



Pulmonary embolism is the least cause of hypoxia during mechanical ventilation in intensive care unit at King Hussein Hospital, Amman

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Abstract

Objective of the study was to evaluate and assess the inducing causes of hypoxia in our intensive care unit patients subjected to mechanical ventilation. This prospective study included 413 adult patients, of both sexes, aged 33-62 years, classed I-III by the American society of anesthesiologists and admitted to our intensive care unit at King Hussein hospital, King Hussein medical city, Amman, Jordan during the period May 2012-June 2014 after obtaining written informed consent from all participants guardians and approval from our local royal medical services committee for ethical and research purposes. All patients admitted to the intensive care unit during the previous period were investigated for hypoxic events and correlated with the cause of admission. Hypoxia was defined as oxygen saturation less than 88% while on mechanical ventilation. Our study included only stable patients on mechanical ventilation with secondary hypoxemia but not secondary to the underlying cause of respiratory failure. For statistical analysis, Students t test was applied and probability value less than 0.05 were considered significant. There were 11.9% of total patients on mechanical ventilation who experienced acute hypoxic episode. The most common cause of acute hypoxia was atelectasis (32.7%). Pulmonary embolism was the least cause of hypoxia (2%) in patients on mechanical ventilation in our intensive care unit. Hypoxic episodes in patients on mechanical ventilator in the intensive care unit are not so uncommon and strict observation has to be implemented to avoid harmful outcome.

Keywords: Embolism: pulmonary; hypoxia; intensive: unit; ventilation: mechanical.

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Introduction

Oxygenation of the tissues is a function of arterial oxygenation, oxygen carriage in blood, delivery of blood to the tissues and transfer of oxygen from the blood. It may be impaired by respiratory or cardiovascular dysfunction, severe anemia or a left-shift of the oxyhemoglobin dissociation curve. Hypoxemia is an inadequate partial pressure of oxygen in arterial blood. Hypoxia is oxygen deficiency at the tissue level. Hypoxemia threatens tissues globally and if allowed to persist risks

permanent damage to those organs mostly dependent on continued oxygen supply. There is no safe or unsafe level of arterial oxygen tension. The risk presented by a level of hypoxemia is dependent upon the patient's hemoglobin concentration, cardiac output, and state of hydration, current diseases and the duration of exposure to the lowered oxygen tension. Few patients are harmed by arterial oxyhemoglobin saturation of greater than 80%, but this low level provides little margin for safety if other complication happens.

Mechanical ventilation in the intensive care unit is considered very crucial in dealing with respiratory failure in critically diseased patients. Mechanical ventilation is a life saving technique. Mechanical ventilation has its own benefits and in the same time its own adverse effects and hazards. Optimum oxygenation is an essential target of mechanical ventilation. Patients on mechanical ventilation commonly suffer from hypoxic episodes due to multiple origins. These origins must be assessed and managed. Complications of mechanical

ventilation are multiple such as: acute respiratory distress syndrome, hypotension and ventilator associated pneumonia [1].

Respiratory failure can be caused by different clinical situations as: chronic obstructive airway disease, pneumonia, acute respiratory distress syndrome, asthma and sepsis. Respiratory failure is a common cause of admission to the intensive care unit. Oxygen consumption is much higher by the presence of systemic illness, fever or agitation. The increased metabolic rate implies that CO₂ levels increase. Hypoventilation in the presence of an adequate inspired oxygen concentration must be very severe to cause hypoxemia. Reduction of the ventilator minute volume from a normal value to a reduced one may cause arterial oxygen saturation to decrease to 90% in a healthy patient [2]. This is severe hypoventilation. The reduction in functional residual capacity and the tendency to hypoventilation make alveolar collapse or atelectasis.

Atelectasis causes impairment of gas exchange and increases the risk of chest infection. Risk factors for its development include lung disease, spontaneous ventilation, high abdominal pressure, high inspired oxygen fractions and the head down position. Extended exposure of the open airway to atmospheric pressure adds to the risk of alveolar collapse [3]. The aim of our investigation was to evaluate and assess the incidence and origins of hypoxic episodes in intensive care unit patients on mechanical ventilation.

Materials and Methods

Our prospective investigation consists of 413 adult patients, of both genders, aged 33-62 years, classed I-III by the American society of anesthesiologists (ASA) and assigned for admission in the intensive care unit at King Hussein hospital, King Hussein medical city, Amman, Jordan, during the period May 2012-June 2014 after obtaining written informed consent from all subjects relatives and approval from the royal medical Jordanian services ethical and research committee.

All our study subjects admitted to the intensive care unit and scheduled for mechanical ventilation were investigated for hypoxic episodes and related to the cause of admission. Hypoxia was defined as oxygen saturation less than 88% and a partial pressure of arterial oxygen less than 60 torr in patients on mechanical ventilation. Hypoxia was correlated with its cause. Causes of respiratory failure

were evaluated in all patients put on mechanical ventilation. Our investigation enrolled stable patients with optimum oxygenation with different modes of ventilation and various oxygen fractions delivered by the ventilator to patients. These patients, experienced acute hypoxia but not due to the inducing cause of respiratory failure. Our study ruled out patients if the cause of hypoxia was secondary to the inducing cause of respiratory failure.

For statistical analysis, Students t test was applied and probability value less than 0.05 was considered significant.

Results

The study group included 413 adult patients. The mean age was 47 years (ranging between 33 and 62 years). There were 199 males and 214 females. Patients with ASA I included 254 patients, patients with ASA II included 146 patients and ASA III included 13 patients. Table 1.

Table 1: Demographic features of participants

Variable	description
N	413
Sex	
M	199
F	214
ASA	
I	254
II	146
III	13
Age(yr)	47(33-62)

There were 11.9% of total patients on mechanical ventilation who experienced acute hypoxic episode. These were 49 patients. Males included 23 subjects and females enrolled 26 subjects. The most common cause of acute hypoxia was atelectasis (32.7%). The most common cause of atelectasis in these patients was mucous plugging (62.5%). Pulmonary embolism was the least cause of hypoxia (2%) in patients on mechanical ventilation in our intensive care unit (Table 2).

The most frequent cause of respiratory failure in patients with acute hypoxic episodes was cardiopulmonary arrest (30.6%). The least cause of respiratory failure was pulmonary embolism (2.1%) (Table 3). All hypoxic episodes were not related to the primary cause of respiratory failure (Table 4).

Table 2: Etiology of hypoxic episodes

Cause	Incidence
Atelectasis	32.7%(16)
Poor suctioning	25%(4)
Right endobronchial intubation	12.5%(2)
Mucous plugging	62.5%(10)
Pulmonary edema	24.5%(12)
pneumonia	16.3%(8)
pneumothorax	10.2%(5)
Endotracheal tube problems	8.2%(4)
Adult respiratory distress syndrome	6.1%(3)
Pulmonary embolism	2%(1)

Table 3: Etiology of respiratory failure in our study group

Cause	Frequency
Cardiopulmonary arrest	30.6%(15)
Septic shock	20.4%(10)
Chronic obstructive airway disease	14.3%(7)
pneumonia	12.2%(6)
postoperative	10.2%(5)
Adult respiratory distress syndrome	6.1%(3)
Pulmonary edema	4.1%(2)
Pulmonary embolism	2.1%(1)

Table IV. Causal relationship between hypoxic episodes and respiratory failure

Hypoxic episode	Respiratory failure								total
	Cardio-Pulmonary arrest	Septic shock	COAD	pneumonia	Postop.	ARDS	Pulmonary edema	PE	
Atelectasis	6	2	3	3	1	0	0	1	16
Pulmonary edema	4	2	2	0	3	0	1	0	12
pneumonia	3	3	2	0	0	0	0	0	8
pneumothorax	1	0	0	0	1	3	0	0	5
ETT problems	0	2	0	1	0	0	1	0	4
ARDS	0	1	0	2	0	0	0	0	3
PE	1	0	0	0	0	0	0	0	1
Total	15	10	7	6	5	3	2	1	49

Discussion

Different mechanisms of hypoxemia are known as disturbed diffusion, ventilation-perfusion mismatch, alveolar hypoventilation, decreased venous oxygen and venous admixture. The causes of hypoxic episodes in a patient on mechanical ventilator are divided into ventilator related problems, deterioration of the primary disease or the appearance of a new clinical disorder. In our investigation, 11.9% of patients on mechanical ventilation experienced severe hypoxemia.

Atelectasis is frequently induced by mucous plugging due to poor suctioning or right endobronchial intubation. Chest-x-ray may ascertain the right endobronchial intubation with endotracheal tube recalibration to manage atelectasis. Adequate suctioning of mucous plugs may relieve the endobronchial obstruction and ameliorating

hypoxemia. Optimum suctioning with removal of secretions may avoid plugging and subsequent atelectasis. Bronchoscopy has a major participation in removal of secretions to ameliorate hypoxemia of atelectasis. Bronchoscopy is used mainly to remove secretions and subsequently to ameliorate atelectasis and hypoxia [4]. Risk factors for atelectasis in intensive care unit patients include disturbed mucociliary clearance, decreased cough ability and immobilization, all causing mucous retention. Atelectasis is a frequent cause of hypoxic episode causing other complications as pneumonia [5]. Right upper lobe atelectasis due to unintentional right endobronchial intubation is well known [6]. The existence of breath sounds after endotracheal intubation in both lungs cannot rule out right endobronchial intubation. Chest-x-ray must be done to confirm the position [7]. Right endobronchial intubation may occlude the orifice of the right upper lobe bronchus because it is close to the carina. Left

lower lobe or whole left lung may collapse due to right endobronchial intubation. Left lower lobe atelectasis can be due to poor suctioning of left main bronchus due to natural anatomical variations. Adequate suctioning needs a suction catheter that is ½ the diameter of the endobronchial tube placed at the level of the carina with minimal pressure suctioning initiated after 1-2 cm withdrawal from the carina for 10 sec. [8].

Pulmonary embolism is an uncommon cause of hypoxic episode in our investigation. The routine administration of preventive anticoagulant therapy in our study can explain the decreased incidence of PE, supporting the implementation of its use in patients in the intensive care unit on mechanical ventilation. PE (pulmonary embolism) can be suspected in subjects who experience sudden hypoxic episode with unexplained tachycardia or hypotension [9]. The use of CT angiogram to diagnose PE is limited to stable patients with low risk of contrast induced complications. Chest-x-ray is abnormal in 66% of cases [10]. Assessment of all hypoxic episodes should be initiated immediately without any delay, starting with chest physical testing. Assessment of the endotracheal tube should clarify if there is bleeding, secretions or dislodgement. Every hypoxic episode has its own management protocol depending on its cause. Hypoxic episode management depends on correct diagnosis and prompt response rather than increasing the fraction of oxygen. PE is often missed in intensive care unit patients. Incidence of PE in admitted hospital patients is 15 % [11]. The frequency of embolic events in pulmonary disease patients is 8-25 %. Intubated COAD patients had no recorded PE [12].

The occurrence of PE was 1.9%, 33% of them were in subjects with ARDS in a previous study [10]. Risk factors for PE in intensive care unit patients are: platelets transfusion, age, vasopressor use, history of DVT, mechanical ventilation, end stage renal failure and length of hospital stay [9].

Conclusion

Hypoxic episodes in patients on mechanical ventilator in the intensive care unit are not so uncommon and strict observation has to be implemented to avoid harmful outcome.

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