ORIGINAL RESEARCH

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A retrospective analysis of non-operating room anesthesia practices at a university hospital

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Abstract

Objective: The use of non-operating room anesthesia is increasing due to its advantages in procedure success and patient management. This study aims to retrospectively evaluate the complication rates and patient outcomes in non-operating room anesthesia practices at a university hospital over a two-year period.

Method: After obtaining ethical approval, the records of patients who underwent sedation-analgesia outside the operating room for diagnostic and therapeutic purposes between 2018 and 2020 were retrospectively analyzed. Recorded data included age, gender, weight, American Society of Anesthesiologists (ASA) physical status classification, comorbidities, types of procedures, anesthesia and recovery times, medications used, and complications.

Results: A total of 1199 patients were included in the study, with 759 (63.3%) adults and 440 (36.7%) pediatric patients. The patient group comprised 829 (69.1%) female and 370 (30.9%) male, with a mean age of 35.62 ± 28.69 years (0-98). Of the patients, 547 (46.1%) were in the ASA 2 risk group. The most common procedure was Magnetic Resonance Imaging (MRI) 541 (45.1%). The most frequently used anesthetic regimen was a combination of midazolam, propofol, and ketamine 840 (70.1%). Hypotension was the most common complication 44 (3.7%), followed by bradycardia 38 (3.2%). Hypertension was the most frequently 144 (12.0%) observed comorbidity.

Conclusion: The frequency of non-operating room anesthesia procedures is steadily increasing due to growing patient and surgeon satisfaction. Comprehensive preanesthetic evaluations, ensuring appropriate physical conditions and patient-specific drug selection are crucial for appropriate and rapid interventions for possible complications.

Keywords: Non-operating room anesthesia practices, pre-anesthetic evaluation, sedation, anesthetic agents, complications

INTRODUCTION

Providing sedation or general anesthesia to patients for painful or uncomfortable procedures outside the operating room is described as non-operating room anesthesia (NORA) (1). NORA procedures are increasingly preferred for both diagnostic and therapeutic purposes. Factors that play a role in choosing NORA include independence from hospital bed capacity, lower nosocomial infection rates, more efficient operations, and reduction of costs. Additionally, advancements in technology have enabled more complex and invasive interventions in NORA settings (2). Current research predicts that within the next decade, NORA practices will account for 50% or more of all anesthesia procedures (3). NORA is frequently applied in endoscopy suites, interventional cardiology labs, radiology settings, pain management procedures, intensive care units, electroconvulsive therapy, and dental offices (4). Anesthesia techniques in non-operating room areas vary from monitoring alone to general anesthesia. These methods reduce or completely eliminate the patient's anxiety and pain, ensure immobility, and increase the success of the procedure, especially in young children and uncooperative adults. However, inadequate sedation/analgesia may lead to patient distress or cardiac and respiratory depression. Despite its advantages, NORA faces several challenges, including environmental issues,

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insufficient or old equipment, inexperienced personnel, and distance from the operating rooms in case of emergency. These areas are often not optimized for anesthesia, leading to difficulties in accessing the patient. Additionally, electromagnetic devices and specially coated walls can block emergency communication via mobile phones (2).

The hypothesis of this study is that complication rates in NORA practices are low, and patient outcomes are generally favorable. Additionally, it is anticipated that the anesthetic agents used and the procedures performed may influence the risk of complications. Complication rates and patient outcomes in NORA applications were retrospectively evaluated in this syudy. Specifically, the aim to assess the effects of the anesthetic agents used and the procedures performed on the occurrence of complications.

METHOD

This study was conducted after obtaining approval from the Non-invasive Ethics Committee of Hatay Mustafa Kemal University Faculty of Medicine (Approval No: 26, dated 11.03.2021). The records of patients who underwent sedation-analgesia outside the operating room for diagnostic and therapeutic purposes between 2018 and 2020, were retrospectively analyzed. The data were obtained from forms in the anesthesia archive. These forms included pre-procedure consent, preoperative assessment, and anesthesia follow-up charts. This study aims to retrospectively evaluate the complication rates and patient outcomes in NORA practices.

Patients were evaluated in the anesthesia clinic before NORA procedures, with consultations with the relevant faculty member as needed. Sedation was administered by an anesthesiologist and anesthesia technician. Demographic data of the patients, including age, gender, weight, American Society of Anesthesiologists (ASA) physical status classification scores, comorbidities, surgical interventions, procedure, anesthesia and recovery times, anesthetic drugs used and any complications that developed were recorded. As hypothesized in this study, the selection of anesthetic agents and the procedures performed were recorded to assess their overall impact on complication rates. The choice of anesthetic drugs was left to the discretion of the anesthesiologist, based on the patient's comorbidities and the type of procedure. The most commonly used drugs were documented, and overall complication rates were analyzed, without directly assessing the association between specific drugs and complications.

In units where NORA is administered, there is an oxygen source, an aspirator, a laryngoscope, an ambu bag, and a monitor that can measure heart rate, non-invasive arterial blood pressure, and oxygen saturation. Additionally, there is an emergency cabinet containing resuscitation equipment, a defibrillator, and an anesthesia machine in some units. In all patients, vascular access was established after the required fasting period. In clinical practice, the most commonly used intravenous (iv) anesthetic agents during procedural sedation were midazolam (0.025-0.1 mg/kg), propofol (0.5-2 mg/kg) or ketamine (0.5-2 mg/kg). Additional doses of anesthetic agents were administered if patients experienced pain or discomfort. The Ramsay sedation score was used to assess the level of sedation, with a target sedation level of 4 or 5 (5). During the procedure, patients were monitored and given oxygen via nasal cannula or face mask.

Hypotension was defined as a decrease in systolic blood pressure below 90 mmHg or a decrease of more than 25% of the baseline value. Patients who developed hypotension were treated by administering 5-10 mg ephedrine intravenously. Bradycardia was defined as a decrease in heart rate below 50 beats/minute, and patients with this condition were administered 0.5-1 mg atropine intravenously. Respiratory depression was considered as spontaneous breathing falling below 12 per minute, and these patients were treated with maneuvers to stimulate breathing,changing head position, use of an airway, and oxygen support with a mask. Patients experiencing an allergic reaction were treated with intravenous antihistamines.

At the end of the procedure, patients were followed in the recovery area of the unit. Patients who were awake, oriented, cooperative, with stable vital signs, without risk of respiratory or cardiac depression, and with a modified Aldrete score ≥ 9 were transferred to the service (6). When complications developed and treatments did not provide a sufficient response, patients were transferred to the intensive care unit.

Statistical Analysis

The relationships between categorical variables were analyzed using Pearson's chi-square test and Fisher's exact test. Descriptive statistics for numerical variables were presented as mean ± standard deviation, median, and range (min-max), while categorical variables were summarized as frequencies and percentages. Data collected from the anesthesia archive were analyzed retrospectively to determine the complication rates and patient outcomes. While statistical analysis was conducted on the overall complication rates, no direct evaluation was made regarding the association between specific anesthetic agents and complication risk. Statistical analyses were performed using SPSS Windows version 24.0, with a p-value of <0.05 considered statistically significant.

RESULTS

The study included 1199 patients, of which 759 (63.3%) were adults and 440 (36.7%) were under 18 years of age. Among the patients, 829 (69.1%) were female, and 370 (30.9%) were male. The median age of the patients was 36 years (mean ± standard deviation: 35.62 ± 28.69 years), with a range from 0 to 98 years. The median weight was 65 kg (mean ± standard deviation: 51.93 ± 28.36 kg), ranging from 3 to 98 kg. The median procedure duration was 20 minutes (mean ± standard deviation: 21.99 ± 17.53 minutes), with a range from 2 to 250 minutes. The median anesthesia duration was 25 minutes (mean ± standard deviation: 27.63 ± 18.49 minutes), ranging from 2 to 265 minutes. The median recovery duration was 5 minutes (mean ± standard deviation: 6.73 ± 3.36 minutes), with a range from 0 to 25 minutes. Regarding interventions, 541 (45.1%) of the patients underwent Magnetic Resonance (MR) imaging, 534 (44.5%) underwent Endoscopic Retrograde Cholangiopancreatography (ERCP), and 124 (10.4%) underwent various other interventional procedures. According to the ASA physical status classification scores, 547 (46.1%) of the patients were ASA 2, 468 (39.5%) were ASA 1, 160 (13.5%) were ASA 3, and 11 (0.9%) were ASA 4 (Table 1).

Table 1. Distribution of general characteristics and American Society of Anesthesiologists scores (ASA=)

Gender	**n**	**%**	
Female	829	69.1	
Male	370	30.9	
	Median	**Mean±SD**	**Min-Max**
Age (year)	36	35.62±28.69	0-98
Weight (kg)	65	51.93±28.36	3-98
Procedure duration (min)	20	21.99±17.53	2-250
Anesthesia duration (min)	25	27.63±18.49	2-265
Recovery duration (min)	5	6.73±3.36	0-25
Procedures	**n**	**%**	
Magnetic Resonance	541	45.1	
Endoscopic Retrograde Cholangiopancreatography	534	44.5	
Interventional procedures	124	10.4	
ASA classification	**n**	**%**	
1	468	39.5	
2	547	46.1	
3	160	13.5	
4	11	0.9	

Table 2 shows the distribution of medications used among the patients. The most commonly used medication combination was Midazolam + Propofol + Ketamine, administered to 840 (70.1%) of the patients. This was followed by Midazolam + Ketamine, used in 259 (21.6%) of the patients. Propofol alone was administered to 52 (4.3%) of the patients, while the combination of Midazolam + Propofol was used in 48 (4.0%) of the patients.

Table 2. Medications administered

Medication	**n**	**%**
Midazolam + Propofol + Ketamine	840	70.1%
Midazolam + Ketamine	259	21.6%
Propofol	52	4.3%
Midazolam + Propofol	48	4.0%

As shown in Table 3, the most frequently observed complication was hypotension, occurring in 44 (3.7%) of the patients, with a significantly higher incidence in adults (40, 5.3%) compared to pediatric patients (4, 0.9%) ($p < 0.001$). Bradycardia was the second most common complication, observed in 38 (3.2%) of the patients, again with a higher frequency in adults (34, 4.5%) than in pediatric patients (4, 0.9%) ($p < 0.001$). Allergic reactions were observed in 10 (0.8%) of the patients, occurring more frequently in pediatric patients (7, 1.6%) than in adults (3, 0.4%) ($p = 0.033$). Respiratory depression affected 10 (0.8%) of the patients and was seen almost equally in both groups, with 6 (0.8%) in pediatric patients and 4 (0.9%) in adults, showing no significant difference ($p = 0.867$). The need for ICU admission was found in 13 (1.1%) of the patients, with higher rates in pediatric patients (6, 1.3%) compared to adults (7, 0.9%), although this difference was not statistically significant ($p = 0.514$). The need for intubation was observed in 8 (0.7%) of the patients, but it only occurred in adults (8, 1.1%) and not in pediatric patients (0%) ($p = 0.028$).

Table 4 shows the distribution of comorbidities among the patients. The most frequently observed comorbidity was hypertension (HT), seen in 144 (12.0%) of the patients. Diabetes Mellitus (DM) affected 125 (10.4%) of the patients. Other comorbidities, affecting 111 (9.3%) of the patients, included conditions such as anemia, malignancies, cerebrovascular diseases, smoking-related complications, and cerebral palsy. Coronary Artery Disease (CAD) was found in 84 (7.0%) of the patients, and epilepsy was noted in 58 (4.8%). Chronic Kidney Disease (CKD) and asthma were found in 40 (3.3%) and 38 (3.2%) of the patients, respectively, while hydrocephalus was observed in 11 (0.9%) of the patients.

DISCUSSION

This study aimed to retrospectively evaluate complication rates and patient outcomes in NORA procedures. The most frequently observed complications were hypotension and bradycardia, particularly in adults. These findings underscore

Table 3. Complications of the patients

Complication	Pediatric <18, n	Pediatric <18, %	Adult >18, n	Adult >18, %	Total, n	Total, %	P-value
Hypotension	4	0.9	40	5.3	44	3.7	<0.001
Bradycardia	4	0.9	34	4.5	38	3.2	<0.001
Allergic Reaction	7	1.6	3	0.4	10	0.8	0.033
Respiratory Depression	6	0.8	4	0.9	10	0.8	0.867
ICU Requirement	6	1.3	7	0.9	13	1.1	0.514
Intubation Requirement	0	0.0	8	1.1	8	0.7	0.028

Table 4. Comorbidities among patients

Comorbidities	n	%
Hypertension	144	12.0%
Diabetes Mellitus	125	10.4%
Other*	111	9.3%
Coronary Artery Disease	84	7.0%
Epilepsy	58	4.8%
Chronic Kidney Disease	40	3.3%
Asthma	38	3.2%
Hydrocephalus	11	0.9%

* Other includes anemia, malignancies, cerebrovascular diseases, smoking-related complications, and cerebral palsy.

the importance of careful monitoring during NORA procedures, as well as the need for appropriate drug selection based on patient characteristics and procedural requirements. The primary goal of NORA is to help patients tolerate invasive procedures by alleviating their anxiety and pain. This plays a critical role in improving the safety and effectiveness of anesthesia practices. There are ongoing discussions regarding the ideal drug combinations for procedural sedation. The selection and dosage of anesthetic drugs should be determined according to the purpose, duration and characteristics of the procedure (7). Drugs used in similar doses may not always provide the desired level of sedation, and this level of sedation may vary from patient to patient (8). Inadequate sedation can lead to significant patient discomfort. Adjusting sedative medications carefully can be particularly challenging for anesthesiologists.

Patients undergoing any interventional procedure outside the operating room should be prepared as if they might need general anesthesia at any moment. In an emergency, it may require transfer to the operating room. This plays an important role in determining the ideal anesthesia approach for each patient and procedure (9). The guidelines emphasize the minimal precautions that should be taken for NORA procedures and the need to create basic conditions to ensure patient safety. Patients should be evaluated and consent obtained before the procedure, and preparations should be made according to the fasting periods determined by the ASA (2). Similarly, Walls and Weiss emphasized that patient-specific comorbidities must be assessed before each NORA procedure, as these patients may be in critical condition and require emergency interventions (10). Karamnov et al. stated that complications developed in more than 5% of patients due to inadequate preoperative evaluation (11). Despite evaluating patients in the clinic, a complication rate of 10.3% was observed, likely linked to factors such as age, comorbidities, and the nature of the procedure.

In previous studies, it has been shown that more than half of NORA patients are female (12). Similarly in this study, 69.1% of the patients were female. The ASA classification is important for perioperative risk assessment in all anesthesia practices. NORA studies often report higher mean patient ages and a greater percentage of ASA Class III-V cases (3). However, Iyilikci et al. analyzed the records of 1622 patients who received NORAand found that 92.4% were ASA I, 5.6% were ASA II, and 4% were ASA III, with no patients in ASA IV (13). Similarly, in Turan et al.'s study, 48.2% of the patients were ASA I, 47.8% were ASA II, and 4% were ASA III (14). In this study, the mean age was determined to be 35.62±28.69 years, and the most common ASA class was found to be ASA II. This lower mean age may be due to the inclusion of pediatric patients in the study.

Studies indicate that medication selection in sedo-analgesia primarily depends on procedure duration and pain level, with propofol favored for its smooth induction, short recovery time, and low postprocedural nausea rates. Commonly used agents include propofol, ketamine, midazolam, dexmedetomidine, fentanyl and meperidine (2). Propofol and midazolam are often preferred, with ketamine frequently added for its analgesic effects. This combination provides effective sedation and quick recovery but may weaken airway reflexes, increasing the risk of aspiration. Continuous monitoring with pulse oximetry and, if available, capnography is vital for early detection of respiratory complications. Reversal agents (naloxone, flumazenil) should always be available to manage complications quickly (1,14-

17).

Hu et al. found that in their procedural sedation study comparing ketamine-propofol with ketamine alone, the ketamine-propofol group had significantly lower rates of cardiovascular side effects, nausea, vomiting, and respiratory complications compared to the ketamine-only group (18). In the study by Turan et al., midazolam, propofol, and ketamine were used as sedative agents. This combination is believed to allow for lower doses of anesthetic agents and to contribute to lower complication rates compared to those reported in the literature (14). In clinical practice, commonly used drug combinations include midazolam, propofol, and ketamine. This choice is made due to the practitioners' familiarity with these drugs and their effectiveness in addressing patient needs and various clinical conditions. Fortunately, reversal agents were not required for any patients. However, since capnography was not available, we could only monitor the patients' respiratory status with pulse oximetry.

The most common adverse effects in NORA patients are nausea and vomiting, inadequate pain control, hemodynamic changes, and respiratory depression (11). During their study conducted across 39 countries between 2010 and 2018, Mason et al. found oxygen desaturation as the most common adverse event, followed by airway obstruction and apnea. They also observed that ASA status above III and procedure duration were the most significant predictors of adverse events, with most events being resolved through minor interventions (19). In the study conducted by Karamnov et al., it was observed that the patient's gender played a role in the frequency of adverse events. In this study, it was noted that female patients experienced significantly more frequent hypotension and oversedation (11). Metzner et al. have indicated that respiratory events are more frequently observed as complications in NORA procedures (20). In this study, nausea or vomiting was not observed; the most frequently observed complication was hypotension. We believe the higher incidence of hypotension is due to older age and the presence of comorbidities, particularly cardiovascular conditions. In non-operating room procedures, just as in the operating room, post-anesthesia care should not be ignored. After the procedure, the absence of pain stimuli can increase the risk of deep sedation. Therefore, the patient should be closely monitored until they are fully recovered (21). All patients were monitored in the recovery room, with safe discharge or transfer to the relevant clinic ensured once their Aldrete score reached ≥ 9.

There are often difficulties in accessing medications and supplies for NORA procedures. Many NORA locations are not equipped with the standard anesthesia equipment and monitors that anesthesiologists are familiar with, and often contain older, unused ventilators. Patient-specific factors, such as age and comorbidities, were found to significantly contribute to the complication rates. This highlights the importance of ensuring adequate preoperative assessment and access to proper equipment in NORA settings. A successful NORA application relies on careful drug selection, preparation for potential complications and multidisciplinary team work. Prioritizing patient safety at every stage of anesthesia is essential to balancing the benefits and risks of sedation (22).

Limitations of the study

This study has a few limitations, including the retrospective data collection and small sample size. Conducted at a single center, the results may not be generalizable to the entire population. Capnography was not available; therefore, respiratory monitoring was conducted using pulse oximetry. The inclusion of pediatric patients impacted the age and ASA class distributions, and separating age groups within the study would have provided clearer insights. Long-term follow-up was not included, limiting the understanding of long-term outcomes. Future research should address these limitations to improve NORA procedure safety and efficacy.

CONCLUSION

In conclusion, patient-specific factors, such as age and comorbidities, were found to significantly influence complication rates in NORA procedures. It is recommended that clinicians focus on preoperative evaluations adapted to individual patient needs. Addressing these factors early can improve the safety and effectiveness of NORA procedures. Furthermore, although most adverse events in this study were minor, careful monitoring of sedation and the use of established drug combinations can enhance outcomes for both providers and patients.

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Peer-Review

Both externally and internally peer reviewed.

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

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Ethical Declaration

Ethical permission was obtained from the Hatay Mustafa Kemal University, Medical Faculty Non-interventional Clinical Research Ethics Committee for this study with date November 3, 2021 and number 26, and Helsinki Declaration rules were followed to conduct this study.

Authorship Contributions

Concept: SU, OK, MÇ, Design: SU, OK, MK, Supervising: SU, OK, MMÇ, MK, MÇ, ÇBÖA, Financing and equipment: SU, OK, MÇ, ÇBÖA, Data collection and entry: SU, OK, MÇ, Analysis and interpretation: SU, OK, MK, Literature search: SU, MMÇ, MÇ, OK, Writing:SU, OK, Critical review: SU, OK, MMÇ, MK, MÇ, ÇBÖA

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