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ORIGINAL RESEARCH

Incidence of Complications in High-Risk Patients Undergoing Combined Esophagogastroduodenoscopy and Colonoscopy with Total Intravenous Anesthesia: A Prospective Cohort Study

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Objective: To evaluate the incidence, characteristics, and risk factors of complications related to anesthesia complication in ASA Class III patients undergoing combined esophagogastroduodenoscopy (EGD) and colonoscopy under total intravenous anesthesia (TIVA).

Materials and Methods: This prospective cohort study was conducted from April 1, 2024, to February 11, 2025. Data collected included baseline characteristics (age, sex, comorbidities, functional capacity, nutritional status, smoking, fasting and medications) and intraoperative/postoperative parameters (anesthetic technique, sedative dosing, IV fluids, complications, and 24-hour status). Descriptive statistics, univariate analysis, and binary logistic regression were applied.

Results: Of 403 ASA Class III patients enrolled, 393 were analyzed after excluding 10 for inadequate bowel prep or early termination due to malignancy. A total of 207 patients (52.7%) experienced at least one complication. Common complications included transient hypotension (40.2%), desaturation (15.8%), and airway obstruction (15.5%). Less frequent events were bradycardia (4.1%), hypoxia (1.8%), hypertension (1.8%), tachycardia (0.3%) and respiratory depression (0.5%). Five independent risk factors were significantly associated with complications: preexisting cardiovascular disease - odds ratio (OR=1.678), respiratory disease (OR=1.877), functional capacity < 4 metabolic equivalents (METs), (OR=1.851), nutritional screening score ≥1 (OR =1.518), and single - dose bowel prep regimen (OR=1.614). Complications were more common in women, patients aged 65 years or older, and inpatients, although the difference in hospitalization and outpatient was not statistically significant. Patients with complications received lower total doses of propofol and fentanyl per weight per hour. Dexmedetomidine use was significantly associated with complications among inpatients ($p = 0.015$). The duration of the procedure was longer in patients with complications ($p = 0.002$).

Conclusion: Anesthesia-related complications were frequent among ASA Class III patients who underwent combined EGD and colonoscopy under TIVA, particularly cardiovascular and respiratory events. Identification of five preprocedural risk factors supports the need for improved risk stratification and individualized sedation planning to optimize safety in this high-risk group.

Plain Language Summary:

What is already known on this topic?

High-risk patients, particularly those classified as ASA Class III, are more vulnerable to anesthesia-related complications during endoscopic procedures. While total intravenous anesthesia (TIVA) with propofol is commonly used for esophagogastroduodenoscopy (EGD) and colonoscopy, its cardiopulmonary effects—such as hypotension and respiratory depression—are more pronounced in

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patients with pre-existing comorbidities. However, there is limited evidence detailing specific preprocedural predictors of complications in this population, especially during combined EGD and colonoscopy.

What this study adds:

This study identifies five independent, clinically accessible preprocedural predictors of sedation-related complications in ASA Class III patients undergoing combined EGD and colonoscopy under TIVA: cardiovascular disease, respiratory disease, functional capacity <4 METs, a nutritional risk score ≥1, and single-dose bowel preparation. These findings provide a practical framework for preprocedural risk stratification and personalized sedation planning. Additionally, the study highlights the importance of adjunct medication use and procedural duration in influencing complication rates, while demonstrating that patient satisfaction remains high despite the presence of transient adverse events.

Keywords: anesthesia complications, high-risk patients, procedural sedation, total intravenous anesthesia

Introduction

Anesthesia for upper gastrointestinal endoscopy (EGD) and colonoscopy is administered following the American Society of Anesthesiologists (ASA) classification system, which categorizes patients by their physical condition and disease severity to guide anesthetic techniques, monitoring, and drug management:[1]

ASA Class I: Healthy patients

ASA Class II: Patients with well-controlled comorbidities (eg, diabetes, hypertension, obesity [BMI < 30 kg/m²], or pregnancy)

ASA Class III: Patients with severe systemic disease affecting daily life (eg, chronic kidney disease requiring dialysis, morbid obesity [BMI ≥ 40 kg/m²], uncontrolled diabetes or hypertension, COPD or alcohol-related liver disease). This group includes patients with previous myocardial infarction (MI), angina, stroke, heart failure (more than three months before surgery), substance abuse, pacemakers, or advanced age (≥ 85 years).

ASA Class IV: Patients with life-threatening conditions (eg, respiratory failure needing ventilation) or severe limitations in activity, with a high risk of anesthesia-related complications.

ASA Class V: Patients expected to die within 24 hours, with or without surgery.

ASA Class VI: Brain-dead patients undergoing surgery for organ donation.

Among these categories, ASA Class III patients present unique challenges for anesthesia providers due to their significant comorbidities.[2] For example, chronic kidney disease impairs drug excretion, increasing the risks of dehydration, fluid overload, hemodynamic instability, and aspiration. These factors may cause complications such as MI, stroke, or metabolic acidosis, leading to delayed recovery. Although dialysis or kidney transplantation improves symptoms, anesthesia for these patients requires cautious planning.[3]

Cardiac conditions, including coronary artery disease, arrhythmias, and cardiomyopathies, worsen anesthesia management. Impaired cardiac function can reduce oxygen delivery and cause fluid retention, increasing the risk of hypertension, hypotension, and metabolic disturbances. Severe cases may develop pulmonary hypertension or hypoxemia, leading to respiratory distress and cyanosis.[4] Careful anesthetic management remains essential, even when surgery aims to improve these conditions.[5]

Intravenous sedation is often preferred for these procedures due to its ability to reduce anxiety, maintain patient comfort, and induce sleep. However, patients with respiratory disorders are more vulnerable to aspiration or complications from a full stomach, requiring careful sedation management. Factors that influence the choice of sedation include patient age, comorbidities, and the presence of respiratory, cardiac, renal, or hepatic dysfunction, as well as conditions such as pregnancy, substance abuse, and obstructive sleep apnea.[6–8]

The benefits of intravenous sedation include rapid recovery, enhanced service efficiency, and cost savings. Many studies recommend moderate to deep sedation, with propofol being a commonly used agent due to its rapid onset, short duration, and minimal accumulation, ensuring quick recovery. Opioids like fentanyl, with fast onset and short half-life, are also frequently used. Additional medications, such as midazolam or dexmedetomidine, may be tailored to individual patient needs.[7–10] However, propofol has been associated with risks such as hypotension, which requires close monitoring, as highlighted in a study by Robert Sneyd et al.[11]

At our university hospital in Thailand, we care for approximately 10,000 patients annually, with 90% receiving anesthesia. Among these, 8200 (91.11%) undergo intravenous sedation, and 800 (8.89%) receive general anesthesia. From 2019 to 2022, upper gastrointestinal endoscopy and colonoscopy cases involved 800–1000 ASA Class I patients annually, 1800–3800 ASA Class II patients, and 600–1200 ASA Class III patients per year.

This study aims to investigate the incidence of complications among high-risk ASA Class III patients undergoing combined EGD and colonoscopy with intravenous sedation.

Primary Objective

To study the incidence of complications in high-risk ASA Class III patients undergoing EGD and colonoscopy with intravenous sedation, both as inpatients and outpatients (one-day surgery).

Secondary Objectives

To examine the relationship between factors such as gender, age, nutritional status, smoking, and Forced Expiratory Tests (FETs) with the occurrence of complications from intravenous sedation during and after the procedures.

To assess patients' satisfaction scores regarding the care provided during intravenous sedation

Materials and Methods

This prospective observational study adhered to the ethical principles outlined in the Declaration of Helsinki and was approved by the Siriraj Institutional Review Board (SIRB) (COA: Si264/2024). Written informed consent was obtained from all participants. The study was conducted at the Siriraj GI Endoscopic Center, Faculty of Medicine Siriraj Hospital, Mahidol University, from April 2024 to February 2025.

Inclusion Criteria

Upper Gastrointestinal Endoscopy Candidates:

- Undergoing upper gastrointestinal endoscopy.
- Intravenous anesthesia restricted to business hours.
- Classified as ASA Class III.
- Includes both inpatients and one-day surgery outpatients.
- No gender restrictions.
- Elective procedures only.

Age:

- Participants aged 18 years and older.

ASA Class III Criteria:

- Stable respiratory and circulatory systems, excluding critical conditions.

Non-Emergency Procedures:

- Patients undergoing non-emergency endoscopy.

Exclusion Criteria

Critical Condition or Sepsis

- Patients in critical condition —for example, those with hemodynamic instability, requiring vasopressors or mechanical ventilation, or presenting with sepsis.

Communication Issues

- Patients with communication difficulties.

Substance Abuse History

- History of substance misuse or inappropriate drug use.

Pregnancy

- Pregnant patients.

Emergency Endoscopy

- Emergency gastrointestinal endoscopy patients.

Participation Refusal

- Patients unwilling to participate.

Withdrawal or Termination Criteria

Patient Request

- The patient requests withdrawal from the study.

Change in Anesthesia Method

- Anesthesia method altered during the procedure.

Endoscopic Procedures

Endoscopy involves flexible scopes to examine the gastrointestinal tract. EGD inspects the esophagus, stomach, and upper small intestine via a flexible tube inserted through the mouth. Colonoscopy uses a similar tube inserted through the rectum to examine the colon for abnormalities.

Both procedures require fasting and, in the case of colonoscopy, bowel cleansing with laxatives. Although the procedures are brief, preparation, —particularly fasting and bowel preparation, can affect circulation during sedation.

- Dehydration Risk.[12]
- Fasting Impact.[13]
- ASA Classification and Risk: Previous study showed a correlation between higher ASA classifications and increased complication rates during endoscopy.[14] Additionally, ASA III patients developed more sedation-related complications than ASA I–II patients.[15]

These insights emphasize the need for thorough preoperative evaluation and careful sedation management to mitigate complications.

Study Protocol

On the procedure day, the research team met participants at the Gastrointestinal Endoscopy Center, explained the study purpose, answered questions, and obtained written consent. For outpatients, consent would be obtain on the examination day, prior to the procedure, with time for discussion with relatives.

Eligible participants had their data recorded in a Research Data Collection Form, which includes:

- Personal and medical history
- Nutritional Screening Tool: The nutritional screening will utilize the tool recommended by the Society of Parenteral and Enteral Nutrition of Thailand (SPENT),[16] which is recognized for its accuracy, sensitivity, and specificity in identifying malnutrition.

The SPENT screening tool comprises four key questions:
Has there been any weight loss in the past 6 months?

Has there been a decrease in food intake for more than 7 days?
Is the BMI <18.5 kg/m² or ≥25 kg/m²?
Is the patient critically ill?

- Procedure indications and duration
- Anesthesia details
- Complications and interventions

Patients were continuously monitored during the procedure using noninvasive blood pressure, heart rate, SpO2, EKG, and the Observer's Assessment of Alertness/Sedation (OAAS) Scale.[17] Adjustments in anesthesia were made to maintain heart rate (HR) and mean blood pressure (MBP) within ±20% of baseline. Anesthesia drug amounts were recorded but not predetermined.

After the procedure, vital signs were monitored every 5–15 minutes until the patient was transferred. Patient satisfaction with anesthesia care was assessed using a numeric rating scale (NRS), and a follow-up visit within 24 hours checks for complications.

Complication Definitions[18]

- Hypotension: ≤ 20% decrease from baseline blood pressure.
- Hypertensive Crisis: Blood pressure ≥180/100 mmHg.
- Bradycardia: HR <50 bpm.
- Tachycardia: HR >100 bpm or >150 bpm (eg, PSVT, VT, AF).
- Laryngospasm: Breathing obstruction, low oxygen, potential cardiac arrest.
- Airway Obstruction: Partial (noisy inhalation) or complete (no breath movement).
- Hypoxia: SaO2 <90% or PaO2 <55 mmHg.
- Apnea: No breathing or chest movement.
- Respiratory Depression: <10 breaths/min.
- Aspiration: Inhalation of food or liquids causing airway obstruction.
- Desaturation: Blood oxygen saturation <95%.
- Sudden Cardiac Arrest: Abrupt cessation of heart function.
- Procedure-Related Complications: Includes bleeding and intestinal perforation.
- Emergence Delirium: Postoperative confusion and agitation.
- Delayed Emergence: Unresponsive to stimulation >30 minutes after anesthesia.

Sample Size Calculation

Based on prior studies in Thailand, 674 out of 1779 patients (37.9%) undergoing endoscopy experienced complications.[19] Using the nQuery Advisor software via confidence interval for proportion using normal approximation (n large). The sample size is 362 cases, a two-sided 95% confidence interval will extend 0.05 from the observed proportion for an expected proportion of 0.379. With a 10% allowance for incompleteness of the data, the total sample size needed was 403 patients.

Given an estimated annual cohort of 400–600 ASA Class III patients, a one-year data collection period was planned to ensure sufficient sample size and robust analysis.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). A p-value <0.05 was considered statistically significant.

Patient demographic, risk factor, complication and outcome were summarized using mean ± standard deviation (SD) or median with interquartile range (IQR: 25th–75th percentile) for continuous data, and frequency with percentage for categorical data. 95% confidence interval for complications was shown.

Group comparisons were performed using the independent Student's *t*-test, Mann–Whitney *U*-test, the chi-square test, or Fisher's exact test, as appropriate.

Binary logistic regression was performed to identify potential risk factors for overall intra-operation complications using estimate crude and adjusted odds ratio (OR) with 95% confidence intervals (CIs). All factors with a p-value < 0.20 in the univariable analysis were entered into multivariable analysis via a multiple logistic regression model using the backward selection method (probability of removal 0.05).

All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). A p-value <0.05 was considered statistically significant

Data Analysis Plan

General Information Analysis

- Age, BMI, ASA classification, medical history, anesthesia duration.
- Fluid volume, anesthesia medications, and intraoperative complications.

Breathing Parameters

- Comparison of breathing rate and oxygen saturation.

Data Presentation

- Quantitative data: Mean ± SD.
- Qualitative data: Numbers and percentages.

Complication Reporting

- Complications reported with percentages and 95% confidence intervals.

Comparative Analysis

- Baseline characteristics compared with t-tests or Chi-square tests.

Risk Analysis

- Crude Relative Risk/Odds Ratio: Calculated using log-binomial regression or logistic regression for binary outcomes.
- Adjusted Relative Risk/Odds Ratio: Controlled for confounders using multiple logistic regression.

Results

The study's overall process and methodology are illustrated in Figure 1. A total of 403 high-risk ASA Class III patients were initially enrolled in the study. Ten patients were excluded due to poor bowel preparation (n = 5) or early termination of colonoscopy following malignancy detection during EGD (n = 5). Therefore, 393 patients were included in the final analysis.

Among these, 207 patients (52.7%) experienced at least one complication. The most common complications were: Transient hypotension: 158 cases (40.2%), Desaturation: 62 cases (15.8%), and Airway obstruction: 61 cases (15.5%).

Less frequent complications included: Bradycardia: 16 cases (4.1%), Tachycardia: 1 case (0.3%), Hypoxia (SpO_2 < 90%): 7 cases (1.8%), Hypertension: 7 cases (1.8%), and Respiratory depression: 2 cases (0.5%) (Table 1).

There was no statistically significant difference in the overall incidence of complications between inpatients (IPD) and outpatients (OPD), although a higher proportion of complications was observed in the IPD group.

Complications were more prevalent among: Females, Patients aged ≥65 years, having cardiovascular, respiratory, or hepatic comorbidities, Those undergoing procedures for gastrointestinal bleeding, Patients with functional capacity < 4 Metabolic Equivalent of Task (METs), Mallampati class III airway, Nutrition screening score ≥ 1, Single-dose bowel preparation regimen, and Initial oxygen saturation (SpO_2) of 98.38 ± 1.55%.

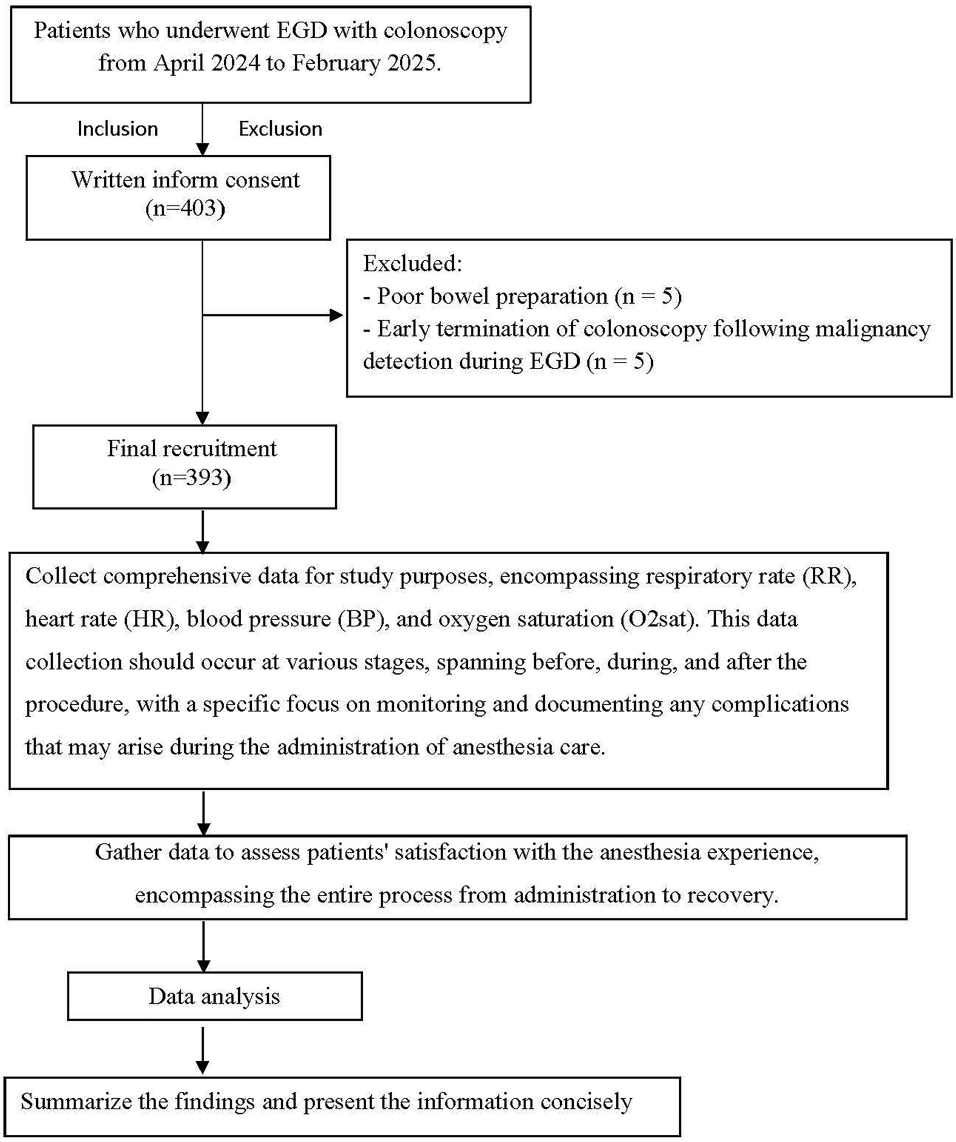

Figure 1 Flowchart depicting participant enrollment, allocation, and analysis in the study.

These factors were found to have p-values approaching 0.20 in univariate analysis. In contrast, smoking status, alcohol use, fasting duration, type of laxative, anesthetic induction technique, and fluid administration showed p-values > 0.20 and were not significantly associated with complications (Table 2).

Five independent risk factors were identified as significantly associated with complications: Preexisting cardiovascular disease: OR = 1.678, p = 0.014, Preexisting respiratory disease: OR = 1.877, p = 0.048, Functional capacity < 4 METs: OR = 1.851, p = 0.016, Nutrition screening score ≥ 1: OR = 1.518, p = 0.050, and Single-dose bowel preparation regimen: OR = 1.614, p = 0.027 (Table 3).

There was no significant difference in the initial propofol bolus dose during induction between the complication and non-complication groups. However, the total propofol dose per body weight per hour was significantly lower in the complication group. Furthermore, IPD patients received significantly lower total propofol doses than OPD patients (p < 0.001).

Fentanyl was the most frequently used opioid. Although the initial induction dose was not significantly different, the total dose of fentanyl per body weight per hour was significantly lower in the complication group (p = 0.002) and in the IPD group compared to the OPD group (p < 0.001).

The use of dexmedetomidine was significantly associated with complications in IPD patients (p = 0.015).

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Table 1 Intraoperative and Postoperative Complications: Detailed Incidence and Types

Adverse Events	Total (n=393)	95% CI	OPD (n=295) (75.1%)	IPD (n=98) (24.9%)	P-value
Intra Op					
Overall	207 (52.7%)	47.7, 57.6	155 (52.5%)	52 (53.1%)	0.929
Hypotension	158 (40.2%)	35.5, 45.1	117 (39.7%)	41 (41.8%)	0.704
Hypertension	7 (1.8%)	0.1, 3.6	6 (2.0%)	1 (1.0%)	0.686
Airway obstruction	61 (15.5%)	12.3, 19.4	47 (15.9%)	14 (14.3%)	0.697
Desaturation	62 (15.8%)	12.5, 19.7	48 (16.3%)	14 (14.3%)	0.640
Hypoxia (SpO_2<90%)	7 (1.8%)	0.1, 3.6	4 (1.4%)	3 (3.1%)	0.373
Arrhythmia	17 (4.3%)	2.7, 6.8	13 (4.4%)	4 (4.1%)	0.293
• Bradycardia	16 (4.1%)	2.5, 6.5	13 (4.4%)	3 (3.1%)	
• Tachycardia	1 (0.3%)	0.0, 1.4	0 (0.0%)	1 (1.0%)	
Respiratory depression	2 (0.5%)	0.0, 1.8	0 (0%)	2 (2%)	0.062
Intra Op					
Overall	8 (2.0%)	1.0, 4.0	4 (1.4%)	4 (4.1%)	0.111
Abdominal pain	1 (0.2%)	0.0, 1.4	1 (0.3%)	0 (0%)	
Hypertension	7 (1.8%)	1.0, 3.6	3 (1.0%)	4 (4.1%)	

Note: p <0.05 indicates statistical significance.
Abbreviations: CI, confidence interval; SpO2, Oxygen saturation.

Table 2 Demographic Characteristics and Univariable Analysis of Preoperative Risk Factors

Variable	Over All Intra-Operation Complication (n=207)	No Complication (n=186)	P-value	Crude OR (95% CI)	P-Value
Type of patient: IPD	52 (25.1%)	46 (24.7%)	0.929	1.02 (0.65, 1.61)	0.929
Gender: female	105 (50.7%)	99 (53.2%)	0.620	0.90 (0.61, 1.34)	0.620
Age ≥ 65 years.	157 (75.8%)	123 (66.1%)	0.034	1.61 (1.04, 2.50)	0.034
Body mass index	24.0±4.9	23.4±4.1	0.157	1.03 (0.99, 1.08)	0.161
Underlying disease					
Hypertension	171 (82.6%)	143 (76.9%)	0.157	1.43 (0.87, 2.34)	0.158
Diabetes mellitus	73 (35.3%)	72 (38.7%)	0.480	0.86 (0.57, 1.30)	0.480
Renal disease	72 (34.8%)	68 (36.6%)	0.713	0.93 (0.61, 1.40)	0.714
Cardiovascular disease	125 (60.4%)	86 (46.2%)	0.005	1.77 (1.19, 2.65)	0.005
Respiratory disease	35 (16.9%)	18 (9.7%)	0.036	1.90 (1.04, 3.48)	0.038
Liver disease	20 (9.7%)	30 (16.1%)	0.055	0.57 (0.30, 1.02)	0.057
Brain disease	60 (29.0%)	53 (28.5%)	0.915	1.02 (0.66, 1.59)	0.915
Dyslipidemia	126 (60.9%)	106 (57.0%)	0.435	1.74 (0.78, 1.76)	0.435
Indication			0.056		
Abdominal pain	8 (3.9%)	9 (4.8%)		0.91 (0.33, 2.50)	0.860
Gastrointestinal hemorrhage	15 (7.2%)	6 (3.2%)		2.57 (0.94, 6.98)	0.065
Bowel habit change	18 (8.7%)	17 (9.1%)		1.09 (0.52, 2.27)	0.823
Anemia	64 (30.9%)	55 (29.6%)		1.20 (0.74, 1.94)	0.469
Colon polyp	16 (7.7%)	8 (4.3%)		2.05 (0.83, 5.09)	0.120
Chronic diarrhea	4 (1.9%)	2 (1.1%)		2.05 (0.37, 11.56)	0.414
Gastrointestinal symptoms	9 (4.3%)	14 (7.5%)		0.66 (0.27, 1.62)	0.365
Check up	74 (35.2%)	74 (40.4%)		Ref	

(*Continued*)

Table 2 (Continued).

Variable	Over All Intra-Operation Complication (n=207)	No Complication (n=186)	P-value	Crude OR (95% CI)	P-Value
Functional capacity					
FC < 4 METs	61 (29.5%)	34 (18.3%)	0.10	1.87 (1.16, 3.01)	0.010
Mallampati			0.110		
Grade 1	35 (48.6%)	37 (51.4%)		Ref	
Grade 2	149 (72.0%)	139 (74.7%)		1.13 (0.68, 1.90)	0.635
Grade 3	23 (11.1%)	10 (5.4%)		2.43 (1.01, 5.83)	0.046
History of smoking					
Smoking	10 (4.8%)	6 (3.2%)	0.421	0.66 (0.23, 1.84)	0.424
History of drinking					
Drinking	12 (5.8%)	6 (3.2%)	0.223	0.54 (0.20, 1.47)	0.230
NPO time (hours)	5 (3, 9)	6 (3, 9)	0.459	1.02 (0.97, 1.08)	0.485
Nutrition screen ≥ 1 score	119 (56.7%)	79 (43.2%)	0.008	1.69 (1.13,2.51)	0.010
Bowel preparation solution			0.212		
Colyte	171 (82.6%)	162 (87.1%)		Ref	
Niflex	33 (15.9%)	24 (12.9%)		1.30 (0.74, 2.30)	0.362
Picosulfate	3 (1.4%)	0 (0%)		NA	NA
Preparation regimen					
Single dose regimen	95 (45.9%)	70 (37.6%)	0.098	1.41 (0.94, 2.10)	0.098
Vital sign (Baseline)					
SBP (mmHg)	135.08 ± 16.29	134.08 ±16.56	0.544	1.00 (0.98, 1.02)	0.543
DBP (mmHg)	71.73 ± 11.49	71.99 ± 11.35	0.818	1.00 (0.98, 1.02)	0.818
HR (time/min)	75.89 ± 13.43	75.98 ± 13.75	0.862	1.00 (0.99, 1.01)	0.951
RR (breath/min)	19.88 ± 0.58	19.90 ± 0.76	0.456	0.96 (0.71, 1.29)	0.777
O2sat (%)	98.38 ± 1.55	98.67 ± 1.42	0.070	0.88 (0.77, 1.01)	0.059
Anesthesia technique					
Topical with TIVA	57 (27.5%)	37 (19.9%)	0.76	1.53 (0.95, 2.45)	0.077
Pre-op of Crystalloid					
Amount of Crystalloid received before procedure (mL)	100 (100, 200)	135 (100, 200)	0.548	1.00 (1.00, 1.00)	0.628

Note: p <0.05 indicates statistical significance.
Abbreviations: OR, odds ratio; CI, confidence interval; FC, Functional capacity; METs, Metabolic Equivalent of Task; NPO, nothing by mouth; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; HR, Heart rate; RR, Respiratory rate; TIVA, Total intravenous anesthesia; mL, milliliter.

Dormicum and ketamine were used in a smaller proportion of patients and did not show statistically significant associations with complications.

The complication group had significantly longer procedure durations compared to the non-complication group (p = 0.002). However, no significant differences in procedure duration were observed between IPD patients and OPD patients (p = 0.594) (Table 4).

Discussion

This prospective observational study evaluated the incidence and predictors of complications in high-risk patients (ASA Class III) undergoing combined esophagogastroduodenoscopy (EGD) and colonoscopy under total intravenous

Table 3 Univariate and Multivariate Analyses of Risk Factors Associated with Overall Intra-Operation Complications

Variable	Crude OR (95% CI)	P-Value	Adjusted OR (95% CI)	P-Value
Underlying disease				
Cardiovascular disease	1.77 (1.19, 2.65)	0.005	1.68 (1.11, 2.53)	0.014
Respiratory disease	1.90 (1.04, 3.48)	0.038	1.88 (1.01, 3.50)	0.048
Functional capacity				
FC < 4 METs	1.87 (1.16, 3.01)	0.010	1.86 (1.12, 3.05)	0.016
Nutrition screen ≥ 1 score	1.69 (1.13,2.51)	0.010	1.52 (1.00, 2.30)	0.050
Preparation regimen				
Single dose regimen	1.41 (0.94, 2.10)	0.098	1.61 (1.06, 2.47)	0.027

Note: p <0.05 indicates statistical significance.
Abbreviations: OR, odds ratio; CI, confidence interval; FC, Functional capacity.

Table 4 Intravenous Anesthetic Details and Outcome

Sedative Agents	Overall Complication (n=207)	No Complication (n=186)	p-value	OPD (n=295)	IPD (n=98)	P-value
Propofol induction (mg/kg)	0.94 (0.76, 1.13)	0.94 (0.77, 1.18)	0.458	0.98 (0.83, 1.19)	0.79 (0.58, 0.94)	<0.001
Propofol total (mg)	240 (170, 330)	250 (187.5, 320)	0.818	250 (200, 350)	200 (150, 285)	<0.001
Propofol total (mg/kg/hr)	5.23 (4.23, 6.51)	6.09 (4.91, 7.66)	<0.001	5.75 (4.75, 7.50)	5.11 (3.54, 6.43)	<0.001
Fentanyl induction (mcg/kg)	0.79 (0.63, 0.93)	0.79 (0.66, 0.92)	0.610	0.82 (0.67, 0.93)	0.72 (0.53, 0.85)	<0.001
Fentanyl total (mcg/kg/hr)	0.85 (0.59, 1.18)	0.99 (0.70, 1.29)	0.002	0.93 (0.69, 1.25)	0.83 (0.51, 1.16)	0.005
Midazolam			1.0			0.167
• Yes	3 (1.4%)	3 (1.6%)		3 (1.0%)	3 (3.1%)	
• No	204 (98.6%)	183 (98.4%)				
Dexmeditomidine			1.0			0.015
• Yes	2 (1%)	1 (0.5%)		0 (0%)	3 (3.1%)	
• No	205 (99%)	185 (99.5%)				
Ketamine			0.473			0.249
• Yes	0 (0.0%)	1 (0.5%)		0 (0%)	1 (1.0%)	
• No	207 (100.0%)	185 (99.5%)				
Operation Time (minutes)	45 (34, 63)	40 (30, 51.25)	0.002	40 (30, 56)	44 (30, 56.5)	0.594
Patient satisfaction	10 (10, 10)	10 (10, 10)	0.350	10 (10, 10)	10 (10, 10)	0.099

Note: p <0.05 indicates statistical significance.

anesthesia (TIVA). Our findings revealed a complication rate of 52.7%, predominantly comprising transient hypotension (40.2%), desaturation (15.8%), and airway obstruction (15.5%). Importantly, five preprocedure factors—cardiovascular disease, respiratory disease, functional capacity <4 METs, nutritional screening ≥1 score, and single -dose bowel preparation, —were identified as independent predictors of complications.

Clinical Implications of Observed Complications

The overall complication rate aligns with prior studies involving high-risk or elderly populations undergoing sedation for endoscopic procedures, reaffirming the vulnerability of these patients to anesthesia-related adverse events (Finkelmeier et al, 2015; Eldawlatly et al, 2023).[20,21] Propofol, the primary agent used in TIVA, is known for dose-dependent suppression of airway reflexes, hypoventilation, and hypotension (Sahinovic et al, 2018).[22] These physiological effects are exacerbated in patients with impaired cardiopulmonary reserve, which explains the high rates of hemodynamic and respiratory instability observed.

While most adverse events were transient and manageable, their occurrence underscores the necessity for vigilant intra-procedural monitoring and proactive airway management. Moreover, propofol's cardiovascular effects vary across individuals. Zhang et al (2024) highlighted its dual potential to induce hypotension or, conversely, offer cardioprotective effects via neurohumoral modulation and ischemia-reperfusion attenuation. This variability may explain the heterogeneity of outcomes among patients with cardiovascular comorbidities.[23]

Upper airway obstruction, observed in 15.5% of patients, reflects propofol's suppressive effect on pharyngeal muscle tone (Simons et al, 2016).[24] Anatomical predispositions, such as narrow airways or undiagnosed obstructive sleep apnea (OSA), likely contribute to this risk. Adjunctive strategies—such as patient positioning and capnography—may mitigate this risk. For example, left lateral positioning during colonoscopy has been associated with lower desaturation rates, although its use may increase hypotension and require patient repositioning (Klare et al, 2015).[25]

Notably, the integration of capnography monitoring can facilitate early detection of apnea and reduce the incidence of hypoxemia, particularly in patients receiving deep sedation (Friedrich-Rust et al, 2013).[26] In high-risk cohorts such as ours, its use may be considered standard practice to improve procedural safety.

Significance of Identified Risk Predictors

This study's most significant contribution lies in identifying five practical, preprocedural predictors of sedation-related complications. Cardiopulmonary comorbidities,—long recognized for their influence on perioperative risk,—were strongly associated with adverse outcomes, reinforcing the importance of medical optimization before sedation.

Additionally, a functional capacity below 4 METs and a nutritional risk score ≥1 were both independently associated with increased complication rates. These parameters, though often overlooked, offer simple, low-cost tools for risk stratification. Incorporating them into routine assessment could improve individualized sedation planning and resource allocation.

The association between single-dose bowel preparation and higher complication rates is particularly noteworthy. Previous literature suggests that single-dose regimens may increase intravascular volume depletion and electrolyte imbalance (Holte et al, 2004; Hooper et al, 2014),[12,27] especially in frail or elderly patients. In our cohort, inadequate fluid compensation may have predisposed patients to hypotension and desaturation. This is consistent with findings by Sriramat et al (2017),[13] who reported a high incidence of hypotension in patients despite fluid preloading. These findings warrant a re-evaluation of bowel preparation protocols, including timing, fluid replacement strategies, and patient education.

Non-Significant and Unexpected Findings

Several traditionally recognized perioperative risk factors—such as smoking status, alcohol use, fasting duration, and laxative type—were not significantly associated with complication rates in this study. This may reflect the influence of standardized perioperative protocols that effectively mitigate these risks or may be attributable to the specific characteristics and homogeneity of the high-risk cohort studied. Interestingly, although the initial dose of propofol induction did not differ significantly between the groups, patients who experienced complications had a lower total exposure to propofol per kilogram per hour, potentially due to earlier onset of adverse events that curtailed further administration.

An additional unexpected finding was the significantly lower usage of both propofol and fentanyl in inpatients (IPD group) compared to outpatients (OPD group), despite the former experiencing higher complication rates. This discrepancy may reflect increased clinical caution when sedating inpatients with more severe comorbidities, or a differing pharmacodynamic response in this subgroup. Further pharmacological studies are warranted to explore these trends.

Role of Additional Medications and Duration of the Procedure

Among the adjunct medications, dexmedetomidine use was significantly associated with complications in the IPD group, possibly due to its synergistic hypotensive and bradycardia effects when used in vulnerable patients.[28] Conversely, midazolam and ketamine showed no significant association with adverse events, although their limited use in this study population limits the strength of conclusions. Additionally, longer procedural durations correlated with increased complication rates, consistent with literature suggesting prolonged sedation increases the cumulative anesthetic burden and procedural fatigue.[29,30] However, this association was consistent in both inpatient and outpatient settings, suggesting that it may be an independent contributor to adverse outcomes.

Patient Satisfaction and Sedation Outcomes

Despite the relatively high incidence of transient complications, patient satisfaction remained uniformly high across all groups. This suggests that the subjective experience of sedation—including comfort, pain control, and recovery—was not adversely affected. These findings highlight the importance of comprehensive preprocedural communication, attentive intraoperative care, and structured postprocedural recovery protocols to maintain patient-centered outcomes, even in high-risk populations.

Recommendations for Practice

- In light of our findings, we recommend the following clinical considerations to enhance the safety and quality of sedation practices in high-risk patients undergoing combined endoscopic procedures:
- Implement comprehensive preprocedural screening protocols that include assessment of cardiopulmonary comorbidities, functional status (<4 METs), and nutritional risk.
- Incorporate capnography as a standard monitoring tool in high-risk populations to allow for early detection of apnea and respiratory compromise.
- Re-evaluate bowel preparation regimens, with preference for split-dose protocols and structured fluid replacement strategies to minimize hypovolemia and electrolyte imbalance.
- Develop individualized sedation plans for patients with cardiovascular or respiratory disease, considering dose adjustments, multimodal anesthesia techniques, or alternative agents with more favorable safety profiles.

Limitations

Several limitations should be acknowledged. First, this was a single-center study, which may limit the generalizability of the findings. Second, while the study included a well-defined high-risk population, the absence of a control group (eg, patients undergoing either EGD or colonoscopy alone) restricts comparisons regarding the added risks of combined procedures. Third, despite the prospective design, the observational nature of the study precludes establishing causal relationships between identified risk factors and complications. Fourth, the study did not evaluate the long-term outcomes or delayed complications, which may be clinically relevant in this population. Finally, while standardized anesthesia protocols were applied, variability in individual anesthetic management and procedural complexity may have influenced complication rates.

Conclusions

This prospective observational study highlights a substantial incidence of anesthesia-related complications in high-risk ASA Class III patients undergoing combined esophagogastroduodenoscopy and colonoscopy under total intravenous anesthesia (TIVA). Transient hypotension, desaturation, and airway obstruction were the most frequently observed events, emphasizing the vulnerability of this population. Importantly, five preprocedural risk factors—preexisting

cardiovascular and respiratory diseases, poor functional capacity, positive nutritional risk screening, and single-dose bowel preparation—were independently associated with higher complication rates. These findings underscore the clinical value of integrating simple, evidence-based screening tools into routine preprocedural assessments to identify patients at elevated risk. Tailored anesthesia planning, vigilant intraoperative monitoring, and early intervention strategies are essential to improve patient safety and outcomes.

Data Sharing Statement

The data that support the findings of this study are not publicly available due to their containing information that could compromise the privacy of research participants but are available from the correspondence upon reasonable request.

Ethics Approval and Informed Consent

This study was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University (COA: Si264/2024) on March 28, 2024.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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