

ENDOSCOPY

Nasal Continuous Positive Airway Pressure to Reduce Hypoxia in Patients With Obesity Undergoing Sedated Upper Gastrointestinal Endoscopy: A Prospective Randomized Trial



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BACKGROUND & AIMS:

Patients with obesity are at high risk of hypoxia during sedated upper gastrointestinal (GI) endoscopy, yet no standardized guidelines exist. This study evaluates the effectiveness of nasal continuous positive airway pressure (nCPAP) in reducing hypoxia during the procedure.

METHODS:

A prospective, randomized controlled study was conducted on patients with obesity (body mass index ≥ 30 kg/m²) scheduled for elective sedated upper GI endoscopy with propofol sedation. Patients were randomly assigned to receive either standard oxygen supplementation (nasal cannula [NC]) or nCPAP during the procedure. The primary outcome was the incidence of oxygen desaturation (SpO₂ <90%) during endoscopy. Secondary outcomes included the need for airway interventions, procedural success, patient tolerance, and adverse events.

RESULTS:

Of the 158 patients included, there were no significant differences in baseline characteristics between groups (male to female ratio, 71/87; mean age, 51 years; mean body mass index, 42.7 kg/m²). The incidence of desaturation was significantly lower in the nCPAP group (7.6%; 95% confidence interval [CI], 1.7%–13.5%) compared with the NC group (25.3%; 95% CI, 15.7%–34.9%; $P = .005$). Patients in the nCPAP group maintained higher minimum SpO₂ levels (97.1% $\pm$ 2.0%) than those in the NC group (95.9% $\pm$ 2.7%; $P = .007$). A multivariable logistic regression model identified age (1.06; 95% CI, 1.01–1.11) as an independent risk factor for desaturation, with odds ratio of 5.4 (95% CI, 2.0–16.8) for desaturation events in the NC group compared with the nCPAP group.

CONCLUSIONS:

nCPAP significantly reduces hypoxia risk and stabilizes oxygen saturation in patients with obesity undergoing sedated upper GI endoscopy. Have we correctly interpreted the following funding source(s) and country names you cited in your article: GI, Germany? GI endoscopy, supporting its routine use in these high-risk patients. Further studies should explore its broader clinical application.

[ClinicalTrials.gov](https://www.clinicaltrials.gov/ct2/show/study/NCT06168682), Number: NCT06168682.

Keywords: Obesity; Nasal Continuous Airway Pressure; Sedation; Upper GI Endoscopy.

In many countries, gastrointestinal endoscopy is performed under deep sedation, which carries specific risks—especially in patients with obesity, who

present unique challenges even with anesthesiologic support.¹ In general, nonanesthesia patient sedation (NAPS) is considered safe and effective for patients at

Abbreviations used in this paper: ASA, American Society of Anesthesiologists; BMI, body mass index; CPD, chronic pulmonary disease; CPAP, continuous positive airway pressure; etCO₂, end-tidal CO₂; FDR, false discovery rate; FiO₂, inspired oxygen concentration; GI, gastrointestinal; HR, heart rate; MOAA/S, modified observer's assessment of alertness/sedation scale; NAPS, nonanesthesia patient sedation; NAPTIME Trial, nasal CPAP and the treatment impact on the oxygenation in high-risk patients during deep sedation for endoscopy; NC, nasal cannula; nCPAP, nasal continuous positive airway pressure; NIBP, noninvasive blood pressure; OR, odds ratio; OSA, obstructive sleep apnea; PACU, post

anesthesia care unit; RCT, randomized controlled trial; SpO₂, peripherally measured oxygen level; WHO, World Health Organization.

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low risk of periprocedural complications, in accordance with current guidelines,²⁻⁵ despite varying patient preferences.^{6,7} For patients at higher risk of airway difficulties, anesthesia-driven sedation is recommended.^{8,9} Patients with obesity fall into this subgroup, making their peri-interventional care particularly challenging.^{10,11} Thus, many of these patients undergo the procedure fully conscious, despite the benefits of sedation for both comfort and examination quality.^{8,12-14}

To prevent desaturation and hypoxia in these patients, various oxygenation methods are used, including nasal cannulas, facemasks, high-flow oxygen, and nasopharyngeal tubes.¹⁵⁻²² Another approach to treating upper airway obstructions is continuous positive airway pressure (CPAP), delivered via nasal or full-face mask.²³ Data on nasal CPAP (nCPAP) ventilation during endoscopy remain limited.^{24,25} The NAPTIME Trial (Nasal CPAP and the Treatment Impact on the oxygenation in high-risk patients during deep sedation for Endoscopy) was initiated to assess the safety, efficacy, and impact of nCPAP on oxygenation in high-risk patients undergoing deep sedation for endoscopy.

Patients and Methods

Study Design

The NAPTIME-Trial was a single-center interventional randomized controlled trial (RCT) conducted between December 2023 and May 2024. Approved by the Ethics Committee of the Hamburg Chamber of Physicians (2023-101035-BO-ff) and registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT06168682), all participants provided written informed consent. All coauthors had access to the study data and reviewed and approved the final manuscript.

Participants

Eligible participants were adults (≥ 18 years) with a body mass index [BMI] ≥ 30 kg/m² scheduled for gastrointestinal endoscopy. Additionally, they had to be classified as at least Level III in the American Society of Anesthesiologists (ASA) physical status system.²⁶ Patients were excluded if they did not meet the inclusion criteria, required emergency endoscopy, had an insufficient fasting interval (< 6 hours), were pregnant, or had untreated heart disease or recent congestive heart failure.

Randomization

Before the study began, the entire study group was randomized using computer-generated allocation, sealed in envelopes. Just before the intervention and sedation, the envelopes were opened to reveal the assigned study arm, minimizing investigator bias.

What You Need to Know

Background

Patients with obesity are at high risk of hypoxia during sedated upper gastrointestinal (GI) endoscopy, with no standardized guidelines for prevention.

Findings

Nasal continuous positive airway pressure (CPAP) reduced hypoxia incidence (7.6% vs 25.3%) and stabilized oxygen levels during endoscopy in obese patients.

Implications for patient care

Routine use of nasal CPAP during sedated GI endoscopy in obese patients improves safety and should be considered standard practice.

Preparation

A single physician managed sedation throughout the trial using propofol monotherapy (without any other medication), minimizing variability that could arise from multiple practitioners. Additionally, a strict protocol was followed for both anesthesia and endoscopy to ensure consistency.

To prevent propofol overdosing, we used the adjusted body weight calculation as detailed in the [Supplementary Appendix](#).^{8,27} We administered a propofol induction bolus (1 mg/kg adjusted body weight) and a maintenance infusion (4 mg/kg/h lean body weight). As our cohort consisted exclusively of high-risk patients (mean BMI, 42.7 kg/m²), all of whom were inherently predisposed to difficult airways with high Mallampati scores due to obesity-related anatomical restrictions of the upper airway, airway devices were prepared in anticipation of potential complications. In accordance with our department's safety protocol, the oxygen flow was adjusted to 10 L/min when oxygen saturation dropped below 80%, marking a severe desaturation event.

Procedure

Patients received standard monitoring and were positioned slightly elevated on their left side. Oxygen flow was set to 6 L/min in both trial arms for 1.5 minutes of preoxygenation. The control group received oxygen via a nasal cannula (NC). The intervention group used the SuperNO2VA Et nCPAP mask (AirLife), which creates an estimated intrinsic positive airway pressure of 3 to 10 cm H₂O when properly positioned with the correct oxygen flow (see [Supplementary Figure 1](#)).

Only when a modified observer's assessment of alertness/sedation scale (MOAA/S) score of 1 or 2 was reached (see [Supplementary Table 1](#)), upper gastrointestinal (GI) endoscopy was started, because higher

scores are associated with a higher risk of complications such as vomiting and patients' discomfort.²⁸ Additionally, repeated 20 mg propofol boluses were administered as needed to achieve comfortable sedation for the participant and reduce complications for the endoscopist.

Patients were assessed by the study physician in the post-anesthesia care unit (PACU) for post-endoscopic adverse events and interviewed about their endoscopy experience (unstructured interviews). PACU duration was recorded.

Endpoints

The primary endpoint of the NAPTIME trial was the incidence of hypoxia after achieving deep sedation (MOAA/S score of 2). The peripheral oxygen saturation (SpO₂) measured via a pulse oximeter, was used to detect hypoxia. Hypoxia was defined as SpO₂ ≤90%, a critical threshold in many medical contexts due to the increased risk of significant tissue hypoxia.

If the primary endpoint of SpO₂ ≤90% was reached, airway intervention was initiated within 10 seconds. Simultaneously, maneuvers such as chin lift, nasopharyngeal airway placement, and suctioning of hypersalivation were performed. Oxygen flow was increased to 10 L/min, and the pulse oximetry position was reassessed.

Secondary endpoints included total endoscopy duration (total examination time), sedation amount, baseline SpO₂ before and after endoscopy, end-tidal CO₂ (etCO₂), timing of hypoxia and necessary airway intervention, time to hypoxia recovery, and incidence of airway interventions.

Statistical Methods

Based on findings from previous research by other authors, we assumed that the difference between the 2 groups would be approximately 10% to 20%, with reference rates ranging from 22% to 33% for the control group.^{15,29,30} Because we exclusively included esophagogastroduodenoscopies—where the procedural risk of SpO₂ drop is assumed to be higher—and restricted enrollment to patients with a BMI over 30 kg/m², we assumed that, in this setting, the difference would be closer to 20% rather than 10%. Therefore, the incidence of the primary outcome was estimated to be 30% in the nasal oxygen insufflation group and 10% in the nCPAP group. A total sample size of 158 participants was calculated to achieve 86% power to detect a 20% difference between the groups at a significance level of .05 using a 2-sided test of proportion.

Statistical analysis was conducted using RStudio (2023.12.1), and data visualization with Python (3.8.5). We assessed structural homogeneity with descriptive statistics and tested for group differences in age, sex, BMI, and preexisting conditions using appropriate statistical tests (*t*-test, Wilcoxon-Mann-Whitney, χ^2). The

primary outcome was the frequency of acute desaturation events (SpO₂ ≤90%). Pearson's χ^2 test with Yates's correction tested for significant group differences. SpO₂ values were compared using Wilcoxon-Mann-Whitney tests. A multiple logistic regression model (R's 'glm' with 'binomial' as family) accounted for additional risk factors, including age, sex, BMI, obstructive sleep apnea (OSA), chronic pulmonary disease (CPD), ASA status, and study duration. A Model- χ^2 test confirmed the alternative model's superiority (*P* = .004), and variance inflation factors indicated minimal multicollinearity. Odds ratios (ORs) were derived, and *P* values < .05 were deemed significant. False discovery rate (FDR)-corrected *P* values (5% FDR) were reported for multiple testing in demographics and preexisting conditions.

Results

Between December 2023 and May 2024, 161 patients were enrolled in the NAPTIME trial, with 158 included in the final analysis. Three were excluded due to non-fasting status or the presence of food residues in the stomach, increasing aspiration risk and requiring airway protection. Both groups were comparable in demographics, medical history (including obesity classes) (Table 1), and procedural characteristics (Supplementary Table 2).

Both groups showed no significant difference in baseline SpO₂ (mean ± SD: SpO₂ NC group: 96.5% ± 2.2%; SpO₂ nCPAP group: 96.5% ± 2.3%; *z* = −0.15; *P* = .88). The nCPAP group had significantly higher SpO₂ than the NC group immediately before sedation (SpO₂ NC: 99.2% ± 1.19%; SpO₂ nCPAP: 99.6% ± 0.76%; *z* = 2.15; *P* = .01).

The primary outcome occurred significantly less often in the nCPAP group, with 6 of 79 patients (7.6%) experiencing desaturation (SpO₂ ≤90%), compared with 20 of 79 patients (25.3%) in the NC group (χ^2 = 7.78; *P* = .005; number needed to treat: 5.6) (Figure 1 and Table 2). Further data including type of interventions in case of desaturation are also shown in Table 2: In 26 cases (19 controls, 7 in nCPAP group; χ^2 = 5.57; *P* = .02), a chin-lift maneuver was sufficient to reopen the airway. Fourteen patients required additional interventions (10 controls, 4 nCPAP; χ^2 = 1.96; *P* = .16) such as suction of saliva/mucus, or a nasopharyngeal tube insertion. In 6 cases, SpO₂ dropped down to 80%, which was considered as severe hypoxia. Simultaneously with airway maneuvers, the oxygen flow was increased to 10 L/min until stable conditions were achieved. The endoscopic procedure was interrupted in 4 cases, all in the control group, with 3 requiring assisted mask ventilation. No endotracheal intubation was needed. Additionally, 2 patients required interventions despite not reaching SpO₂ ≤90%: one needed a chin lift for endoscope insertion, and another required saliva suctioning to prevent aspiration due to hypersalivation.

Table 1. Demographic Information and Comorbidities of the Study Population

	nCPAP	Control	All	<i>P</i>	<i>P</i> _{FDR-corr.}
No. patients	79	79	158	–	–
Sex (male/female)	33/46 (41.8/58.2)	38/41 (48.1/51.9)	71/87 (44.9/55.1)	.52	1.0
Age, y	51 (18–81)	51 (21–83)	51 (18–83)	.94	1.0
BMI, kg/m ²	43.3 (30.7–72.9)	41.6 (30.1–66.2)	42.7 (30.1–72.9)	.20	1.0
30.1–34.9	16 (20.3)	17 (21.5)	33 (20.9)	1.00	1.0
35.0–39.9	13 (16.5)	19 (24.1)	32 (20.3)	.32	1.0
40.0–49.9	18 (22.8)	21 (26.6)	39 (24.7)	.70	1.0
50.0+	32 (40.5)	22 (27.8)	54 (34.2)	.13	1.0
ASA status					
ASA III	71 (89.9)	70 (88.6)	141 (89.2)	1.0	1.0
ASA IV	8 (10.1)	9 (11.4)	17 (10.8)	1.0	1.0
Comorbidities					
Arterial hypertension	42 (53.2)	49 (62.0)	91 (57.6)	.33	1.0
Dyslipidemia	42 (53.2)	49 (62.0)	91 (57.6)	.33	1.0
T2D	41 (51.9)	40 (50.6)	81 (51.3)	1.00	1.0
OSA	18 (22.8)	18 (22.8)	36 (22.8)	1.00	1.0
CPD	18 (22.8)	21 (26.6)	39 (24.7)	.71	1.0
Cardiac diseases	14 (17.2)	12 (15.2)	26 (16.5)	.83	1.0

ASA, American Society of Anesthesiology classification system; BMI, body mass index; CPD, chronic pulmonary diseases; nCPAP, nasal continuous positive airway pressure; T2D, type 2 diabetes.

Cardiac diseases include atrial fibrillation, congestive heart failure, and coronary artery disease. Chronic pulmonary diseases include chronic obstructive pulmonary disease, asthma, smoking, and pulmonary hypertension.

Data are presented as number (%) or median (range).

Among patients without desaturation events, the nCPAP group had significantly higher minimal oxygen saturation compared with the NC group (group-mean individual minimum SpO₂: NC 95.9% ± 2.7%; SpO₂ nCPAP 97.1% ± 2.0%; $z = -2.67$; $P = .007$). They also experience a significant lower SpO₂ variance (group-mean individual variance: NC 1.78 ± 1.8; nCPAP 1.03 ± 1.3; $z = 2.9$; $P = .003$) and significantly higher rates of SpO₂ after completing the endoscopy and after sedation (SpO₂ 98.18 ± 1.6; $z = 3.82$; $P < .001$) compared with the NC group (SpO₂ 96.84 ± 2.4). However, the average SpO₂ was comparable in both groups (SpO₂ NC: 98.7% ± 4.7%; SpO₂ nCPAP: 98.5% ± 1.0%; $P = \text{n.s.}$). Figure 2A depicts individual time courses of blood oxygen

saturation during endoscopy, whereas Figure 2B illustrates the occurrence of desaturation events.

To identify key factors contributing to desaturation, we applied a multivariable logistic regression model adjusted for age, sex, BMI, OSA, chronic lung disease, ASA grade, procedure duration, total propofol dose, and group assignment. This analysis confirmed a significant advantage of the nCPAP mask in reducing desaturation events ($\beta_{\text{nCPAP}} = -1.68$; $P = .002$). The analysis indicated that the odds of desaturation were 5.4 times higher in the NC group compared with the nCPAP group. The multivariable logistic regression model also identified age as an independent risk factor for desaturation, with OR of 5.4 for desaturation events in the NC group

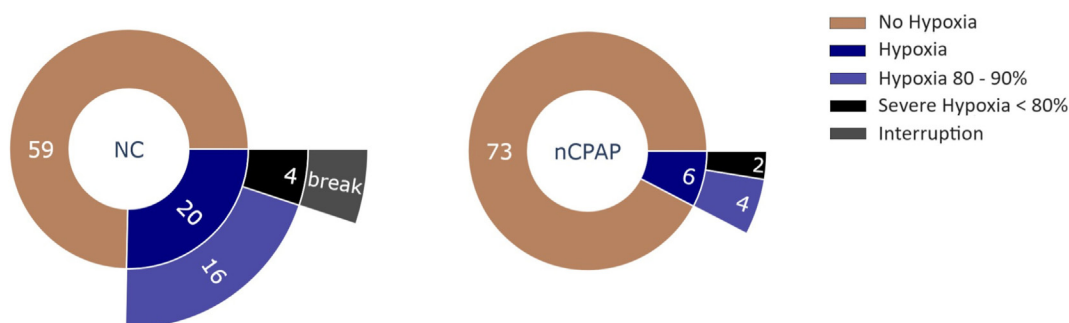


Figure 1. Primary and secondary outcomes: hypoxia rates and severe hypoxia, as well as procedural interruption. NC, nasal cannula; nCPAP, nasal continuous positive airway pressure.

Table 2. Desaturation Events and Types of Airway Interventions During Endoscopy

	nCPAP	Controls	Total	<i>P</i>	<i>P</i> _{FDR-corr.}
Desaturation events					
No desaturation (SpO ₂ ≥90%)	73 (92.4%)	59 (74.6%)	132 (83.5%)		
SpO ₂ ≤90% and SpO ₂ ≥80%	4 (5.0%)	16 (20.3%)	20 (12.7%)		
≤80% SpO ₂	2 (2.5%)	4 (5.0%)	6 (3.8%)		
Airway interventions					
All cases where required	8	19	27	.04 ^a	.14
Type of intervention:					
Esmarch/chin-lift maneuvers	7	19	26	.02 ^a	.14
Oropharyngeal tube	0	0	0	1.0	1.0
Nasopharyngeal tube	0	2	2	.48	.67
Suction of saliva	4	5	9	1.0	1.0
Assisted mask ventilation	0	3	3	.24	.42
Interruption of endoscopy	0	4	4	.13	.30

nCPAP, nasal continuous positive airway pressure; SpO₂, peripherally measured oxygen level.

^a*P* < .05.

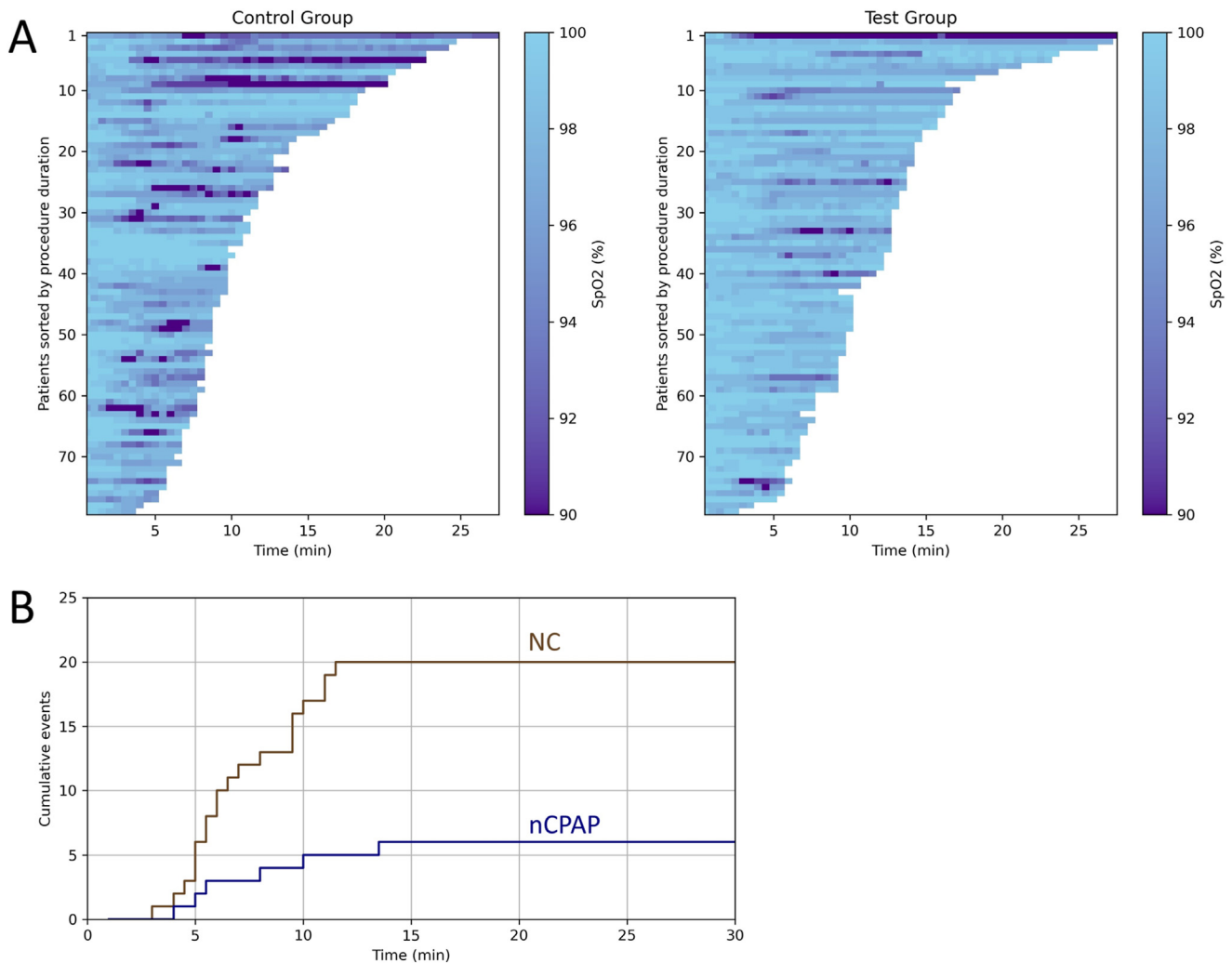


Figure 2. Peripheral oxygen saturation during endoscopy (sorted by procedure duration). The color bar indicates the peripherally measured oxygen saturation (%) (A). (B) Cumulative events of periprocedural desaturation. NC, nasal cannula; nCPAP, nasal continuous positive airway pressure; SpO₂, peripherally measured oxygen level.

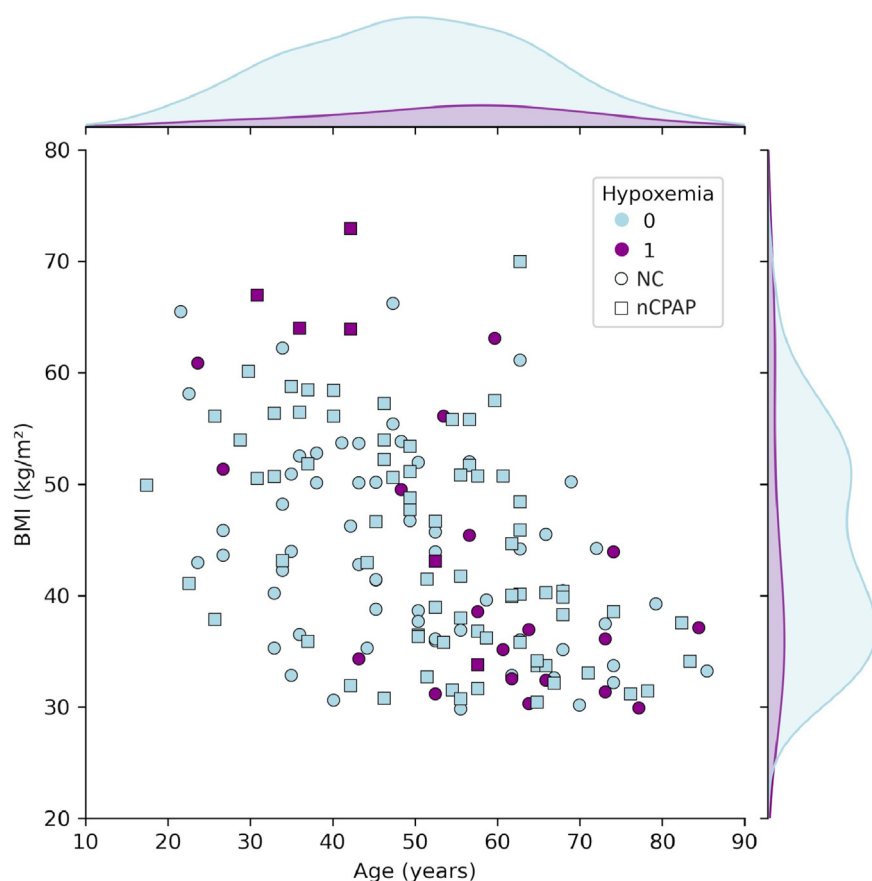


Figure 3. The occurrence of desaturation events as a function of age and BMI. BMI, body mass index; NC, nasal cannula; nCPAP, nasal continuous positive airway pressure.

compared with the nCPAP group; in addition, older age was shown to be associated with a greater risk of desaturation ($\beta_{\text{Age}} = 0.06$; $P = .02$) (see Figure 3). The effect of age corresponded to an R of 1.06, indicating a 6% increase in the odds of desaturation per year. Additionally, a statistical trend was observed regarding chronic lung disease ($\beta_{\text{CPD}} = 0.92$; $P = .07$). Concomitant routine medications with sedative/analgesic effects did not influence desaturation (see Supplementary Table 3).

In the recovery unit, no prolonged stays were observed. None of these cases required nCPAP during transfer to the PACU. All patients were sleepy but responsive and were transported to the PACU breathing spontaneously, accompanied by the anesthesiologist or physician. Oxygen flow was maintained at 2 L/min. Nearly all patients provided positive feedback in an unstructured survey, reporting reduced stress and anxiety, as well as willingness to repeat or recommend endoscopy under sedation, with no appreciable differences between groups.

Discussion

Our randomized trial of 158 gastroscopies in patients with obesity found that nCPAP use significantly reduced desaturation events, stabilized oxygenation, and minimized procedure interruptions.

Several strategies, including nCPAP and hyperoxygenation, can reduce sedation-related desaturation, especially in patients with obesity.^{31–33} However, existing nCPAP data is limited and heterogeneous in study size, sedation methods, and patient populations.^{24,25} Studies on nCPAP use during sedation for upper GI endoscopy are scarce. A smaller randomized trial ($n = 98$) in upper and lower GI endoscopy (mean BMI, 26 kg/m²) showed a clear benefit of the nCPAP mask.³⁴

Our data from a large cohort of patients with obesity undergoing high-risk upper GI endoscopy show that nCPAP is safe and effective—even in World Health Organization (WHO) Class III obesity—under a standardized sedation protocol. nCPAP significantly reduced total and severe hypoxic events, prevented procedure interruptions, and allowed easy airway support with maneuvers like chin lifts. With equal preparation time, nCPAP patients reached optimal preoxygenation faster and maintained more stable oxygen levels compared with NC oxygen. Even excluding those who reached the primary endpoint, nCPAP provided more consistent oxygenation and a safer recovery phase.

Our study was conducted under anesthesiologic supervision, but it could be used by properly trained non-anesthesia personnel, and the mask needs no special expertise.²⁵ As it enhances overall procedural safety, nCPAP can be even more effective with trained non-anesthesia personnel. Additionally, our study showed

that nCPAP significantly reduced SpO₂ variability throughout the procedure. Although not systematically analyzed, experienced endoscopists in our study perceived the procedure as more stable and accurate with sedation. Awake patients were more likely to retch, which made the procedure more challenging and less efficient. In the nCPAP group, fewer desaturation events and less shallow sedation may have allowed endoscopists to focus more on the procedure. Additionally, the presence of an anesthesiologist likely contributed to their increased sense of safety.³⁵

However, our trial had some limitations and challenges. The nCPAP mask comes in only 2 standard sizes, which may not fit all patients perfectly, potentially causing pressure-related discomfort in the eyes or nasolacrimal region. Additionally, the Venturi effect could prevent the reservoir from filling properly, with increased oxygen flow intensifying this issue. Despite this, the sealed mask and even a small oxygen reservoir provided better oxygenation and likely a higher inspired oxygen concentration (FiO₂) than a conventional nasal cannula. According to current S3 guidelines for “Oxygen Therapy in the Acute Treatment of Adult Patients,” NCs provide a FiO₂ of 0.26 to 0.54, whereas reservoir-connected masks can reach up to 0.9.³⁶

Capnography can be a valuable addition to patient monitoring. EtCO₂ monitoring via the nCPAP mask helps ensure regular breathing during sedation, and the detection of absent CO₂ allows for timely airway intervention, potentially preventing drops in SpO₂—especially in high-risk patients. Capnography has also been repeatedly suggested for routine use in GI endoscopy, although guideline recommendations remain vague.^{9,37} In a separate study, Kalner et al measured transcutaneous SpCO₂ and found no significant difference between the nCPAP and control groups.²⁵ In our study, CO₂ was measured only in the intervention group, as the NC does not allow for attachment of a CO₂ detection line. However, during upper GI endoscopy—where CO₂ rather than air insufflation has become the standard—capnography interpretation is nearly impossible.²⁹ Although we used a newer version of the mask that includes a CO₂ reservoir to capture exhaled air (see [Supplementary Figure 1B](#)), we were still unable to obtain meaningful, respiration-synchronous CO₂ measurements.

Propofol dosing for sedation varies worldwide, aiming to balance depth and safety.³⁷ In NAPS, titration ensures adequate sedation, although obesity increased risks in our cohort. The NAPTIME trial used an “adjusted body weight” formula, but it is complex to calculate. Based on our findings, we recommend using 70% to 80% of total body weight and a maintenance dose of 4 to 5 mg/kg/h to reduce fluctuations. In our study, one physician managed sedation, but broader implementation, including NAPS, seems feasible. We also examined the impact of chronic or as-needed use of narcotics and sedatives ([Supplementary Table 3](#)) but found no significant effect on outcomes.

In conclusion, nCPAP support offers a feasible and straightforward way to enhance sedation safety for patients with obesity undergoing GI endoscopy, including those with WHO Class III obesity, who can be safely sedated using this approach. Compared with conventional NC oxygen insufflation, nCPAP support outperformed every assessed parameter. Given its ease of use, we believe the nCPAP device could also be effectively utilized for nurse-administered propofol sedation (NAPS) in patients without special risk factors.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org, and at <https://doi.org/10.1016/j.cgh.2025.06.015>.

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Conflicts of interest

The authors disclose no conflicts.

Data Availability

The deidentified individual participant data supporting the findings and results of this study will be made available 3 months following publication and will remain accessible for 10 years upon personal request to the first author. The study protocol signed informed consent and statistical workflow can also be made available in the same way. Access to the data will be provided only upon request from qualified researchers who have a legitimate need for the data. We believe that data sharing promotes scientific advancement and enhances transparency and accountability in research.

Supplementary Methods

Details of Body Weight Determinations for Deep Sedation With Propofol

Parameters used were total body weight (TBW), ideal body weight (IBW), adjusted body weight (ABW), and lean body weight (LBW). In severely obese patients, the high proportion of body fat relative to total body weight accelerates propofol redistribution into fat tissue. To ensure optimal sedation while preserving spontaneous breathing, these factors must be considered.

The formula to IBW was initially set up by insurance companies and was revised multiple times.¹ We used the Devine's formula, which is slightly different in females and males.²

- IBW for males (kg) = $50 + [0.9 \times (\text{Height (cm)} - 154)]$
- IBW for females (kg) = $45.5 + [0.9 \times (\text{Height (cm)} - 154)]$

The need for an ABW was described by Bauer et al, who applied a drug-dependent correction factor (CF) for the drug distribution in the formula between TBW and IBW. It has been found that a CF of approximately 0.4 corresponded with the volume distribution in obese patients.³

- $ABW = IBW + [CF \times (TBW - IBW)]$

The LBW, on the other hand, was evaluated in a greater range of BMIs and seemed to be a promising estimator of the body weight at this point in time:^{4,5}

- LBW for males (kg) = $(9270 \times TBW) / [6680 + (216 \times BMI)]$
- LBW for females (kg) = $(9270 \times TBW) / [8780 + (244 \times BMI)]$

The SuperNO2VA Et Nasal CPAP Mask (AirLife)

Extractable information from the SuperNO2VA website and training video. The mask is designed to form a complete seal and, when connected to an oxygen source and pressure relief valve, provides positive airway pressure for ventilatory support in supine, lateral, and prone positions.

The mask's ergonomic design minimizes air leak among a large demographic population. High flow rates are needed to fill the reservoir bag and generate positive pressure. A pressure of 5 to 10 cm H₂O is generally sufficient to maintain airway patency.

With a proper seal and fresh gas flow exceeding the patient's minute ventilation, the reservoir bag fills and intermittently deflates during inhalation, indicating effective ventilation. A firm seal is ensured by downward pressure and securing the head strap.

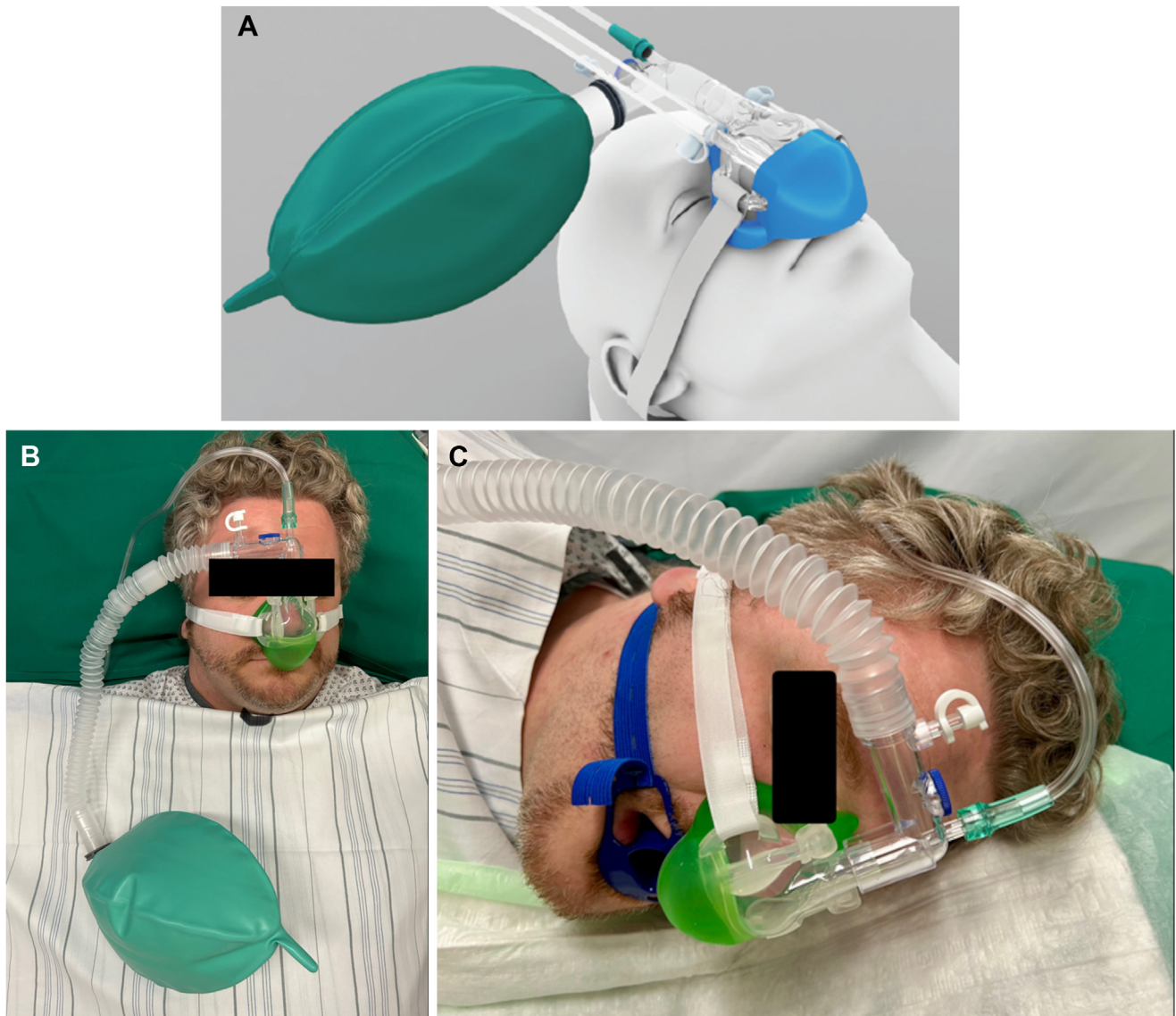
When used with a ventilator, the pressure manometer and waveform will show intermittent decreases in pressure during spontaneous ventilation, and the reservoir bag refills during exhalation. In remote locations where anesthesia machines are absent, the supernova device is effective with the use of a hyperinflation bag and supplemental oxygen source. Similar to the ventilator, a pressure relief valve between mask and the hyperinflation bag is used to titrate pressure build-up within the mask.⁶

A silicone lip briefly captures exhaled air, enabling sidestream CO₂ monitoring without interfering with the examination, endoscope insertion, or saliva aspiration (see [Supplementary Figure 1](#)).

In some patients, the reservoir bag may not pressurize due to oral cavity leaks. Manual mouth closure or firm submental pressure at the tongue base can seal the oral cavity, allowing effective nasal ventilation. Slight head flexion may also help minimize oral leakage. When a bite block is used (eg, during transoesophageal echocardiography or endoscopy), submental pressure can create a seal around the probe, pressing the tongue against the hard palate. This is also useful when capnography signal is lost due to mouth exhalation. The reservoir bag accumulates up to 2 L of oxygen-rich air, enhancing FiO₂. The combination of hyperinflation bag, oxygen flow, and pressure valve pressurizes inhaled air. According to the manufacturer, assisted ventilation is possible once the oropharynx is sealed by applying submental pressure, allowing airflow exclusively through the nasal route. To provide ventilatory support, the clinician may assist the patient by squeezing the reservoir bag during inhalation. Additionally, manual rescue ventilations can be performed during apnea or hypoventilation by occluding the oral cavity. However, this maneuver was not utilized in the study.

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Supplementary Figure 1. SuperNO2VA Et nasal CPAP mask (AirLife). A schematic representation (clinical use protocol, A) and photos of clinical practice.⁷ The inflated reservoir bag indicates ventilation and generates positive airway pressure (B). A close-up: combined with a bite block, the silicon lip did not interfere endoscopic procedures or airway manipulation (C).

Supplementary Table 1. MOAA/S

Score	Description
5	Responds readily to name spoken in normal tone
4	Lethargic response to name spoken in normal tone
3	Responds only after name is called loudly and/or repeatedly
2	Responds only after mild prodding or shaking
1	Responds only after painful trapezius squeeze
0	No response after painful trapezius squeeze

MOAA/S, modified observer's assessment of alertness/sedation scale.

Supplementary Table 2. Information on Endoscopic Procedures

	nCPAP	Controls	All	<i>P</i>	<i>P</i> _{FDR-corr.}
EGD duration, <i>minutes</i>	12.7 (3.6–29.5)	10.8 (4.9–37.4)	11.3 (3.6–37.4)	.64	.96
Duration of sedation, <i>minutes</i>	9.7 (3.3–27.5)	8.9 (3.9–36.4)	9.1 (3.3–36.4)	.88	1.0
Time until sedation – “preoxygenation,” <i>minutes</i>	1.5 (0.3–7.5)	1.5 (0.5–5.0)	1.5 (0.3–7.5)	.26	.96
Diagnostic/therapeutic procedure	34/45 (43.1/56.9)	39/40 (49.4/50.6)	73/85 (46.2/53.8)	.43	.96
EGD indications					
Prior to bariatric surgery	39	40	79	1.0	1.0
Search for esophageal varices	6	5	11	1.0	1.0
Barrett's esophagus surveillance	11	12	23	1.0	1.0
Suspected GI	2	5	7	.44	.96
Suspected achalasia	0	4	4	.13	.96
Other indications	21	13	34	.18	.96
Amount of propofol (induction), <i>mg</i>	92.3 (59.8–134.8)	91.1 (55.0–128.6)	90.6 (55–134.8)	.60	.96
Total amount of propofol, <i>mg</i>	301.6 (96.0–677.0)	275.0 (127.0–612.0)	291.8 (127–677)	.56	.96

EGD, esophagogastroduodenoscopy; GI, gastrointestinal; nCPAP, nasal continuous positive airway pressure.

Data are presented as number (%), median (range), or mean (range)

Invasive procedures include ligation of varices, argon plasma coagulation, dilatation of pylorus/esophagus, etc.

Other indications include evaluation before transplantation, search for primary cancer, control after invasive procedures like bariatric surgery, interventional endoscopy, etc.

Supplementary Table 3. Sedatives and Analgesics as Routine or On-demand Medication Used by Patients in the Study; Agents Were Discontinued on the Day of Endoscopy

	nCPAP (n = 79)	NC (n = 79)
All patients with these medications	18	18
Narcotics/opioids	6 (7.6%)	5 (6.3%)
Benzodiazepine	0	1 (1.3%)
Co-analgesics ^a	15 (19.0%)	14 (17.7%)
Hypoxia in this subgroup	6 (7.6%)	20 (25.3%)
Patients experiencing hypoxia in this subgroup ^b	1 (16.7%) - 1 × SSRI	7 (35%) - 1 × opioids - 6 × SSRI

Note: Data are presented as number (%).

NC, nasal cannula; nCPAP, nasal continuous positive airway pressure; SNRI, serotonin and norepinephrine reuptake inhibitor; SSRI, selective serotonin reuptake inhibitor.

^aSSRI (citalopram, etc); SNRI (duloxetine, etc); gabapentinoids (gabapentin/pregabalin); methocarbamol.

^bP = .62, statistically not significant (Fisher's Exact test).