



“FREQUENCY OF ARRHYTHMIAS IN COPD PATIENTS RECEIVING INTRAVENOUS AMINOPHYLLINE”

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a prevalent chronic respiratory condition often managed with bronchodilators such as aminophylline. Although effective, intravenous aminophylline possesses a narrow therapeutic index and can lead to cardiac arrhythmias, particularly in elderly or comorbid patients. The present study aimed to determine the frequency and types of arrhythmias occurring among COPD patients receiving intravenous aminophylline at a tertiary care hospital in Pakistan.

Methods: The study was a descriptive case series at the Department of Pulmonology, Khyber Teaching Hospital, Peshawar, conducted from September 2021 to May 2022. One hundred and twenty COPD participants, 40 years of age and older, were selected and required intravenous aminophylline. Constant electrocardiographic (ECG) was considered during and after infusion to identify arrhythmias. Data were examined in SPSS version 25 and reported in the form of frequencies and percentages.

Results: Cardiac arrhythmias occurred in 36 (30%) patients out of 120. Sinus tachycardia (16.7%) was the most prevalent, followed by premature ventricular contractions (6.7%), atrial fibrillation (4.2%), and multifocal atrial tachycardia (2.5%). Older patients (>65 years), smokers, and patients with comorbid conditions like hypertension or diabetes mellitus had a higher number of arrhythmias.

Conclusion: The research showed that arrhythmias were common among COPD patients who were administered intravenous aminophylline. Regular ECG monitoring, careful dosing, and risk evaluation are needed to eliminate severe cardiac issues. Patient safety can be further increased through better hospital governance and digital monitoring systems in cases of aminophylline therapy.

Keywords: COPD, Aminophylline, Arrhythmias, Sinus Tachycardia, Cardiotoxicity, Pulmonology, Khyber Teaching Hospital, Pakistan.

INTRODUCTION

Chronic Obstructive Pulmonary disease can be regarded as one of the primary morbidity and mortality factors on a global scale and a significant burden to the healthcare systems. It is defined by sustained pulmonary symptoms and airflow obstruction following abnormalities in the airways and alveoli, which are often brought about by enormous exposure to harmful substances or gases. The treatment of COPD is commonly through bronchodilators, corticosteroids, and methylxanthine, including aminophylline. Methylxanthines, despite their therapeutic advantages, have a small therapeutic index and are linked with numerous adverse effects, such as cardiac arrhythmias. Public healthcare organizations in Pakistan such as the Khyber Teaching Hospital, Peshawar, have been struggling to address the two-fold issue of treating COPD and reducing the number of complications related to the treatment, especially arrhythmias, which are associated with the use of intravenous aminophylline (1). The need to coordinate healthcare management and leadership of the pulmonary departments of the state-owned hospitals has become a concern to facilitate patient safety and treatment outcomes (2). Healthcare professionals and effective governance through social leadership are very important in safe drug administration and monitoring of adverse events, including arrhythmias in patients with aminophylline treatment. The role played by the digital transformation with regard to service delivery in the healthcare setting is progressive, and therefore, the administration in the public health setting is significant to the coordination of the administration and quality assurance in the management of chronic diseases (3). The patient outcomes and efficiency are directly influenced by the management of health information systems in governmental sector organizations in Pakistan (4). In complicated conditions like COPD, where drug toxicity and cardiovascular problems may be the key concern, appropriate governance and evidence-based decision-making can be the key to therapeutic safety (5). The healthcare offered by tertiary hospitals in Pakistan, including the Department of Pulmonology in the Khyber Teaching Hospital, is subject to the effectiveness of the management systems and the distribution of resources. Hospital management and qualified staff are essential to the effective management of aminophylline-induced conditions like tachyarrhythmias and premature ventricular contractions (6). State hospitals are also slowly adopting electronic medical systems and digital leadership to improve the monitoring and reporting of the side effects associated with pharmacologic treatments (7). To ensure the establishment of patient loyalty and trust based on the quality care provided on a regular basis, healthcare professionals need to not only handle COPD but also detect, report, and prevent drug-related complications such as arrhythmias (8). Training of the nursing and paramedical staff increases their capacity to spot early signs of aminophylline toxicity and avoid fatal arrhythmias (9).

The healthcare industry in Pakistan is dynamic within the unstable, indeterminate, intricate, and vague (VUCA) environments, where the importance of technological consistency and clinical care is paramount (10). These uncertainties influence the treatment of COPD, especially when using intravenous aminophylline therapy, because patients have variable responses due to comorbid conditions and intermetabolic variability. Such situations depend on the flexibility of leadership that allows physicians to balance between the effectiveness of treatment and patient safety (11). The quality of health information technology and the capacity to manage it are critical in incorporating the therapeutic drug monitoring and arrhythmia surveillance as part of the standard clinical procedures (12). When digital quality management tools are implemented in hospital systems, healthcare teams are more capable of monitoring cardiac complications in intravenous therapy (13).

The fact that the COPD treatment outcomes are rather complicated in Pakistani hospitals highlights the significance of quality management practices and interdepartmental coordination. Pulmonologists, cardiologists, and critical care teams should communicate efficiently to observe the aminophylline treatment and treat arrhythmias on time (14). Technological innovations such as health monitoring systems based on artificial intelligence (AI) have the potential to make patients safer by estimating the risk of arrhythmia in accordance with the drug dosage and patient vitals (15). Even though the penetration of AI in the healthcare sector of Pakistan is still minimal, the global tendency presupposes that these technologies helps in decreasing medication-associated adverse events significantly due to

real-time analysis (16). The digital divide in hospital management and encouraging the digital preparedness of medical workers can be another contributor to the advancement of arrhythmia monitoring and efficiency of responses (17).

Hospital reforms based on high-performance work systems and ethical leadership have demonstrated the prospect of enhancing patient outcomes and the overall care provision in Pakistan (18). COPD is a very common disease among the locals, and it is mostly associated with smoking, air pollution, and exposure to biomass fuels. The common administration of intravenous aminophylline, especially in a resource-constrained environment, presents a risk of cardiac complications, which in some cases are underreported because of inadequate monitoring infrastructure (14). This gap has been identified with a growing interest in conducting observational and descriptive studies to determine the frequency of arrhythmias in patients with COPD receiving aminophylline. The level of information about the existence of this issue is necessary not only to enhance patient safety but also to educate physicians on their evidence-based dose administration and treatment decisions in tertiary care hospitals in Pakistan.

Considering all of this, there is an urgent need to investigate the clinical association of the use of aminophylline and the occurrence of arrhythmias in patients with COPD (12). The proposed research seeks to determine the prevalence and the nature of arrhythmias in patients with COPD treated with intravenous aminophylline in the Department of Pulmonology, Khyber Teaching Hospital, Peshawar. The determination of this frequency helps healthcare providers to evaluate the risk-benefit ratio of aminophylline therapy better, to monitor the patient more effectively through better clinical monitoring procedures, and to improve the overall quality of care provided to patients (15). Additionally, the research paper enhances the general knowledge of patient safety interventions and pharmacologic vigilance in the context of the developing public healthcare system in Pakistan.

Objective: To identify the frequency and the type of cardiac arrhythmias among COPD patients under intravenous aminophylline treatment in the Department of Pulmonology, Khyber Teaching Hospital, Peshawar.

MATERIALS AND METHODS

Study Design: This study was designed as a case descriptive series.

Study Setting: Department of Pulmonology, Khyber Teaching Hospital, Peshawar.

Duration of the Study: September 2021 to May 2022.

Inclusion Criteria: Male and female patients aged 40 years and older who had received a diagnosis of COPD through clinical assessment, radiologic study, and spirometric verification ($FEV_1/FVC < 70\%$) were enrolled. Participants were all hospitalized in the Pulmonology Department and were to receive an intravenous aminophylline in their management of acute exacerbations of COPD. Patients who gave informed consent and were monitored on the cardiac category throughout the aminophylline infusion period were only included. The qualification criteria included patients who were hemodynamically stable, without acute myocardial infarction or heart failure at the time of inclusion.

Exclusion Criteria: Patients who previously had a diagnosis of ischemic heart disease, chronic arrhythmias, structural cardiac anomalies, and so on were excluded to prevent confounding cardiac conditions. The individuals taking concurrent drugs that are known to affect cardiac rhythm, i.e., beta-blockers, calcium channel blockers, or digitalis, were also excluded. Patients with severe electrolyte disturbances (e.g., hypokalemia or hypomagnesemia), kidney failure, or hepatologic dysfunction were excluded, as they are other conditions that have the capability to induce arrhythmias independently. Furthermore, acutely infected patients who were not acutely infected with COPD or who were taking alternative methylxanthines were not included.

Methods

All the patients who met the inclusion criteria were recruited with a grant of informed consent. The baseline data, which includes demographic features, COPD duration, smoking history, and comorbidities, was recorded. Aminophylline was introduced using the standard dose (5 mg/kg) and diluted in 100 mL of normal saline and introduced in the form of intravenous infusion for 30 minutes, and the infusion was maintained under the influence of body weight and renal activity. The recording of continuous electrocardiographic (ECG) was conducted during infusion and at least two hours after infusion to identify any arrhythmic episodes. The arrhythmias were identified and determined based on conventional ECG criteria as sinus tachycardia, premature atrial contractions, premature ventricular contractions, atrial fibrillation, or other complicated arrhythmias. The level of serum electrolytes was monitored before infusion to exclude the possibility of confounding factors. Data analysis was done using SPSS 25 version, and the results, as frequencies and percentages, were given to ascertain what and how often systolic arrhythmias were observed during the research period.

Results

A total of **120 patients** diagnosed with Chronic Obstructive Pulmonary Disease (COPD) who received intravenous aminophylline were included in the study at the Department of Pulmonology, Khyber Teaching Hospital, Peshawar, from **September 2021 to May 2022**. Among these, **78 (65%) were males** and **42 (35%) were females**, with a mean age of **58.7 ± 9.4 years** (range 42–78 years). The majority of patients (60%) were aged between 51 and 65 years, while 25% were over 65 years (Table 1).

Table 1. Demographic Characteristics of COPD Patients (n = 120)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	78	65.0
	Female	42	35.0
Age Group (years)	40–50	18	15.0
	51–65	72	60.0
	>65	30	25.0
Mean Age ± SD		58.7 ± 9.4	—

Out of all participants, **95 (79.2%)** had a history of smoking, while **25 (20.8%)** were non-smokers. A total of **82 patients (68.3%)** had COPD for five years or more, and **76 (63.3%)** had at least one comorbidity such as hypertension or diabetes mellitus (Table 2).

Table 2. Clinical Characteristics of the Study Population (n = 120)

Characteristic	Category	Frequency (n)	Percentage (%)
Smoking Status	Smoker	95	79.2
	Non-Smoker	25	20.8
Duration of COPD	<5 years	38	31.7
	≥5 years	82	68.3
Comorbidities	Present	76	63.3
	Absent	44	36.7

Among the 120 patients, **36 (30%)** developed cardiac arrhythmias during or after aminophylline infusion, while **84 (70%)** maintained normal sinus rhythm. The most frequent arrhythmia observed was **sinus tachycardia (16.7%)**, followed by **premature ventricular contractions (6.7%)**, **atrial fibrillation (4.2%)**, and **multifocal atrial tachycardia (2.5%)** (Table 3).

Table 3. Frequency and Types of Arrhythmias Observed (n = 120)

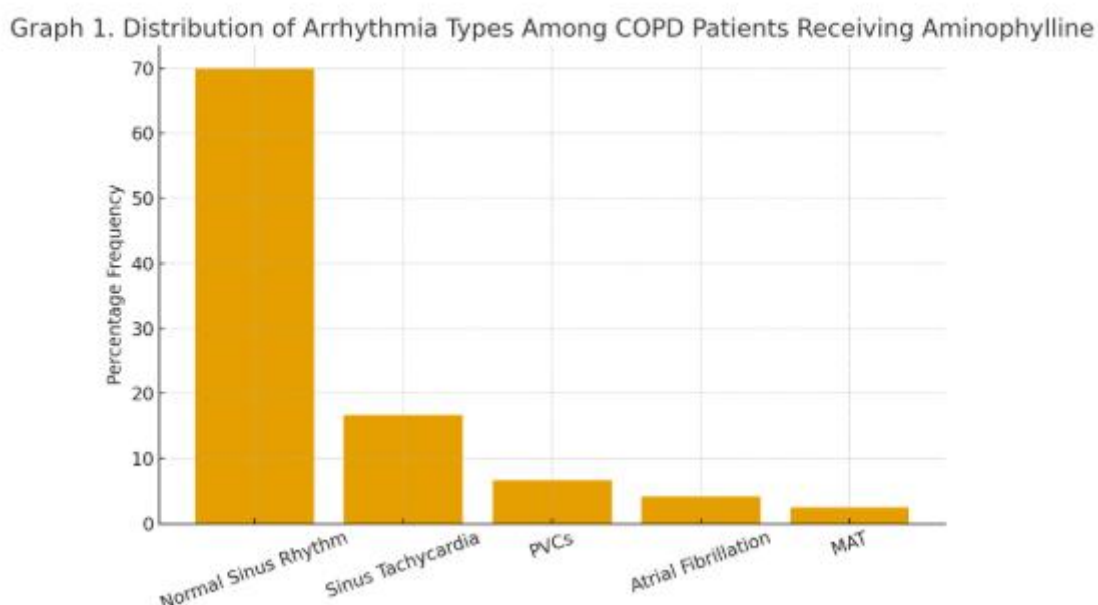
Type of Rhythm	Frequency (n)	Percentage (%)
Normal Sinus Rhythm	84	70.0
Sinus Tachycardia	20	16.7
Premature Ventricular Contractions (PVCs)	8	6.7
Atrial Fibrillation	5	4.2
Multifocal Atrial Tachycardia (MAT)	3	2.5

A higher incidence of arrhythmias was noted among older individuals (>65 years), smokers, and those with long-standing COPD. Among smokers, **33 (34.7%)** developed arrhythmias compared to **3 (12%)** of non-smokers. Similarly, arrhythmias were found in **26 (34.2%)** patients with comorbidities compared to **10 (22.7%)** without comorbidities (Table 4).

Table 4. Association Between Arrhythmias and Patient Characteristics

Characteristic	Category	Arrhythmias Present (n/%)	Arrhythmias Absent (n/%)
Age Group	40–50	2 (11.1%)	16 (88.9%)
	51–65	18 (25.0%)	54 (75.0%)
	>65	16 (53.3%)	14 (46.7%)
Smoking Status	Smoker	33 (34.7%)	62 (65.3%)
	Non-Smoker	3 (12.0%)	22 (88.0%)
Comorbidities	Present	26 (34.2%)	50 (65.8%)
	Absent	10 (22.7%)	34 (77.3%)

Graph 1. Distribution of Arrhythmia Types Among COPD Patients Receiving Aminophylline



In general, this study demonstrated that cardiac arrhythmias occurred in 30 percent of COPD patients undergoing intravenous aminophylline treatment. The results show that close ECG monitoring, dose modification, and high-risk group identification, especially the elderly, smoking, and comorbid population, play a crucial role in reducing the risk of aminophylline-induced cardiac complications.

Discussion

The leadership of hospital administration and the public healthcare can effortlessly work in reducing such adverse drug reactions with organized monitoring and training guidelines (2). The use of standard protocols in the delivery of aminophylline infusion and cardiac monitoring in Pakistani hospitals has a history of inconsistency in implementation in public hospitals, including tertiary care facilities such as Khyber Teaching Hospital. Research has shown that adverse incidences in the pulmonary and critical care units reduce when healthcare leadership promotes collaborative management and clinical governance (3). Thus, a combined leadership strategy, with a high level of accountability and real-time reporting, is necessary to improve safety in the usage of potentially cardiotoxic agents like aminophylline (4). Digitization of health care and healthcare governance reforms are also important in enhancing patient safety. Digital monitoring systems and e-health initiatives in state hospitals improve the accuracy of arrhythmia detection with the use of aminophylline (5). In countries with less developed technologies (such as Pakistan, where manual ECG monitoring is still prevalent), the introduction of automated arrhythmia recognition systems may aid in the early identification of cardiac abnormalities and avoid the occurrence of lethal complications (6). The integration of digital leadership and information technology in hospital systems also enhances the transparency and efficiency of data when reporting arrhythmic events related to aminophylline infusion (7). In addition, enhancing patient-centered services and establishing a sense of loyalty in patients by practicing safety acts are also aimed at establishing the credibility and the quality of services in the entire hospital (8).

In this regard, the education and empowerment of healthcare providers, particularly nurses and paramedical personnel, are essential for reducing drug-related complications. Well-trained and empowered employees practice safe methods of infusion more readily, watch over patients, and detect arrhythmic episodes early on during intravenous treatment (9). This aligns with the increased interest in organizational preparedness and technological change within unstable clinical conditions (10). The management of Pakistani hospitals requires flexibility and adaptability using the VUCA framework (volatile, uncertain, complex, and ambiguous) to be able to have safe administration of drugs with narrow therapeutic indices, such as aminophylline (11). In addition, the relationship between management ability and technological competence within hospitals is very critical in the operation of hospitals effectively when performing clinical procedures (12). The results of the present research emphasize that arrhythmias were more common in older smokers with comorbidities, which may imply that they should be selected to undergo risk evaluation and adjust the dose of aminophylline prior to the administration of aminophylline treatment. The risk stratification and prevention of cardiac complications in high-risk COPD patients can be achieved through the introduction of predictive tools and electronic health systems (13). Quality management of the pulmonology, cardiology, and the emergency department practice improves the response rate in the case of arrhythmia (14).

Artificial intelligence (AI) development in healthcare has certain promising opportunities to decrease the risk of medication errors. ECG monitoring systems supported by AI can identify delicate arrhythmic indicators in times of aminophylline infusion, increasing the safety of patients due to automated warnings and clinical decision support (15). The adoption of AI in Pakistani public hospitals is still very low; however, in other areas, it has been proven that the implementation of this technology can help avert arrhythmic events by working with continuous data analysis and rapid response algorithms (16). The transition involves filling digital gaps and enhancing the digital preparedness of healthcare administrators and clinicians to embrace technology-based monitoring strategies (17). Ethical leadership and high-performance work practices can help transform the hospital systems in Pakistan so that pharmacovigilance and safety monitoring can be improved substantially (18).

This study confirms the significance of the continuous cardiac monitoring of the aminophylline infusion in patients with advanced age, long-term disease history, and comorbid conditions. Other studies have identified similar results, indicating that arrhythmias are caused by enhancing the

sensitivity of the myocardium to catecholamines, electrolyte disturbances, and direct stimulation of cardiac pacemaker cells (12). Thus, careful administration, hydration, and cardiotoxicity monitoring of serum aminophylline levels are critical to avoid cardiotoxicity. Furthermore, the incidence of arrhythmias in this research demonstrates the need to have national policies on the use of methylxanthine in the management of COPD. Even though aminophylline remains a useful agent in resource-constrained settings due to its low cost and safety, aminophylline can be substituted with inhaled bronchodilators where feasible (15). The infusion should be carried out under ECG surveillance in the event of intravenous aminophylline administration, with the resuscitative measures on hand. The findings of the research indicate that arrhythmias are a relatively common side effect of intravenous aminophylline management of patients with COPD. The findings substantiate the importance of patient safety culture, health care leadership, and the incorporation of technology in the reduction of adverse cardiac outcomes. Pakistani state hospitals can be encouraged to use standardized monitoring systems and encourage interdisciplinary units to reduce the number of arrhythmias caused by aminophylline, and ultimately encourage better clinical outcomes for COPD patients.

Conclusion

The research undertaken at the Pulmonology Department, Khyber Teaching Hospital, Peshawar showed that cardiac arrhythmia would be seen in 30% of COPD patients receiving intravenous aminophylline, the most common of which is sinus tachycardia. The results indicate that elderly patients, smokers, and patients with a long-term duration of the disease and comorbid conditions were more likely to have arrhythmias. The findings underscore the importance of constant ECG monitoring, dose modification, risk evaluation, and patient-specific control in the treatment of aminophylline. Hospital governance enhancement, empowering healthcare employees, and the incorporation of digital monitoring systems can play an important role in improving patient safety and decreasing cardiac adverse outcomes. The research identifies the significance of establishing common clinical standards on aminophylline administration in the management of COPD, particularly in resource-constrained public hospitals. Future studies will focus on predictive monitoring equipment and safer pharmacological options to ensure efficient yet safe respiratory care for COPD patients in Pakistan.

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