Section: Pulmonary Medicine

Original Research Article

ETIOLOGICAL PROFILE AND OUTCOME OF PATIENTS WITH ACUTE RESPIRATORY FAILURE : A CROSS SECTIONAL STUDY

Shahzad Hussain Arastu[1], Mohammed Saifuddin[2], Khaja Javed Ali[3]

[1]*Associate Professor, Pulmonary Medicine, Shadan Institute of Medical Sciences and Research Center, Hyderabad, Telangana India.*
[2]*Associate Professor, Pulmonary Medicine, Dr. VRK women's Medical College Teaching Hospital & Research Center, Telangana, India.*
[3]*Assistant Professor, Pulmonary Medicine, Shadan Institute of Medical Sciences and Research Center, Hyderabad, Telangana India.*

Received *: 10/07/2024*
Received in revised form *: 09/09/2024*
Accepted *: 24/09/2024*

Corresponding Author:
Dr. Khaja Javed Ali,
Assistant Professor, Pulmonary medicine, Shadan institute of medical sciences and research Centre, India.
Email: khajajavedali1992@gmail.com

DOI: 10.70034/ijmedph.2024.3.174

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2024; 14 (3); 966-971

ABSTRACT

Background: Respiratory failure is classified into Type 1 (hypoxemic) and Type 2 (hypercapnic), each with distinct causes and presentations. Type 1 results from impaired oxygen transfer, while Type 2 stems from ineffective carbon dioxide clearance. This study explores etiological profiles and outcome in terms of mortality in a tertiary care hospital setting.

Materials and Methods: This was a cross sectional study conducted in the department of respiratory medicine of a tertiary care medical institute. 60 patients with type I or type II respiratory failure were included in this study on the basis of a predefined inclusion and exclusion criteria. The duration of study was 18 months. A detailed history and through clinical examination was done in all the cases. Arterial blood gas analysis and other relevant investigations were done in all cases. Etiological profile and outcome in terms of mortality was deteminded in all cases. SPSS 22.0 software was used for statistical analysis and p value less than 0.05 was taken as statistically significant.

Results: In this study of 60 patients with respiratory failure, 61.67% were male. Majority of the patients were between 51-60 age group. Type I respiratory failure was more common and was seen in 56.67% of cases, while Type II occurred in 43.33%. Chronic obstructive airway disease (16.67%) was the most common cause followed by pneumonia aspiration, and severe ARDS. The overall mortality rate was 18.33%, with sepsis and multiorgan dysfunction and postoperative respiratory failure showing the highest mortality (50%), while pneumonia had a 14.29 % mortality rate. Despite these challenges, 81.67% of patients were successfully discharged, with several conditions showing 100% survival rates.

Conclusion: The most common primary etiological cause of respiratory failure was pneumonia followed by chronic obstructive airway disease. Overall mortality in cases of respiratory failure was 18.33% with highest mortality seen in cases of respiratory failure due to sepsis with multiorgan dysfunction and post-operative respiratory failure.

Keywords: Respiratory Failure, Arterial Blood Gas analysis, Pneumonia, Multiorgan Dysfunction.

INTRODUCTION

Respiratory failure is a condition characterized by the inability of the respiratory system to maintain adequate gas exchange either due to failure in oxygenation or elimination of carbon dioxide. It is classified into two broad categories, Type 1 (hypoxemic) and Type 2 (hypercapnic) respiratory failure. Type 1 is primarily caused by conditions that impair oxygen transfer at the alveolar-capillary membrane, such as pneumonia, acute respiratory distress syndrome (ARDS), and pulmonary embolism.[1] Type 2 respiratory failure occurs when the ventilatory system is unable to clear carbon

dioxide effectively, often seen in diseases like chronic obstructive pulmonary disease (COPD), neuromuscular disorders and conditions causing central nervous system depression. The risk factors for respiratory failure are multifactorial and include underlying pulmonary pathology, systemic illnesses, age-related physiological decline, and environmental factors such as smoking and obesity.[2]

Type 1 (hypoxemic) respiratory failure is defined by an arterial partial pressure of oxygen (PaO2) less than 60 mm Hg in the presence of normal or low arterial partial pressure of carbon dioxide (PaCO2). It typically results from mismatches in ventilation and perfusion or from diffusion abnormalities. This is usually seen in ARDS, pneumonia, and pulmonary edema.[3] Type 2 (hypercapnic) respiratory failure is characterized by an elevated PaCO2 greater than 50 mm Hg and is usually accompanied by hypoxemia.[4] This occurs due to alveolar hypoventilation, seen in conditions such as COPD, asthma, obesity hypoventilation syndrome and neuromuscular disorders. The diagnostic workup for respiratory failure primarily revolves around arterial blood gas (ABG) analysis, which is crucial in assessing the severity of hypoxemia and hypercapnia. Chest imaging, including chest radiography and computed tomography (CT).[5]

The clinical presentation of respiratory failure varies depending on the underlying etiology and whether the failure is hypoxemic or hypercapnic. In Type 1 respiratory failure, patients typically present with signs of hypoxemia, including dyspnea, tachypnea, cyanosis, and altered mentation, particularly in severe hypoxic states.[6] Patients with ARDS or severe pneumonia may show marked respiratory distress, use of accessory muscles and intercostal retractions.[7] Cyanosis and confusion may develop in patients with profound hypoxemia which may lead to multi-organ failure. Type 2 respiratory failure often presents with features of hypercapnia, including dyspnea, headache, confusion and somnolence. Patients may exhibit signs of respiratory fatigue such as paradoxical abdominal movements or accessory muscle use.[8] Chronic hypercapnic respiratory failure is frequently associated with polycythemia, cor pulmonale, and peripheral edema due to pulmonary hypertension. In both types of respiratory failure, a thorough clinical examination, along with targeted investigations, is essential for determining the severity of the failure and guiding appropriate therapeutic interventions.[9]

While risk factors such as advanced age, comorbidities, and mechanical ventilation use are well-documented, there is a paucity of research examining how these factors differentially impact the clinical course and prognosis of the two types of respiratory failure.[10] This study aims to address these gaps by providing detailed insights into the clinical profiles, risk factors, and outcomes of patients with Type 1 and Type 2 respiratory failure in a tertiary care hospital. By identifying specific clinical patterns the study seeks to inform therapeutic strategies thereby improving patient care in tertiary healthcare settings.

MATERIAL AND METHODS

This was a cross sectional study conducted in the department of respiratory medicine of a tertiary care medical institute. 60 patients with type I or type II respiratory failure were included in this study on the basis of a predefined inclusion and exclusion criteria. The duration of study was 18 months. Sample size was calculated on the basis of pilot studies done on the topic of respiratory failure in adults. Keeping power (1-Beta error) at 80% and the confidence interval (1-Alpha error) at 95% minimum sample size required was 56 patients, therefore we included 60 adult patients with respiratory failure in this study.

Demographic details such as age, gender and area of residence was noted in all cases. A detailed history was obtained with respect to presence of risk factors for respiratory failure. History of any significant illness such as diabetes, hypertension and bronchial asthma was asked and noted. Any personal history of previous episode of respiratory failure as well as dyspnea was asked for and noted. A detailed clinical examination that included assessment of respiratory rate, use of accessory respiratory muscles, and paradoxical abdominal breathing. Arterial blood gas (ABG) analysis, electrocardiography (ECG), chest X-ray (CXR), baseline blood chemistry, and complete blood count (CBC), Fasting blood sugar level (FBS), renal function tests (RFT) and liver function tests (LFT) as well as viral markers were done in all cases. High-resolution computed tomography (HRCT) and 2D ECHO was done in all cases. Additional investigations, as deemed necessary by the attending physician including chest ultrasound, lower limb ultrasound, computed tomography pulmonary angiography (CTPA), B-type natriuretic peptide (BNP), and C-reactive protein (CRP) were done in selected cases.

Diagnosis of type I and type II respiratory failure was done on the basis of following criteria.[11]

Type I Respiratory failure

Partial pressure of arterial oxygen (PaO_2) less than 60 mm Hg in presence of normal or low carbon dioxide levels ($PaCO_2$) typically remaining below 45 mm Hg.

Type II Respiratory failure

Partial pressure of arterial carbon dioxide ($PaCO_2$) exceeds 50 mm Hg accompanied with or without hypoxemia, depending on the underlying condition.

Data on the length of hospital stay, ICU admission, and in-hospital mortality were recorded. The final diagnosis for each patient was confirmed after a comprehensive review of clinical history, physical examination, and available investigation results. Based on the suspected diagnosis, decisions regarding emergency treatment and admission were

made. Patients remained under observation in the emergency department initially and were later transferred to intensive care unit (ICU) for further management.

Statistical analysis was done with Statistical Package for the Social Sciences (SPSS) version 23.0 software. Quantitative data was expressed as mean and standard deviation whereas qualitative data was expressed as frequency and percentage tables. For the analysis of quantitative variables, a paired t-test was employed, and the Chi-square test was applied to qualitative variables. A p-value of less than 0.05 was considered statistically significant.

Inclusion Criteria

1. Patients presenting with either type I (Partial pressure of arterial oxygen (PaO_2) less than 60 mm Hg in presence of normal or low carbon dioxide levels ($PaCO_2$) typically remaining below 45 mm Hg) or type II (Partial pressure of arterial carbon dioxide ($PaCO_2$) exceeds 50 mm Hg) respiratory failure.
2. Age above 18 years.
3. Those who gave written and informed consent to be part of study.

Exclusion Criteria

1. Age less than 18 years
2. Those who refused consent.
3. Patients of respiratory failure secondary to polytrauma.

Any significant psychiatric illness.

RESULTS

Out of the 60 studied cases there were 37 (61.67%) were males and 23 (38.33%) were females. There was a significant male preponderance in the studied cases with a M:F ratio of 1:0.621. [Figure 1]

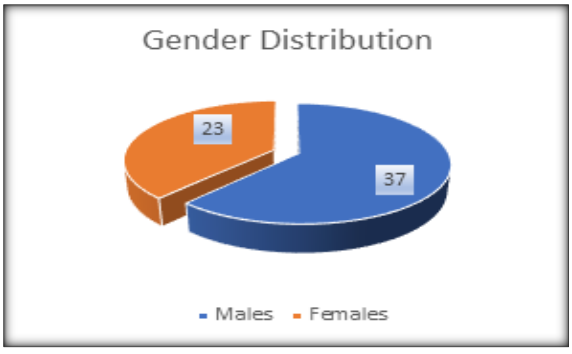

Figure 1

The analysis of age distribution among the studied cases showed that the majority of cases were in the 51-60 years age group with 30% of males (18 cases) and 18.33% of females (11 cases) in this range. In the 41-50 years category 11.67% of males (7 cases) and 8.33% of females (5 cases) were present. Smaller percentages were observed in the 61-70 years group, with 10% of males (6 cases) and 6.67% of females (4 cases). Among those above 70 years, there were 8.33% of males (5 cases) and 5% of females (3 cases). There were no cases in the 18-30 years age group. The mean of male and female patients was found to be 52.89 ± 9.82 and 53.17 ± 9.30 years respectively. The mean age of male and female patients was found to be comparable with no statistically significant difference (P=0.9131). [Table 1]

Out of 60 patients 34 (56.67%) patients were found to have type I respiratory failure whereas remaining 26 (43.33%) patients had Type II respiratory failure. In cases of mix type of respiratory failure predominant type was considered. [Figure 2]

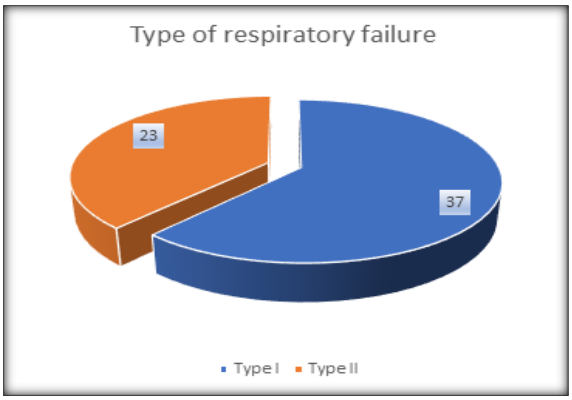

Figure 2: Predominant Type of respiratory failure in studied cases

The analysis of primary etiological cause of respiratory failure showed that the most common primary etiological cause of respiratory failure was Pneumonia (23.33 %) followed by chronic obstructive airway disease (16.67%) Aspiration (6.67%) and Severe acute respiratory distress syndrome (6.67%). Congestive heart failure, cerebral edema due to diabetic ketoacidosis and encephalitis accounted for 3 cases (5.0%). Pleural effusion, status epilepticus, septicaemia with multiorgan dysfunction and cerebral malaria were observed in 2 cases each (3.33%). Various other conditions, including pneumothorax, interstitial lung disease, SLE with pulmonary involvement, bronchiolitis, bacterial meningitis, viral meningitis and acute pancreatitis were noted in 1 case each (1.67%). [Figure 3]

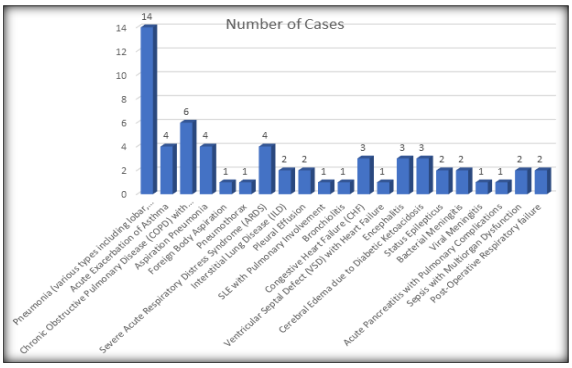

Figure 3: Etiological Profile of patients with respiratory failure

The analysis of outcome of cases with acute respiratory failure showed that out of 60 patients 11 (18.33%) patients succumbed to respiratory failure during hospital stay and 49 (81.67%) could be successfully discharged. Sepsis with multiorgan dysfunction and post operative respiratory failure cases had highest mortality rate at 50.0% (1 death out of 2 patients. Pneumonia, affecting 14 patients, had the mortality rate of 14.29 % (2 deaths) and a survival rate of 85.71%. Conditions such as COPD, Congestive Heart Failure (CHF), Encephalitis and Cerebral Edema due to Diabetic Ketoacidosis each had a mortality rate of 33.33% (1 death) and a survival rate of 66.67%, affecting 3 patients in each case. Aspiration Pneumonia and Severe Acute Respiratory Distress Syndrome (ARDS) both showed a mortality rate of 25.0% (1 death each) and a survival rate of 75.0%. Meanwhile, several conditions, including Foreign Body Aspiration, Pneumothorax, Interstitial Lung Disease (ILD), Pleural Effusion, Systemic Lupus Erythematosus (SLE) with Pulmonary Involvement, Bronchiolitis, Ventricular Septal Defect (VSD) with Heart Failure, Status Epilepticus, Bacterial Meningitis, Viral Meningitis, Acute Pancreatitis with Pulmonary Complications had no mortality with a 100.0% survival rate across all patients. [Table 2]

Table 1: Gender wise Age distribution of the studied cases

Age Group	Male		Female	Female (%)
	No of cases	Percentage	No of cases	Percentage
18-30 years	0	0.00%	0	0.00%
31-40 years	1	1.67%	0	0.00%
41-50 years	7	11.67%	5	8.33%
51-60 years	18	30.00%	11	18.33%
61-70 years	6	10.00%	4	6.67%
Above 70 years	5	8.33%	3	5.00%
Total	37	61.67%	23	38.33%
Mean Age	52.89 +/- 9.82		53.17 +/- 9.30	
P = 0.9131 (Not Significant)				

Table 2: Outcome of studied cases in terms of mortality

Outcome in terms of mortality	Total Patients	Survivals	Survival %	Deaths	Death %
Pneumonia (various types including lobar, bronchopneumonia)	14	12	85.71%	2	14.29 %
Acute Exacerbation of Asthma	4	4	100.0 %	0	0.0 %
Chronic Obstructive Pulmonary Disease (COPD)	6	4	66.6 %	2	33.33 %
Aspiration Pneumonia	4	3	75.0 %	1	25.0 %
Foreign Body Aspiration	1	1	100.0 %	0	0.0 %
Pneumothorax	1	1	100.0 %	0	0.0 %
Severe Acute Respiratory Distress Syndrome (ARDS)	4	3	75.0 %	1	25.0 %
Interstitial Lung Disease (ILD)	2	2	100.0 %	0	0.0 %
Pleural Effusion	2	2	100.0 %	0	0.0 %
SLE with Pulmonary Involvement	1	1	100.0 %	0	0.0 %
Bronchiolitis	1	1	100.0 %	0	0.0 %
Congestive Heart Failure (CHF)	3	2	66.67 %	1	33.33 %
Ventricular Septal Defect (VSD) with Heart Failure	1	1	100.0 %	0	0.0 %
Encephalitis	3	2	66.67 %	1	33.33 %
Cerebral Edema due to Diabetic Ketoacidosis	3	2	66.67 %	1	33.33 %
Status Epilepticus	2	2	100.0 %	0	0.0 %
Bacterial Meningitis	2	2	100.0 %	0	0.0 %
Viral Meningitis	1	1	100.0 %	0	0.0 %
Acute Pancreatitis with Pulmonary Complications	1	1	100.0 %	0	0.0 %
Sepsis with Multiorgan Dysfunction	2	1	50.0 %	1	50.0 %
Post-Operative Respiratory Failure	2	1	50 %	1	50.0%
Total	60	49	81.67%	11	18.33%

DISCUSSION

This was a cross sectional study comprising of 60 cases with respiratory failure admitted to a teritiary care medical institute. there were 37 (61.67%) were males and 23 (38.33%) were females. There was a significant male preponderance in the studied cases with a M:F ratio of 1:0.621. The mean of male and female patients was found to be 52.89 ± 9.82 and 53.17 ± 9.30 years respectively. The mean age of male and female patients was found to be comparable with no statistically significant difference.

The observed male predominance in acute respiratory failure (ARF) cases can be attributed to a combination of behavioral, occupational, and biological factors.[12] Men are generally more exposed to risk factors such as smoking,

occupational hazards, and environmental pollutants. All these factors may increase the risk of developing severe respiratory conditions like Chronic Obstructive Pulmonary Disease (COPD) and pneumonia leading to ARF.[13] Additionally, biological differences, particularly the cardioprotective effects of female hormones such as estrogen, play a crucial role in mitigating the severity of respiratory and cardiovascular complications. Estrogen has been shown to modulate inflammatory responses and improve pulmonary function, thereby reducing the susceptibility and severity of ARF in females. Studies done by et al and et al reported increased propensity of developing respiratory failure in men as compared to women.[14]

In this study, the most common primary etiological cause of respiratory failure was pneumonia (23.33%), followed by chronic obstructive pulmonary disease (10%), aspiration pneumonia (6.67%), severe acute respiratory distress syndrome (6.67%), and congestive cardiac failure (5%). Less frequent causes included pneumothorax, interstitial lung disease, SLE with pulmonary involvement, bronchiolitis, bacterial meningitis, viral meningitis, and acute pancreatitis (in 1.67% of cases each). Wani AA et al conducted a prospective study to assess the causes, clinical features, treatment, and outcomes of acute respiratory failure in adults in Kashmir, North India.[15] For this purpose, the authors undertook a study of 100 patients over 18 years old with acute respiratory failure over a period of one and a half years. Respiratory failure was diagnosed using criteria such as SpO2 ≤92% or altered respiratory patterns, among others. The study found that the mean age of the cohort was 55 years (SD ± 19). The most common cause of respiratory failure was COPD with acute exacerbation (45%), followed by sepsis with MODS (20%), acute organophosphate poisoning (12%), massive intracerebral hemorrhage (4%), and other causes including acute liver failure, ARDS, opioid poisoning, left ventricular failure, pulmonary thromboembolism, anaphylaxis, acute myocardial infarction, myasthenia crisis, strangulation, and fat embolism. Type-2 respiratory failure was present in 45% of patients, while 55% had type-1 respiratory failure. Invasive ventilation was required in 55% of patients, 26% required non-invasive ventilation (NIV), and 19% needed high-flow oxygen via nasal cannula. Similar etiological profile of respiratory failure was also reported by the authors such as Magazine R et al,[16] and Karande S et al.[17]

The analysis of etiology-related outcomes showed that sepsis with multiorgan dysfunction had the highest mortality rate at 50.0% (1 death out of 2 patients). Pneumonia had a 14.29% mortality rate (2 deaths among 14 patients). Conditions such as congestive heart failure, encephalitis, and cerebral edema due to diabetic ketoacidosis each had a 33.33% mortality rate (1 death in 3 patients). Aspiration pneumonia and severe ARDS had a 25.0% mortality rate (1 death each), and COPD had a 33.33% mortality rate (2 deaths out of 6 patients). Several conditions, including foreign body aspiration, pneumothorax, ILD, and others, had no mortality, with a 100.0% survival rate. The overall mortality in this study was 18.33%.O.R. Luhr et al conducted a prospective cohort study to determine the incidence and 90-day mortality of acute respiratory failure (ARF), acute lung injury (ALI), and acute respiratory distress syndrome (ARDS) across Sweden, Denmark, and Iceland.18 The study involved 1,231 ARF patients, identifying 287 with ALI and 221 with ARDS. The incidences were 77.6 per 100,000/year for ARF, 17.9 for ALI, and 13.5 for ARDS. The 90-day mortality rates were 41.0% for ARF, 42.2% for ALI, and 41.2% for ARDS. Similar mortality rates were also reported by the authors such as Antonsen K et al,[19] and Lewandowski K et al.[20]

CONCLUSION

The most common primary etiological cause of respiratory failure was Pneumonia, chronic obstructive airway disease followed by acute exacerbation of asthma, Severe acute respiratory distress syndrome, aspiration and congestive cardiac failure. Overall mortality in cases of respiratory failure was 18.33% with highest mortality seen in cases of respiratory failure due to sepsis with multiorgan dysfunction.

Conflict of Interest: None.

REFERENCES

1. Lamba TS, Sharara RS, Singh AC, Balaan M. Pathophysiology and Classification of Respiratory Failure. Crit Care Nurs Q. 2016;39(2):85-93. doi:10.1097/CNQ.0000000000000102
2. Sundh J, Ekström M. Risk factors for developing hypoxic respiratory failure in COPD. Int J Chron Obstruct Pulmon Dis. 2017; 12:2095-2100. Published 2017 Jul 20. doi:10.2147/COPD.S140299
3. Chen L, Rackley CR. Diagnosis and Epidemiology of Acute Respiratory Failure. Crit Care Clin. 2024;40(2):221-233. doi: 10.1016/j.ccc.2023.12.001
4. Pontoppidan H, Geffin B, Lowenstein E. Acute respiratory failure in the adult. 1. N Engl J Med. 1972;287(14):690-698. doi:10.1056/NEJM197210052871404
5. Hagens LA, Heijnen NFL, Smit MR, et al. Systematic review of diagnostic methods for acute respiratory distress syndrome. ERJ Open Res. 2021;7(1):00504-2020. Published 2021 Jan 18. doi:10.1183/23120541.00504-2020
6. Bartlett RH, Morris AH, Fairley HB, Hirsch R, O'Connor N, Pontoppidan H. A prospective study of acute hypoxic respiratory failure. Chest. 1986;89(5):684-689. doi:10.1378/chest.89.5.684
7. Fiott DL, Gauci J, Pace Bardon M, Balzan M. Type 2 respiratory failure secondary to left hemidiaphragmatic paralysis. Breathe (Sheff). 2022;18(1):210165. doi:10.1183/20734735.0165-2021
8. Budweiser S, Jörres RA, Pfeifer M. Treatment of respiratory failure in COPD. Int J Chron Obstruct Pulmon Dis. 2008;3(4):605-618. doi:10.2147/copd. s3814
9. Garland A, Dawson NV, Altmann I, et al. Outcomes up to 5 years after severe, acute respiratory failure. Chest. 2004;126(6):1897-1904. doi:10.1378/chest.126.6.1897

10. See KC. Approach to acute respiratory failure for frontline clinicians. Singapore Med J. 2022;63(12):740-745. doi: 10.4103/singaporemedj.SMJ-2022-002
11. McNicholas BA, Madotto F, Pham T, et al. Demographics, management and outcome of females and males with acute respiratory distress syndrome in the LUNG SAFE prospective cohort study. Eur Respir J. 2019;54(4):1900609. Published 2019 Oct 17. doi:10.1183/13993003.00609-2019
12. Heffernan DS, Dossett LA, Lightfoot MA, et al. Gender and acute respiratory distress syndrome in critically injured adults: a prospective study. J Trauma. 2011;71(4):878-885. doi:10.1097/TA.0b013e31822c0d31
13. Gorman EA, O'Kane CM, McAuley DF. Acute respiratory distress syndrome in adults: diagnosis, outcomes, long-term sequelae, and management. Lancet. 2022;400(10358):1157-1170. doi:10.1016/S0140-6736(22)01439-8
14. Tofovic SP. Estrogens and development of pulmonary hypertension: interaction of estradiol metabolism and pulmonary vascular disease. J Cardiovasc Pharmacol. 2010;56(6):696-708. doi: 10.1097/FJC.0b013e3181f9ea8d
15. Wani AA, Ahmad M, Shafi A, et al. Etiology, clinical profile and outcome of acute respiratory failure in adults in Kashmir Valley (North India): A hospital-based prospective study. Int J Innov Res Med Sci. 2020;5(9):407-411. doi:10.23958/ijirms/vol05-i09/774.
16. Magazine R, Rao S, Chogtu B, Venkateswaran R, Shahul HA, Goneppanavar U. Epidemiological profile of acute respiratory distress syndrome patients: A tertiary care experience. Lung India. 2017;34(1):38-42. doi:10.4103/0970-2113.197097
17. Karande S, Murkey R, Ahuja S, Kulkarni M. Clinical profile and outcome of acute respiratory failure. Indian J Pediatr. 2003;70(11):865-869. doi:10.1007/BF02730586
18. Luhr OR, Antonsen K, Karlsson M, et al. Incidence and mortality after acute respiratory failure and acute respiratory distress syndrome in Sweden, Denmark, and Iceland. The ARF Study Group. Am J Respir Crit Care Med. 1999;159(6):1849-1861. doi:10.1164/ajrccm.159.6.9808136
19. Antonsen K, Wetterslev J, Bonde J. Incidens, svaerhedsgrad og mortalitet af akut lungesvigt i Danmark [Incidence, severity and mortality of acute respiratory failure in Denmark]. Ugeskr Laeger. 2000;162(20):2876-2881.
20. Lewandowski K, Metz J, Deutschmann C, et al. Incidence, severity, and mortality of acute respiratory failure in Berlin, Germany. Am J Respir Crit Care Med. 1995;151(4):1121-1125. doi:10.1164/ajrccm.151.4.7697241.