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Research Article

Role of Preoperative Arterial Blood Gas Analysis in American Society of Anesthesiologists Grade III and IV Patients in a Tertiary Care Hospital

Ravela Lakshmi Sravya[1], Soumya Samal[1], Sumita Swain[1*], Bikash Parida[2]

[1] Department of Anesthesiology, Institute of Medical Sciences and SUM Hospital, Siksha O Anusandhan Deemed to be University, Bhubaneswar-751003, India

[2] Department of Radiodiagnosis, Institute of Medical Sciences and SUM Hospital, Siksha O Anusandhan Deemed to be University, Bhubaneswar-751003, India

* Corresponding author's email: sumitabikash2015@gmail.com

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ABSTRACT

Background: The American Society of Anesthesiologists (ASA) physical status classification system was created to give doctors an easy way to categorize a patient's physiological status to forecast their risk for surgery. The study aimed to assess whether preoperative arterial blood gas analysis (ABG) in these patients affects the postoperative ventilation status regarding the number of patients intubated, needing oxygen support, or on room air.

Subjects and Methods: This prospective observational study was conducted on 100 patients over one year of ASA-Grade III & IV. An arterial blood sample was drawn under all aseptic precautions. An ABG analyzer was used to evaluate blood gas parameters. The quantitative variables were expressed as mean and standard deviation. All quantitative variables were analyzed using the independent students test, and categorical variables were analyzed using the chi-square test.

Results: Parameters evaluated were patients' postoperative ventilation status, a comparison of preoperative and postoperative ventilation status, an association of preoperative PH, PaO2, PCO2, bicarbonate, and lactate with postoperative ventilation status, the percentage of patients with serum electrolyte abnormalities, the preoperative mean blood glucose level, and the postoperative ventilation status of the patients. It was statistically significant (P=0.002) that the patients on acidosis before surgery were already intubated. Most preoperative acidotic patients needed postoperative mechanical ventilator support, which is statistically significant with P=o.oo8.

Conclusions: Our study observed a statistically significant association of preoperative PH, lactate, and blood glucose in ABG with patients requiring mechanical ventilation postoperatively. Higher preoperative mean blood glucose levels were associated with more intubated patients postoperatively.

Introduction

The American Society of Anesthesiologists (ASA) physical state classification system was created to provide clinicians with a direct way to classify a patient's physiological status and aid in predicting their risk for surgery [1,2]. The anesthesiologist evaluates the patient's physical condition before surgery after considering the patient's presentation, medical history, and functional restrictions. The score is subjective and is based on the patient's physical status. According to the patient's physical condition and general health, this score, which ranges from ASA I to ASA VI, would thus make an attempt to classify the patient's risk of perioperative problems. More groups have a higher risk of perioperative adverse events for the patients assigned to them. The ASA Physical Status Classification System (ASA-PS) was developed with the aim of predicting perioperative risk and improving patient outcomes [3]. Its frequent application in clinical practice and implementation in various healthcare-related settings serve as evidence of its significance.

Since the development of modern medicine, blood gas and pH analyses have been the most reliable laboratory and bedside methods for diagnosing and monitoring serious diseases [4]. Blood gas and pH are frequently evaluated using arterial blood gas (ABG). Ventilation and oxygenation are crucial for high-risk and emergency patients with concomitant disorders. According to a number of studies, even seasoned emergency physicians routinely underestimate the severity of hypoxemia. Abnormal physiologic conditions frequently observed in individuals with concomitant disorders might impair the capacity to get accurate measures evaluating oxygenation and ventilation with noninvasive techniques like pulse oximetry and capnometry [4]. End-tidal CO2 (EtCO2) readings may be affected by irregular ventilation/perfusion (V/Q) relationships in some circumstances (such as shock, hemorrhage, during a cardiac massage, etc.), and the inability of pulse oximetry to determine arterial hemoglobin saturation may also occur (SpO2).

ABG analysis is a diagnostic method that impartially assesses a patient's breathing, acid-base balance, and oxygenation. The outcome of an ABG will reveal the patient's respiratory condition and the health of their kidneys, among other internal organs (metabolic system). ABG can be used to optimize the electrolyte status, particularly the levels of potassium (K) and ionized calcium (Ca2+), which is crucial in the treatment of developing or apparent heart failure [5]. The number of intubated patients requiring oxygen support or room air after surgery depends on the preoperative abnormal ABG values in ASA grades III and IV patients, which increases morbidity and death. So, we conducted this study to determine whether preoperative arterial blood gas analysis in ASA grade III and IV patients affects the postoperative ventilation status. Whether preoperative ABG analysis in ASA grade III and IV patients affects the postoperative ventilation status regarding the number of patients intubated, on oxygen support, or with room air. The comparison of parameters evaluated in this study was the association of preoperative PH, partial pressure of arterial oxygen (paO2), partial pressure of arterial carbon dioxide (paCO2) bicarbonate, blood glucose, and lactate with postoperative ventilation status, and the relation of preoperative ventilation status with postoperative ventilation status.

Subjects and Methods

This prospective observational study was carried out after obtaining approval from the institutional ethics committee and written informed consent from the patients. The specimen was obtained through an arterial puncture or an indwelling arterial catheter preoperatively on the day of surgery. Once obtained, the arterial blood sample was analyzed as soon as possible to reduce the possibility of erroneous results. Automated blood gas analyzers were used to analyze blood gas samples, and results were obtained within 10 to 15 minutes. Automated blood gas analyzers, directly and indirectly, measure specific components of the arterial blood gas sample. ASA grade III and IV patients with both genders for elective and emergency surgery were included. This study excluded patients with abnormal coagulation profiles, failure to withdraw arterial blood, and refusal. Parameters observed were preoperative ventilation status, preoperative pH, PO2, PCO2, HCO3, lactate, glucose, electrolytes (Na, K, Cl), and post-operative ventilation status.

The data was analyzed using a statistical software package for the social sciences, version 25 (SPSS Inc. Chicago, USA). The quantitative variables were expressed as mean and standard deviation, whereas categorical variables are expressed in number and percentage. All quantitative variables were analyzed through an independent student test. However, categorical variables were analyzed by chi-square test. P value < 0.05 was statistically significant.

Results

Of 100 patients, 62 (62%) were male, 38 (38%)were female, 61 (61%) had ASA grades III, and 39 (39%) had ASA grades IV. Preoperatively, 30 (30%) were intubated, 26 (26%) required oxygen assistance, and 44 (44%) were breathing room air. Out of which, postoperatively, 56(55%) needed mechanical ventilation, 18 (18%) needed oxygen assistance, and 26 (26%) were on room air. All 30 of the patients who underwent preoperative intubation underwent postoperative intubation. None were on room air or oxygen support. Of the 26 patients receiving oxygen assistance before surgery, 30.8% were intubated, 50% were still receiving it, and 19.2% were breathing ambient air. Of the four patients on room air before surgery, 40.9% were intubated, 11.4% had oxygen assistance, and 47.7% were still on room air (Figure 1). Thirty patients had normal PaO2, twenty-three patients had decreased PaO2, and forty-seven patients had raised PaO2 out of 100 (Table 1).

In contrast, in 23 patients with reduced PaO2, 13(56.52%) required postoperative ventilator support, which is not statistically significant, with a p-value of 0.118. With normal PaO2, 14 (46.7%) required postoperative ventilator support out of 30 patients. Postoperative ventilatory support was necessary for 29 patients with elevated PaO2 (61.7%). Of 100 patients, 35 % had normal PaCO2, 54% had decreased PaCO2, and 11% had raised PaCO2. Of 54 patients with preoperative decreased PaCO2, 51.9 % were intubated postoperatively, 18.5% were on oxygen support, and 29.6% were on room air. Of 11 patients with increased PaCO2, 90.9% were intubated, and 9.1 % were on oxygen support. For patients with normal PaCO2, 51.4% were intubated, 20% were on oxygen support, and 28.6% were on room air (Table 2).

Of the 36 patients with bicarbonate levels within the normal range, 14 (38.9%) required intubation, 8 (22.2%) required oxygen assistance, and 14 (38.9%) required room air after surgery. Of the 49 patients who had reduced bicarbonate, 33 (67.34%) required intubation, 8 (16.33%) needed oxygen assistance, and 8 (16.33%) required room air after surgery. Out of 15 patients with elevated bicarbonate, 60% required postoperative intubation, 13.33% needed oxygen assistance, and 26.67% were breathing ambient air (Table 2). Out of 8 patients with normal lactate levels, 1(12.5%) had intubation, 2(25%) needed oxygen assistance, and 5(62.5%) were on room air. 92 patients had elevated lactate levels; of them, 55(59.78%) had postoperative intubation, 16 (17.39%) were receiving oxygen assistance, and 21(22.83%) were breathing room air. Most patients with elevated lactate levels before surgery needed postoperative mechanical ventilator assistance, which is statistically significant, with a p-value of 0.022 (Table 3). In the study population, 41% of patients had sodium within the normal range, 49 % had decreased, and 10% had increased sodium. In the study population, 51% had potassium within the normal range, 38% had hypokalemia, and 11% had hyperkalemia. Of 100 patients, 49% had chloride within the normal range, 7% had hypochloremia, and 44% had hyperchloremia. The mean blood glucose of patients intubated postoperatively was 185.23±93.47. The mean blood glucose of patients on oxygen support postoperatively was 145.83±66.73. The mean blood glucose of patients on room air postoperatively was 141.77±52.73. A statistically significant association exists between mean blood glucose and postoperative ventilation P=0.039.

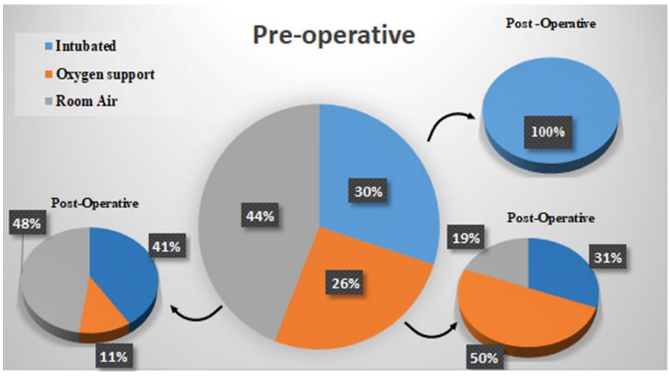

Figure 1: Preoperative and post-operative ventilation status

Table 1: Comparison of preoperative and post-operative ventilation status

Pre-operative ventilation	Post-operative ventilation				
	Number (%)	Intubated (%)	Oxygen Suppo (%)	Room air (%)	P-value
Intubated	30(30%)	30(100%)	0(0%)	0(0%)	
Oxygen support	26(26%)	8(30.8%)	13(50%)	5(19.2%)	<0.001
Room air	44(44%)	18(40.9%)	5(11.4%)	21(47.7%)	

Table 2: Comparison of preoperative ABG and postoperative ventilation status

Pre-Operative ABG		Post-Operative ventilation status				
Parameters		Number (%)	Intubated (%)	Oxygen support (%)	Room air (%)	p-value
PaO2	Normal	30 (30%)	14 (46.7%)	3 (10.0%)	13 (43.3%)	
	Decreased	23(23%)	13 (56.52%)	5 (21.74%)	5 (21.74%)	0.118
	Increased	47 (47%)	29 (61.7%)	10 (21.3%)	8 (17.0%)	
PaCo2	Normal	35(35%)	18 (51.4%)	7 (20.0%)	10 (28.6%)	
	Decreased	54 (54%)	28 (51.9%)	10 (18.5%)	16 (29.6%)	0.166
	Increased	11 (11%)	10 (90.9%)	1 (9.1%)	0 (0.0%)	
HCO3	Normal	36 (36%)	14 (38.9%)	8 (22.2%)	14 (38.9%)	
	Decreased	49 (49%)	33 (67.34%)	8 (16.33%)	8 (16.33%)	0.102
	Increased	15 (15%)	9 (60%)	2 (13.33%)	4 (26.67%)	

ABG: arterial blood gas analysis

In pre-operative 45 cases, 10(22.2%) of Normal pH were intubated, 10 (22.2%) were on oxygen support, and 25 (55.6%) were on room air. Out of 28 patients with acidosis 16 (57.1%) were intubated, 7(25.0%) were on oxygen support, and 5(17.9%) were on room air (Figure 2). Out of 27 cases with alkalosis, 4(14.8%) were intubated, 9(33.3%) were on oxygen support, and 14(51.9%) were on room air (Table 4). The patients who developed acidosis preoperatively were already intubated, and it was statistically significant P=0.002.

Table 3: Lactate and postoperative ventilation status

Pre-Operative ABG	Post-Operative ventilation status				
Lactate	Number (%)	Intubated (%)	Oxygen support (%)	Room air (%)	p-value
Normal	8(8%)	1 (12.5%)	2 (25.0%)	5 (62.5%)	
Increased	92 (92%)	55 (59.78%)	16 (17.39%)	21 (22.83%)	0.022

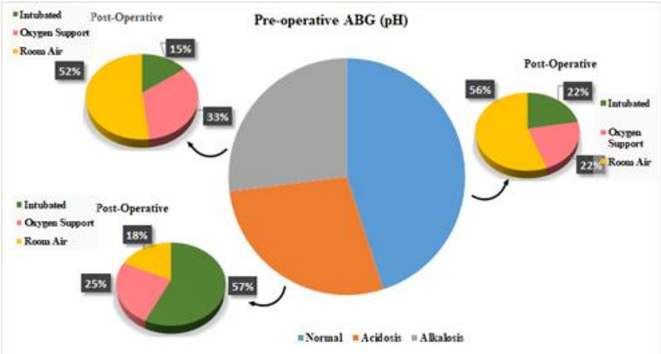

Figure 2: pH and post-operative ventilation status

Out of 27 cases with alkalosis, 4(14.8%) were intubated, 9(33.3%) were on oxygen support, and 14(51.9%) were on room air (Table 4). The patients who developed acidosis preoperatively were already intubated, and it was statistically significant *P*=0.002.

Table 4: pH and post-operative ventilation status

Pre-operative ABG	Post-Operative ventilation status				
pH Status	Number (%)	Intubated	Oxygen support	Room air	p-value
Normal	45 (45%)	10 (22.2%)	10 (22.2%)	25 (55.6%)	
Acidosis	28 (28%)	16 (57.1%)	7 (25.0%)	5 (17.9%)	0.002
Alkalosis	27 (27%)	4 (14.8%)	9 (33.3%)	14 (51.9%)	

Discussion

In our study of 100 ASA grade III and IV patients, we observed the relation of preoperative arterial blood gas in predicting postoperative ventilation status in several patients intubated, on oxygen support, and in-room air. Also, the study observed that common electrolyte abnormalities occurred in the patients preoperatively. Most patients with increased PaO2 are also on mechanical ventilation, possibly because they are on oxygen support or have already been intubated preoperatively. This indicates that both decreased PaO2 and increased PaO2 were associated with adverse outcomes in COVID-19 patients (6). The study showed that alteration in SpO2 and PaO2, both high and low values, are good predictors of adverse outcomes irrespective of the oxygen strategies used (6).

The research examines the connection between critical patients' in-hospital mortality, arterial oxygen, and carbon dioxide tension (7). The study was conducted between 2008 to 2012 on 7689 patients who were admitted to the ICU. They found no statistically significant difference between PaO2 and PCO2 levels in mortality. A statistically insignificant change in mortality was also not identified in connection to PaO2 or FiO2 (7). High mortality rates were seen in patients with high FiO2 levels in a retrospective research of 50 intensive care units (ICUs) examining the connection between arterial oxygen pressure and mortality in patients receiving mechanical ventilator assistance (7,8). In the first 24 hours in the ICU, they discovered that low and high PaO2 levels increased death rates (8).

Current study also identified no statistical significance between PCO2 and post-operative mechanical ventilator support. A recent retrospective study by Schneider et al. on a large series of patients monitored in the ICU with mechanical ventilation support demonstrated that hypocapnia led to poor clinical results (9,10). Most of the patients with acidosis are already intubated preoperatively, and they also require postoperative mechanical ventilatory support. The patients who developed acidosis preoperatively were already intubated, and it was statistically significant P=0.002. A retrospective observational study on patients sent to the emergency department after cardiac arrest occurred out of the hospital. Patients admitted to the hospital may not receive advanced life support, prehospital adrenaline, or soda bicarbonate. They collected samples for blood gas within 5 min after ALS had begun and concluded that the blood pH at an early stage of cardiac arrest could be an independent prognostic factor of neurological outcome after cardiac arrest occurred outside of the hospital (11).

Current study tried to find the association of bicarbonate with the outcome of ventilation status and found that arterial bicarbonate levels had poor or no relation with the ventilation status postoperatively. This contradicts the study on 336 patients diagnosed with acute aortic dissection (AAD) and admitted to ICU (12). The HCO3 levels are potentially valuable in predicting short-term and long-term outcomes in AAD patients. The low serum HCO3 level at admission is an independent index to predict long-term and short-term mortality in ICU patients with AAD. Our study observed that patients with high preoperative glucose levels were significantly associated with postoperative mechanical ventilation. Patients with high glucose levels were intubated postoperatively; a retrospective cohort study on patients older than 18 years. The objective was to evaluate the effect of preoperative blood glucose (POBG) level on hospital length of stay (LOS) in patients undergoing appendectomy or laparoscopic cholecystectomy. The blood glucose levels were measured 48 hours before surgery and closest to the surgical incision. They found that pre-operative blood glucose was significantly associated with prolonged hospital length of stay (13, 14).

A retrospective observational study was conducted on 61,000 elective noncardiac surgery patients (15). In a very large cohort of patients undergoing elective non-cardiac surgery, they assessed the statistical relationship between preoperative blood glucose concentration and postoperative in-hospital outcomes and 1-year mortality, as well as the impact of a diagnosis of diabetes mellitus on these relationships. They noticed that individuals with preoperative euglycemia and diagnosed diabetes often had poorer 1-year mortality than those without diabetes (15). Preoperative hyperglycemia should be given greater consideration in patients without diabetes than in patients with diabetes undergoing elective noncardiac surgery.

As a limitation, this study has selection bias as it included patients from a single urban center. Additionally, some patients were optimized pre- and intra-operatively, and the post-operative ventilation status of patients was affected by the duration and types of surgery.

Conclusion

A statistically significant association exists between preoperative pH and lactate in ABG and the number of patients requiring mechanical ventilation postoperatively. No significant association of preoperative PaO2, PCO2, and HCO3 with postoperative ventilation status had been found. More patients have been significantly found to be intubated postoperatively compared to preoperative ventilation status. Higher preoperative mean blood glucose levels were associated with more intubated patients postoperatively.

Funding

No fund has received.

Conflict of Interest

The authors declare that there is no conflict of interest.

Data availability

Data are available upon reasonable request.

ORCID

Ravela Sravya 0009-0003-2302-438X
Sumita Swain 0000-0002-6057-7333
Bikash Parida 0000-0002-9805-7982

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