	31.20 (7.81)	0.35
Creatinine, <i>Mean (SD)</i>	0.88 (0.16)	0.86 (0.23)	0.66
Albumin, <i>Mean (SD)</i>	3.19 (0.63)	3.33 (0.61)	0.21
Platelet, <i>Mean (SD)</i>	161.19 (74.01)	156.20 (57.94)	0.66
Fasting hours, <i>Mean (SD)</i>	14.09 (1.73)	13.77 (1.47)	0.25
Surgery duration (min.) , <i>Mean (SD)</i>	268.64 (93.00)	160.57 (72.60)	<0.001
Inhalational agent			
Isoflurane, <i>N (%)</i>	29 (25.44)	85 (74.56)	0.01
Desflurane, <i>N (%)</i>	2 (15.38)	11 (84.62)	
Sevoflurane, <i>N (%)</i>	11 (55.00)	9 (45.00)	
Intraoperative blood loss (ML), <i>Mean (SD)</i>	600.23 (272.88)	251.23 (229.58)	<0.001
Haemodynamic status			
Stable, <i>N (%)</i>	31 (23.66)	100 (76.34)	<0.001

Unstable, <i>N (%)</i>	11 (68.75)	5 (31.25)	
RBC Transfusion			
Yes, <i>N (%)</i>	13 (86.67)	2 (13.33)	<0.001
No, <i>N (%)</i>	29 (21.97)	103 (78.03)	
Plasma transfusion			
Yes, <i>N (%)</i>	6 (100.00)	0 (0.00)	<0.001
No, <i>N (%)</i>	36 (25.53)	105 (74.47)	
ICU admission			
Yes, <i>N (%)</i>	5 (71.43)	2 (28.57)	0.02
No, <i>N (%)</i>	37 (26.43)	103 (73.57)	
Sleep			
Inadequate, <i>N (%)</i>	14 (60.87)	9 (39.13)	0.001
Adequate, <i>N (%)</i>	28 (22.58)	96 (77.42)	
Infection			
Present, <i>N (%)</i>	14 (82.35)	3 (17.65)	<0.001
Absent, <i>N (%)</i>	28 (21.54)	102 (78.46)	
Analgesics			
Paracetamol, <i>N (%)</i>	12 (12.24)	86 (87.76)	<0.001
Paracetamol and Diclofenac, <i>N (%)</i>	2 (50.00)	2 (50.00)	
Paracetamol and Epidural, <i>N (%)</i>	27 (61.36)	17 (38.64)	
Paracetamol, Epidural, and Diclofenac, <i>N (%)</i>	1 (100.00)	0 (0.00)	

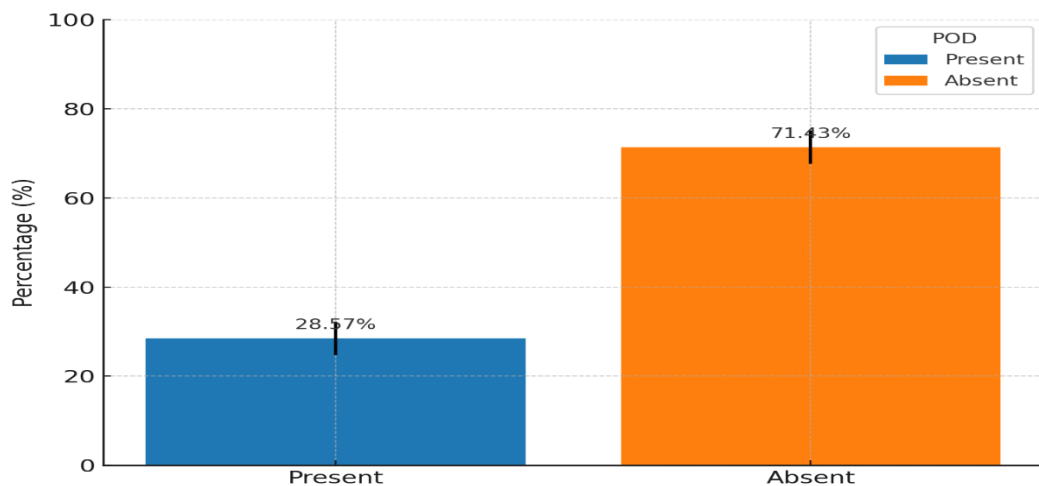


Figure 2. Incidence of POD in our study

POD	Odds ratio	Std. error	95% confidence interval		p-value
			Lower limit	Upper limit	
Age	1.03	0.04	0.94	1.13	0.42
Gender, <i>Female</i>	0.44	0.28	0.12	1.53	0.20
Pulmonary disorder, <i>absent</i>	0.31	0.23	0.07	1.36	0.12
Active Smoker, <i>No</i>	0.34	0.22	0.09	1.21	0.09
Haemoglobin	0.97	0.15	0.71	1.34	0.89
Duration of surgery (min.)	1.00	0.005	0.99	1.01	0.15
Inhalational anesthetics					
Desflurane	0.15	0.19	0.01	1.91	0.14
Sevoflurane	1.44	1.08	0.33	6.26	0.62
Blood loss (mL)	1.00	0.002	0.99	1.00	0.60
Haemodynamic, <i>unstable</i>	1.26	1.27	0.17	9.17	0.81

RBC transfusion, <i>Absent</i>	0.11	0.12	0.01	0.98	0.04
ICU admission, <i>No</i>	0.15	0.17	0.01	1.39	0.09
Sleep, <i>Adequate</i>	0.32	0.23	0.08	1.31	0.11
Infection, <i>Absent</i>	0.29	0.25	0.05	1.59	0.15
Constant	11.72	51.51	0.002	64461.63	0.57

DISCUSSION

POD is a common yet underrecognized form of disorder which occurs following surgery, especially in elderly. In our study we found 28.57% incidence of POD, with certain perioperative variables which included male gender, lower haemoglobin levels, prolonged surgery duration, higher blood loss, haemodynamic instability, blood transfusions, postoperative infection, inadequate sleep, and increased requirement of analgesia have association with the development of POD. Previous studies by Saravana-Bawan et al[19] reported a 22.7% incidence of POD, Ansaloni et al[5] reported 13.2% incidence, Almashari et al[20] reported 10.18% in abdominal surgeries, and Janssen et al[21] reported 10% after major abdominal surgeries, which was lesser than our finding Whereas, another study by Fenta et al[22] reported 41% incidence of POD after surgery, which was much higher than our incidence. This can also be attributed to the acute condition of delirium in which the symptoms fluctuate, and with the presence of hypoactive features, the assessment can produce variable results.

Our significant finding of higher incidence in Male patients aligns with previous study by Almashari et al[20]. The predominance of male gender can be linked to heightened acute stress response in males, compared to females. This could be responsible for increased rates of POD in males. Across other variables, age, hypertension, diabetes, thyroid status, cardiovascular disorder, cerebrovascular disorder, pulmonary disorder, dyslipidemia, hepatic disorder and smoking, we could not obtain statistically significant association with POD and future studies are required to explore these association in detail.

We found a significant association between haemoglobin levels and POD. The association of lower haemoglobin level and POD can be linked to reduced oxygen perfusion to cerebral tissues. Our study also found surgery duration as an important factor. Patients who developed delirium had significantly longer surgeries. It may be attributed to dysfunction of cholinergic and serotonergic pathways due to stress caused by prolonged surgery duration, as elderly has decreased physiological regulation[23].

We observed a significant association between inhalational anesthetic and POD. Studies have found inhalational anesthetics such as isoflurane, sevoflurane, and desflurane can activate microglia in the CNS, which will release pro-inflammatory cytokines and produce reactive oxygen species, contributing to neuronal inflammation and disruption of neuronal and cognitive function[24,25]. Greater intraoperative blood loss (mean=600.23 mL) and haemodynamic instability (p-value=<0.001) were both strongly linked with POD. This can be attributed to cerebral hypoperfusion resulting from increased intraoperative blood loss, which may lead to postoperative delirium (POD)[22].

Patients who required RBC transfusions or plasma transfusions had POD rate of 86.67% and 100%, respectively. Another study by Janssen et al[21] has found blood transfusion as significant risk factor for POD. A hypothesis has been suggested that blood product transfusions triggers already existing systemic inflammation, predisposing them towards delirium. Restrictive and careful transfusion practices have been advocated to reduce complications[26,27].

A significantly higher number of patients who were admitted to the ICU developed POD (71.43%). Inadequate sleep was another significant risk factor (p-value=0.001). Disturbed sleep architecture which could be also due to ICU admission, is recognized as a potential risk factor for delirium, likely by impairing cognitive function, enhancing neuroinflammatory processes, and altering circadian regulation of the hypothalamic-pituitary-adrenal axis[28,29].

In our study, 82.35% patients with post-operative infection, developed POD. Infection can trigger a systemic inflammatory response, crossing the blood-brain barrier and altering neurotransmission in susceptible individuals, especially elderly. Heightened inflammation, cytokine release, impaired brain oxygenation and metabolic derangements can induce or exacerbate delirium[30]. Our study also found a significant association between the requirement of postoperative analgesic and POD. Multiple studies have been conducted in the past, finding a lower incidence of delirium with the use of paracetamol as an analgesic, which aligns with our findings[31,32]. Additionally, the route and type of analgesia may vary according to surgery and these findings should be interpreted with adequate judgement. Rest variables like urea, creatinine, albumin, platelet and fasting duration were insignificant on univariate analysis.

In Multivariate Logistic regression analysis, only the absence of RBC transfusion significantly lowered the risk of delirium (OR=0.11, p-value=0.04). This suggests that patients who did not require transfusions were at far lower risk than those

who did. Adequate sleep (OR=0.32, p-value=0.11) and the absence of infection (OR=0.29, p-value=0.15) indicated towards reduced risk of delirium but weren't statistically significant.

CONCLUSION

Postoperative delirium remains a significant problem, in elderly undergoing major abdominal surgery. Although many variables were correlated with delirium in univariate analyses, the most consistent findings were lower haemoglobin levels, longer surgeries, haemodynamic instability, blood transfusions, inadequate sleep, and postoperative infections. In logistic regression, only the absence of RBC transfusion was significant, i.e. patients who did not receive RBC transfusion were less likely to develop POD.

RECOMMENDATIONS:

- Modifiable factors such as preoperative anemia management, minimizing intraoperative blood loss, and preventing haemodynamic swings should be addressed to mitigate risk of POD.
- Limiting transfusions through judicious strategies may be especially important.
- Postoperatively, ensuring adequate pain relief without excessive sedation, promoting good sleep, and immediately treating infections could further reduce POD incidence.
- The ICU environment needs special attention with protocols that encourage early mobilization and minimize overnight disturbances to reduce delirium.

LIMITATIONS

Firstly, it was conducted in a single institution, limiting the generalizability of its findings to other populations and healthcare settings. While the overall sample size was adequate for many analyses, the distribution within smaller subgroups—such as patients with specific comorbidities or those undergoing particular procedures was limited. As an observational study, it demonstrates associations but cannot establish causation. Furthermore, the inclusion of a variety of abdominal surgeries may have introduced variability in anaesthetic methods, surgery durations, and postoperative care, potentially influencing the outcomes related to postoperative delirium. Lastly, the accuracy of delirium diagnosis depends heavily on the consistency and timing of assessments; intermittent evaluations or assessor bias could be present.

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