Cardiopulmonary Complications During and After Endoscopy in Elderly Patients:a Prospective Study

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ABSTRACT

Background: *The high incidence of gastrointestinal and pancreaticobiliary diseases among elderly has led to increased endoscopic procedures in this population. Previous studies indicate a higher risk of cardiopulmonary complications during and after endoscopy in elderly patients compared to younger individuals. This study investigated the incidence and contributing factors of endoscopy-related cardiopulmonary complications in elderly patients.*

Methods: *A prospective cohort study was conducted on 194 patients aged ≥ 60 years undergoing endoscopy at the Gastrointestinal Endoscopy Center, Cipto Mangunkusumo National General Hospital, Jakarta, Indonesia, from August to October 2023. Consecutive sampling method was used. Multivariate analysis with logistic regression was conducted.*

Results: *Among the 194 patients included, 49.52% experienced cardiopulmonary complications. The most common complications were tachycardia (23.20%), hypoxemia (15.03%), and hypotension (6.20%). Multivariate analysis identified the complexity of the procedure (ASGE level ≥ 3) as a significant risk factor (RR 1.505, 95% CI 1.039-2.179; p=0.03), while mild-moderate sedation was associated with a reduced risk of complications (RR 0.668, 95% CI 0.458-0.975; p=0,037)*

Conclusions: *The incidence of cardiopulmonary complications during and after endoscopy is high among Indonesian elderly. Procedure complexity is an independent risk factor, whereas mild-moderate sedation mitigates the risk. In opposite, advanced age, multimorbidities, high ASA class, long duration of procedure, poor nutritional and functional status, and type of procedure did not affect outcomes.*

Keywords: *Cardiopulmonary complications, endoscopy, elderly, sedation*

ABSTRAK

Latar belakang: *Tingginya insidensi penyakit saluran cerna, bilier, dan pankreas pada pasien usia lanjut membuat kebutuhan endoskopi tinggi. Studi-studi terdahulu menunjukkan bahwa komplikasi kardiopulmoner intra- dan pascatindakan endoskopi pada pasien usia lanjut lebih tinggi dari kelompok usia lebih muda. Studi ini mengidentifikasi insidensi dan faktor-faktor yang memengaruhi komplikasi kardiopulmoner intra- dan pascatindakan endoskopi pada pasien usia lanjut.*

Metode: *Studi kohort prospektif dilakukan terhadap 194 subjek berusia ≥60 tahun yang menjalani endoskopi di Pusat Endoskopi Saluran Cerna Rumah Sakit Umum Pusat Nasional Cipto Mangunkusumo Jakarta, Indonesia sejak Agustus-Oktober 2023. Pengambilan sampel dilakukan secara konsekutif. Selanjutnya, dilakukan analisis multivariat dengan regresi logistik.*

Hasil: *Dari 194 subjek, sebanyak 49,52% subjek mengalami komplikasi kardiopulmoner. Komplikasi tersering adalah takikardia (23,20%), hipoksemia (15,03%), dan hipotensi (6,20%). Hasil analisis multivariat menemukan bahwa tingkat kompleksitas tindakan ASGE kelas ≥3 merupakan faktor independen dengan RR 1,505 (IK 95% 1,039 – 2,179), p=0,03; sedangkan sedasi ringan-sedang memiliki RR 0,668 (IK 95% 0,458 – 0,975), p=0,037 terhadap komplikasi kardiopulmoner intra- dan pascatindakan endoskopi pada pasien usia lanjut.*

Kesimpulan: *Insidensi komplikasi kardiopulmoner intra- dan pascatindakan endoskopi pada pasien usia lanjut di Indonesia tergolong tinggi. Tingkat kompleksitas tindakan tinggi menjadi faktor independen, sedangkan sedasi ringan-sedang menurunkan risiko komplikasi kardiopulmoner intra- dan pascatindakan endoskopi. Sementara itu, usia lanjut, komorbiditas banyak, kelas ASA buruk, durasi tindakan lama, status nutrisi buruk, status fungsional buruk, dan jenis tindakan tidak berpengaruh.*

Kata kunci: *Komplikasi kardiopulmoner, endoskopi, lansia, sedasi*

INTRODUCTION

According to the Central Statistics Agency (BPS), the elderly population in Indonesia has increased significantly, from 8.37% to 10.48% in 2023.[1] This demographic shift has been accompanied by a rise in gastrointestinal and pancreaticobiliary diseases, many of which require endoscopic evaluation and treatment.[2] However, older people are particularly vulnerable to endoscopy-related complications due to diminished physiological reserves and the presence of multiple comorbidities.[3-4]

Cardiopulmonary complications are among the most common and severe adverse events associated with endoscopy in the elderly, accounting for a substantial portion of procedure-related morbidity and mortality.[5] These complications, which include tachycardia, hypoxemia, and hypotension, typically occur during or immediately after the endoscopic procedure.[6] The elderly population is particularly susceptible to these complications due to several factors: a decline in functional capacity, the presence of multiple comorbidities, and an increased likelihood of higher American Society of Anesthesiologists (ASA) class ratings (≥III), which are associated with higher risk of procedural complications.[7-8] Additionally, the prolonged duration of endoscopic procedures in older people, coupled with the use of sedation, can exacerbate the risk of cardiopulmonary events. The pharmacokinetics of sedative agents, particularly fat-soluble drugs, are altered in older people, leading to prolonged drug effects and increased vulnerability to complications such as respiratory depression and hypotension.[8] Nutritional deficiencies and impaired functional status, which are more common in older adults, further compound the risk by compromising the body's ability to respond to the stress of the procedures.[9]

Despite the recognition of these risk factors, the incidence and specific predictors of cardiopulmonary complications during endoscopy in the elderly population remain under-researched. This study aims to fill that gap by examining the incidence of these complications and identifying the factors contributing to their occurrence in elderly patients undergoing endoscopy.

METHODS

Study Design and Population

This single-center prospective cohort study was conducted at the Gastrointestinal Endoscopy Center, Cipto Mangunkusumo National General Hospital, Jakarta, Indonesia, from August to October 2023. Consecutive sampling method was used. Inclusion criteria were patients undergoing endoscopy aged ≥ 60 years. Patients who underwent other procedures along with endoscopy that could result in cardiopulmonary complications, experienced acute cardiopulmonary conditions, hemodynamic instability, or significant ECG changes before endoscope insertion, refused to participate, and were uncooperative were excluded. Patients with failed endoscopy met the drop-out criteria. Written informed consent was obtained from each patient. Privacy and confidentiality were ensured.

Endoscopic Procedures

Endoscopic procedures consisted of esophagogastroduodenography (EGD), colonoscopy, enteroscopy, endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound (EUS), and peroral endoscopic myotomy (POEM) with or without intervention (biopsy, polypectomy, etc.), both elective and emergency. Several procedures were classified as procedures for one patient at the same time. Patients undergoing multiple procedures at different times were recorded as separate procedures. A standard endoscope diameter was used. Endoscopy operators were consultants and trainees. All subjects were given prophylactic oxygen supplementation during procedures with nasal cannulas.

TYPE OF SEDATION

Endoscopy with or without sedation was included. The group without sedation was given 10% lidocaine spray as pharyngeal anesthesia. Based on its depth, sedation is categorized as mild sedation, moderate sedation, deep sedation, and general anesthesia. Each person responds to sedation differently. Therefore, the depth of sedation required varies for each person undergoing the same procedure, and even for the same person during different phases of the same procedure. Choices of intravenous sedative agents varied, depending on ASA class and patient response.

Ethical Statements

This research has received approval from the Medical Research Ethics Committee at the Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo National General Hospital, Jakarta, Indonesia (registration number KET-898/UN2.F1/ETIK/PPM.00.02/2023.

Data Collection and Risk Factors

Baseline characteristics, including demographics, comorbidities, and medications, were obtained through direct interviews and medical records. Comorbidity indices were assessed using the Cumulative Illness Rating Scale Geriatric (CIRS-G), ASA classification, nutritional status via the Mini Nutritional Assessment (MNA), and functional status using the Barthel Index. The complexity was categorized according to the American Society of Gastroenterology (ASGE) guidelines. Endoscopy-related data included the type and complexity of the procedure, duration, and type of sedation.

Outcomes

Operators and nurses continuously monitored blood pressure, heart rate, oxygen saturation, and ECG recordings, which were recorded every five minutes until the procedure was completed. Each study subject was followed from the time of endoscope insertion, either through the mouth or anus, depending on the type of endoscopy performed, until 30 minutes after the endoscope was withdrawn in the recovery room. A repeat 12-lead ECG recording was performed only if significant changes were observed on the ECG monitor or if the patients exhibited clinical symptoms such as palpitations, shortness of breath, chest pain, or sudden loss of consciousness.

The clinical outcomes assessed included: 1) hypoxemia, defined as a blood oxygen saturation level ≤94% for ≥10 seconds or a decrease > 4% from baseline; 2) myocardial ischemia, indicated by ST segment depression or elevation of ≥0.1 mV 60 ms from the J point for ≥1 minute; 3) hypotension, defined as systolic blood pressure <90 mmHg or mean arterial pressure (MAP) < 55 mmHg, or decrease of 20% from baseline requiring intravenous fluids of vasopressors; 4) bradycardia, defined as a heart rate <60 beats per minute for ≥1 minute or decrease of 20% from baseline requiring chronotropic agents; 5) tachycardia, defined as a heart rate > 100 beats per minute for ≥1 minute or a decrease of 20% from baseline; and 6) cardiac arrest, defined as the cessation of cardiac function characterized by asystole ventricular fibrillation, or pulseless electrical activity on the ECG requiring cardiopulmonary resuscitation, regardless of the duration.

Bias

This study addressed potential biases, including selection, allocation measurement, and maintenance biases. Selection bias was minimized by employing a consecutive sampling method. Allocation bias was reduced by grouping patients with or without risk factors for cardiopulmonary complications based on objective criteria, such as laboratory data. Using standardized, objective hemodynamic parameters, the measurement bias was controlled by defining cardiopulmonary complications. Maintenance bias was managed by excluding data from patients who dropped out of the study from the final analysis.

Study size

This study's sample size was determined based on the incidence formula (n) and the proportion difference (m) needed to identify the influence of risk factors on endoscopic cardiopulmonary complications. The biggest sample size to answer both study questions was then determined. To ensure sufficient power, we added 10% to the calculated sample size, resulting in 194 subjects in the analysis.

$$n = \frac{Z^2\alpha \,.\, P \,.\, (1-P)}{\delta^2}$$

$$m = \frac{m'}{4}\left[1+\sqrt{\left\{1+\frac{2(r+1)}{rm'\delta}\right\}}\right]^2$$

$$m' = \frac{[z_\alpha\sqrt{\{(r+1)\bar{P}\bar{Q}\}}+z_\beta\sqrt{(rP_1Q_1+P_2Q_2)}]^2}{r\delta^2}$$

Statistical analysis

Data were analyzed using STATA version 14.2. Logistic regression assessed the relationship between risk factors and cardiopulmonary complications. Variables with a p-value of less than 0.25 in the univariate analysis were included in the multivariate analysis. The results were expressed as relative risks (RR) with 95% confidence intervals (CI). A p-value of less than 0.05 was considered statistically significant.

RESULTS

Characteristics of Subjects and Endoscopic Procedures

During the period from August to October 2023, a total of 221 patients undergoing endoscopy were initially part of the study. However, 26 patients were excluded for various reasons, including refusal to participate (n=15), uncooperativeness (n=6), undergoing additional procedures along with endoscopy (n=3), unstable hemodynamics pre-procedure (n=1), and significant ECG changes pre-procedure (n=1). Additionally, one subject dropped out due to inadequate bowel preparation. As a result, the final number of subjects included in the data analysis was 194. The characteristics of the subjects and endoscopies can be found in **Table 1** and **Table 2**.

Table 1. Characteristics of research subjects

Variable	N = 194
Age, median (IQR), year	65 (60 - 84)
Age classification	
<70, n (%)	150 (77.32)
≥70, n (%)	44 (22.68)
Sex	
Male, n (%)	103 (53.09)
Female, n (%)	91 (46.91)
Type of comorbidity	
Hypertension, n (%)	75 (38.66)
Malignancy, n (%)	51 (26.29)
Diabetes, n (%)	49 (25.56)
Chronic kidney disease, n (%)	30 (15.46)
Pulmonary disease, n (%)	15 (7.73)
Coronary artery disease, n (%)	11 (5.67)
All-cause heart failure, n (%)	6 (3.09)
Cerebrovascular disease, n (%)	5 (2.58)
Routine medication	
Calcium channel blocker, n (%)	39 (20.10)
Beta-blocker, n (%)	30 (15.46)
Non-insulin antidiabetes, n (%)	23 (11.90)
Insulin, n (%)	8 (4.10)
Total CIRS-G score, mean (SD)	13.27 (4.39)
CIRS-G classification	
No comorbidities	0 (0.00)
≥1 1st degree CIRS-G comorbidity 1, n (%)	169 (87.11)
≥1 2nd degree CIRS-G comorbidity, n (%)	190 (97.94)
≥1 3rd degree CIRS-G comorbidity, n (%)	126 (64.95)
≥1 4th degree CIRS-G comorbidity, n (%)	84 (43.30)
ASA class	
ASA I, n (%)	
ASA II, n (%)	
ASA III, n (%)	
ASA IV, n (%)	
ASA V, n (%)	
MNA score, median (IQR)	
Nutritional status classification	
Well-nourished, n (%)	
At risk, n (%)	
Malnourished, n (%)	
ADL score, median (IQR)	
Functional status classification	
Independent, n (%)	
Slight dependency, n (%)	
Moderate dependency, n (%)	
Severe dependency, n (%)	
Total dependency, n (%)	

a) ADL, activities of daily living; b) ASA, American Society of Anesthesiologists; c) CIRS-G, cumulative illness rating scale-geriatric; d) MNA, mini nutritional assessment.

Table 2. Characteristics of endoscopic procedures

Variable	N= 194
Type of procedure	
Colonoscopy, n (%)	79 (40.72)
EGD, n (%)	78 (40.21)
ERCP, n (%)	42 (21.65)
EUS, n (%)	20 (10.31)
POEM, n (%)	3 (1.55)
Enteroscopy, n (%)	2 (1.03)
Indication for endoscopy	
Malignancy, n (%)	58 (29.90)
Gastrointestinal bleeding, n (%)	27 (13.92)
Dyspepsia, n (%)	21 (10.82)
Changes in excretion, n (%)	17 (8.76)
Complexity of procedure (ASGE)	
Level 1, n (%)	104 (53.61)
Level 2, n (%)	77 (39.69)
Level 3, n (%)	10 (5.15)
Level 4, n (%)	3 (1.55)
Type of sedation	
Without sedation, n (%)	36 (18.56)
Mild sedation, n (%)	0 (0.00)
Moderate sedation, n (%)	80 (41.24)
Deep sedation, n (%)	75 (38.66)
General anesthesia, n (%)	3 (1.55)
Sedative agent	
Fentanyl, n (%)	158 (81.44)
Midazolam, n (%)	96 (49.48)
Lidocaine, n (%)	79 (40.72)
Ketamine, n (%)	61 (31.44)
Propofol, n (%)	22 (11.34)
Duration of procedure (median), minute	30 (15 - 60)
< 30, n (%)	82 (42.27)
≥ 30, n (%)	112 (57.73)

a) ASGE, American Society of Gastroenterology; b) EGD, esophagogastroduodenography; c) ERCP, endoscopic retrograde cholangiopancreatography; d) EUS, endoscopic ultrasound; e) POEM, peroral endoscopic myotomy

Incidence of Cardiopulmonary Complications

Among the 194 subjects, 96 (49.52%) experienced cardiopulmonary complications. The primary complications included tachycardia (46.86%), hypoxemia (30.21%), and hypotension (12.5%), as detailed in **Table 3**. Most cardiopulmonary complications occurred within the first 30 minutes of endoscopy (60.42%). Three patients experienced premature atrial contractions (PAC), one patient experienced bigemini premature ventricular contractions (PVC), and one patient experienced paroxysmal atrial fibrillation. The rest experienced sinus tachycardia. All tachycardia events were transient, did not require intervention, and disappeared when the endoscope was removed. All hypoxemia complications recovered with jaw thrust maneuver or increasing the dose of oxygen supplementation. Out of 12.5% of subjects who experienced hypotension, 35 (79.55%) conditions resolved with crystalloid fluid resuscitation with a volume of at least 100 ml. Meanwhile, seven (15.91%) conditions required the vasopressor ephedrine, and one (2.27%) condition resolved with phenylephrine. There was one (2.27%) case that was managed with a combination of crystalloid fluid resuscitation and ephedrine.

In addition, two subjects (2.08%) in this study experienced myocardial ischemia. They were asymptomatic and did not require intervention. Both were <70 years old, had mild dependency status, and had an ASA class <III. One subject suffered from type 2 diabetes and hypertension, while the rest had no comorbidities. Both subjects were at risk of malnutrition. One subject underwent moderate sedation for EGD and diagnostic colonoscopy (complexity level 1), whereas the other subject underwent general anesthesia for POEM (complexity level 4) both of which lasted ≥30 minutes.

Table 3. Description of cardiopulmonary complications

Variable	N= 96
Type of cardiopulmonary complication	
Tachycardia, n (%)	45 (46.86)
Hypoxemia, n (%)	29 (30.21)
Hypotension, n (%)	12 (12.5)
Myocardial ischemia, n (%)	2 (2.08)
Bradycardia, n (%)	0 (0.00)
Cardiac arrest, n (%)	0 (0.00)
Onset of cardiopulmonary complication	
First 30 minutes during endoscopy, n (%)	58 (60.42)
>30 minutes during endoscopy, n (%)	25 (26.04)
After endoscopy, n (%)	13 (13.54)

Factors Influencing Cardiopulmonary Complications

The study found that nutritional status, type of sedation, type of procedure, and level of complexity were all significantly associated with cardiopulmonary complications during and after endoscopy. The specific relationships between these variables are detailed in **Table 4**. After using a backward logistic regression method, it was determined that the complexity of the procedure with an ASGE level ≥3 was an independent factor with a Relative Risk (RR) of 1.505 (95% Confidence Interval [CI] 1.039 – 2.179). All subjects who underwent complexity level 4 procedures experienced cardiopulmonary complications, including 2 tachyarrhythmias, 1 hypoxemia, 1 hypotension, and 1 myocardial ischemia.

Table 4. Bivariate and multivariate analysis of independent variables on cardiopulmonary complications

Variable	Total (n=194)	Cardiopulmonary complications		Bivariate analysis		Multivariate analysis	
		Yes	No	RR (CI 95%)	P value	RR (CI 95%)	P value
Age ≥ 70 years	56 (28.9)	28 (50.0)	28 (50.0)	1.014 (0.742 – 1.386)	0.927		
Total CIRS-G score ≥ 14	93 (47.9)	44 (47.31)	49 (52.69)	0.918 (0.690 – 1.223)	0.562		
ASA class ≥III	42 (21.6)	20 (47.62)	22 (52.38)	0.952 (0.667 – 1.357)	0.788		
Malnutrition	50 (25.8)	29 (58.0)	21 (42.0)	1.247 (0.929-1.672)	0.141		
Severe-total dependency	13 (6.7)	5 (38.46)	8 (61.54)	0.773 (0.382 – 1.564)	0.475		
Moderate dependency	10 (5.1)	6 (60.0)	4 (40.0)	1.207 (0.711 – 2.046)	0.485		
Duration of procedure ≥ 30 minutes	112 (57.7)	58 (51.79)	54 (48.21)	1.117 (0.833 – 1.498)	0.458		
Deep sedation-general anesthesia	78 (40.2)	42 (53.85)	36 (46.15)	0.881. (0.632 – 1.227)	0.455	0,850 (0.604 – 1.197)	0.354
Mild-moderate sedation	80 (41.2)	32 (40.0)	48 (60.0)	0.654 (0.450 – 0.951)	0.026	0.668 (0.458 – 0.975)	0.037
Advanced endoscopy	56 (28.9)	32 (57.14)	24 (42.86)	1.232 (0.922 – 1.645)	0.157		
Complexity of procedure ASGE level ≥ 3	13 (6.7)	10 (76.92)	3 (23.08)	1.618 (1.158 – 2.262)	0.005	1,505 (1.039 – 2.179)	0.030

Data are presented as the number (%).

a) ASA, American Society of Anesthesiologists; b) CIRS-G, cumulative illness rating scale-geriatric; c) EGD, esophgogastroduodenography; d) ERCP, endoscopic retrograde cholangiopancreatography; e) EUS, endoscopic ultrasound; f) MNA, mini nutritional assessment; g) POEM, peroral endoscopic myotomy.

Significantly different.

In opposite, mild-moderate sedation had an RR of 0.668 (95% CI 0.458 – 0.975) for endoscopic cardiopulmonary complications. moderate sedation had an RR of 0.668 (95% CI 0.458 – 0.975) for endoscopic cardiopulmonary complications. While mild sedation is not commonly used in this study setting, as much as 61.5% of moderate sedation is used for complexity level 1 procedures. Although without statistical significance, the proportion of endoscopic cardiopulmonary complications in the deep sedation-general anesthesia group was higher than in the mild-moderate sedation group (53.85% vs 40%). Subjects with moderate sedation had better general characteristics than subjects with deep sedation, namely age <70 years (41.3% vs 36%), no comorbidities (32.4% vs 24.3%), ASA class <3 (44, 1% vs 33.6%), and no risk of malnutrition (53.6% vs 35%). The largest proportion of moderately sedated subjects were functionally independent (54.2%), while deeply sedated subjects were mildly dependent (44.4%). A total of 71.4% of deep sedation was used for complexity level 2 procedures, while three subjects under general anesthesia underwent complexity level 4 procedures. Those three subjects each experienced complications, namely: 1) myocardial ischemia and hypotension; 2) hypoxemia and tachycardia; and 3) tachycardia. Subjects undergoing unsedated endoscopy experienced higher rates of cardiopulmonary complications than deep sedation-general anesthesia and mild-moderate sedation groups (61.11% vs 53.85% vs 40%), mostly in a form of asymptomatic tachycardia.

Bivariate analysis of each main comorbidity with endoscopy-related cardiopulmonary complications also showed that hypertension (RR 1.182, 95% CI 0.891 – 1.569; p=0.245), diabetes (RR 1.218, 95% CI 0.904 – 1.641; p=0.194), pulmonary disease (RR 0.914, 95% CI 0.470 – 1.774; p=0.791), coronary artery disease (RR 0.655, 95% CI 0.315 – 1.360; p=0.257), and all-cause heart failure (RR 1.362, 95% CI 0.759 – 2.443; p=0.300) were not associated with endoscopic cardiopulmonary complications.

DISCUSSION

In this particular research study, the median age of the participants was 65 years, with a significant

majority (77.32%) being under 70. These findings are consistent with studies conducted in Asian countries, such as Japan and Korea.[10] The study also revealed that 126 subjects (64.95%) had at least one grade 3 CIRS-G comorbidity. This prevalence can be attributed to the fact that RSCM functions as a national referral center specializing in managing patients with complex multimorbidities.[11] Furthermore, most subjects were classified as ASA class II (n = 152, 78.35%). A study by Cha et al.[12] indicated that the proportion of ASA class ≥III subjects was relatively low (5% and 26.3%, respectively) in the age groups of 75 - 79 and ≥90. This suggests a stringent selection process for elderly patients undergoing endoscopy.[12] According to the Mini Nutritional Assessment (MNA), the prevalence of malnutrition in this study was determined to be 25.77%, aligning with findings from a cross-sectional study conducted by Gupta et al.[13] Additionally, the study found a prevalence of underweight subjects at 26.6%, which was commonly observed in both hospital and community settings, particularly among acute care patients resembling those in this study.[14] Differences in functional status were observed across various care settings, with moderate sedation being this study's most frequently utilized method (41.24%). Due to its high satisfaction rates among clinicians and patients, it was primarily used for essential endoscopy procedures.[14]

Among 194 subjects, 96 (49.52%) experienced cardiopulmonary complications, which is higher than the findings of previous studies. This difference could be because close monitoring of vital signs was only performed in 25.9% of gastrointestinal procedures.[15] Most complications occurred within the first 30 minutes during endoscopy (n = 58, 60.42%), mainly attributed to the initial placement of the endoscope.[17]

Tachycardia was the most common cardiopulmonary complication, occurring in 45 out of 96 patients (46.86%). During endoscopy, continuous heart rate acceleration can occur due to vagal tone, reducing parasympathetic excitability and making the myocardium easily excitable, potentially triggering arrhythmias. Tonnesen et al.[18] study involving patients undergoing endoscopy with a median age of 60 years found a positive correlation between serum cortisol levels as a marker of stress and increased heart rate ($p< 0.05$).[19-20]

The study found that 30.21% of patients experienced hypoxemia. This aligns with previous data, which suggests that the occurrence of hypoxemia ranges from 1.5% to 70%.[21] Another study observed 40% to 60% desaturation rates in sedated patients and even 40% in unsedated patients.[15] This is believed to be caused by the calming effect of propofol, which can lead to respiratory depression and inadequate ventilation. Additionally, aging of the respiratory system in older individuals is characterized by alveolar dilation, widened air spaces, reduced gas exchange area, and loss of peripheral airway support tissue.[22] Furthermore, respiratory compensation for acute conditions is weakened in older individuals.[23]

As many as 12.5% of all subjects experienced hypotension. This finding shows a relatively similar incidence compared to the study by Leslie et al.[24], which found that 11% of elective endoscopies and 17% of emergency endoscopies in patients with a median age of 60 years were complicated by significant hypotension. Additionally, the incidence of hypotension in this study was lower than that of previous studies, which ranged from 31% to 35%.[24-25] This difference might be due to variations in the population, duration of preprocedural fasting, definition and measurement of cardiopulmonary complications, and sedation techniques. Furthermore, endoscopy-related hypotension is also associated with dehydration from bowel preparation.[26]

The incidence of myocardial ischemia in this study was 2.08%. This incidence is lower than the findings of a cohort study Fisher et al.[27] in which 10% of ERCP subjects aged ≥65 years had ST segment changes on ECG. This difference may be attributed to the study by Fisher et al.[27] that used pre- and post-procedure cardio-specific troponin examinations as criteria for myocyte necrosis to overcome ECG interpretation errors.

No subjects experienced bradycardia complications, which aligns with the results of Mahawongkajit et al.[28] clinical trials involving 204 endoscopic procedures. The combined sedation strategy used in our endoscopy center may have contributed to the absence of bradycardia cases. [29] Similarly, none of the subjects experienced cardiac arrest. This contrasts with the findings of Lieber et al.[30] study, which reported a 0.38% incidence of severe endoscopy complications, with 46% of those being cardiac arrests. The high number of ASA class ≥III subjects may influence this data, precisely 81%.[30]

In this study, the complexity of the procedure, rated ASGE level ≥ three, had a significant effect on cardiopulmonary complications compared to procedures rated ASGE level <3 [RR 1.505 (95% CI 1.039 – 2.179); p=0.03]. It is believed that insufflation pressure, combined with injury to small blood vessels during complex endoscopy procedures, can cause

air to enter the bile duct and venous system, moving from the portal vein to the right ventricle via the inferior vena cava. Most endoscopy-related deaths occur due to complex therapeutic maneuvers.[16] This is an evidence of the potential fatality of endoscopy involving high-pressure air insufflation, even though they are rare.[31]

The use of mild to moderate sedation significantly decreased the risk of cardiopulmonary complications (risk ratio 0.668 [95% CI 0.458 – 0.975]; p=0.037). Lieber et al.[30] cross-sectional study of 9007 endoscopic procedures found that cardiovascular complications were more closely associated with patient unfitness than with sedation technique. Based on a cross-sectional study by Yahya et al.[32], subjects undergoing unsedated endoscopy experienced higher rates of cardiopulmonary complications compared to those under deep sedation-general anesthesia and mild-moderate sedation (61.11% vs. 53.85% vs. 40%). The study found that while 90.6% of subjects aged 65 and above were able to tolerate unsedated endoscopy based on the visual analog scale (VAS), 3.6% experienced severe hypoxemia (SpO2 < 90%), and 11.4% experienced mild hypoxemia (SpO2 90%-95%) within the first 2 to 4 minutes of the procedure. The main complication observed was asymptomatic transient tachycardia, which may be a physiological response to vagal reflexes and stress during endoscopy. The study noted differences in populations and definitions of complications may lead to variations in study findings.[33-34]

This study revealed that being 70 years or older did not correlate with cardiopulmonary complications during endoscopy compared to those under 70 years old (p = 0.927). This suggests that age alone may not be the only factor contributing to an increased risk of endoscopic complications; degenerative diseases may also play a role.[35] A cohort study by Yamaguchi et al. [36] also found significant differences in the prevalence of cardiovascular disease among different age groups, with 24.5% for those over 80 years old, 18.8% for those aged 65-79, and 5.4% for those under 65 years old (p<0.001).

The study found no links between the comorbidity index and endoscopic cardiopulmonary complications (p = 0.562). Park et al.[37] study noted that life-threatening conditions related to endoscopy were caused by the worsening of underlying comorbidities, particularly pulmonary diseases (57.5%). Furthermore, Mendez-Bailon et al.[38] study of heart failure patients undergoing colonoscopy found that comorbidities were linked to higher mortality, especially in those aged over 85 years, with a relative risk of 1.34 (1.15 – 1.55). Unfortunately, previous studies had not adjusted for confounding factors, such as medication history.

There were no relationships between ASA class and endoscopic cardiopulmonary complications (p = 0.788). Lieber et al.[30] study of 9,007 endoscopists in the United States noted that cardiac complications were closely associated with ASA class IV-V (OR 3.84; 95% CI 1.09 – 13.57). However, the study was not specific to older people because it used subjects with liver cirrhosis aged ≥18 years.[30] As many as 81% of subjects in Lieber et al.[30] study was in ASA class ≥III. This number far exceeded the proportion of subjects with ASA class ≥III in this study, namely 21.65%. In addition, cross-sectional designs based on national databases can potentially report bias, coding inaccuracies, and incomplete registers.[30]

In this study, the procedure duration was not associated with endoscopic cardiopulmonary complications (p = 0.458). A study by Muller et al.[19] found that the endoscopy duration was unrelated to the incidence of hypoxemia (p = 0.047). Hypoxemia occurred 7 (5.77) minutes after administration of sedation, so hypoxemia is thought to be more closely related to hypoventilation than the duration of endoscopy.[19] In addition, the study of Sharma et al.[16] Trainee involvement was highly associated with cardiopulmonary complications (OR 1.3; CI 1.1-1.4, P<0.001). Trainees generally took longer to intubate the cecum.[21]

The study found no links between malnutrition and cardiopulmonary complications (p=0.141). This contradicts the findings of Kim et al.[39] study on patients aged ≥65 years with periampullary neoplasm who underwent pancreatoduodenectomy [HR 3.45 (1.10 – 11.09), p=0.037]. The malnourished group had significantly higher total morbidity compared to the non-malnourished group (50% vs 20%, p=0.026).[39] In surgical procedures, factors like inflammation, body fluid shifts, and wound healing trigger a systemic response, which is absent in patients undergoing procedural sedation. Consequently, it's unwise to equate these two conditions.[26]

Functional status was not associated with cardiopulmonary complications. Takatori et al.[40] studies of 128 subjects undergoing hemostatic endoscopy with a mean age of 70.4 (14.7) documented that poor preprocedural ADL was associated with an increased need for intensive care. On average, the duration of hospitalization for patients with poor ADL

is ten days longer for recovery.[40] However, the small sample size, retrospective design, and study population limited to inpatients are limitations that may cause differences in findings.

There were no significant relationships between the type of procedure and cardiopulmonary complications (p=0.157).[16] A study by Sharma et al.[16] also stated that cardiopulmonary complications related to EGD, colonoscopy, ERCP, and EUS were equivalent at 0.6-2.1%. Compared to EGD, ERCP had the most significant risk of cardiopulmonary complications, with an OR of 2.4 (95% CI 2.0-3.0).[16] Unfortunately, the operational definition of complications was not described. Additionally, the study population differed from this study in that it excluded flexible sigmoidoscopy procedures, procedures without sedation, and general anesthesia.[16]

There are a few limitations to this study. We did not assess other internal factors in elderly people, such as frailty and sarcopenia. The CIRS-G scoring was suboptimal because we needed to examine all laboratory data. The sedation sheet had incomplete drug use reports. Additionally, at times, ECG artifacts appeared during the procedure due to gag reflex or positional changes related to the endoscope maneuver.

The incidence of cardiopulmonary complications during and after endoscopy in elderly patients is high. This study provides essential information for patient education, rigorous pre-procedural selection, and close monitoring of patients undergoing complex procedures. Additionally, mild to moderate sedation is a safe option for endoscopy in the elderly. Since this study was conducted at the national referral hospital, its findings can be applied to other elderly endoscopy populations in various hospitals across Indonesia. However, further research with improved resources is needed to determine other influencing factors, such as frailty and sarcopenia status.

CONCLUSION

The incidence of cardiopulmonary complications during and after endoscopy is high among Indonesian elderly. Procedure complexity is an independent risk factor, whereas mild-moderate sedation mitigates the risk. In opposite, advanced age, multimorbidities, high ASA class, long duration of procedure, poor nutritional and functional status, and type of procedure did not affect outcomes.

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COMPETING INTERESTS

The authors have no potential competing interests.

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