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THE STUDY OF OXYGENATION AND ASSOCIATED MORTALITY IN SURGICAL ICU PATIENTS

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ABSTRACT

The aim of this study was to investigate association of mortality with the hypoxemia and hyperoxaemia in surgical patients. The study was a prospective, observational study, conducted on the 167 patients admitted in Surgical ICU over a period of eighteen months (January 2014 - June 2015) in Department of Surgery, Mathura Das Mathur Hospital attached to Dr. S. N. Medical College, Jodhpur. PaO_2 values were analysed at admission, at 24 hours, at 48 hours, at 72 hours, at the time of shifting to ward in survivors and before death in nonsurvivors. At admission, PaO_2 was normal (80 – 100 mm of Hg) in 19.2% patients, hypoxemia (PaO_2<80 mm of Hg) was seen in 63.5% patients and hyperoxaemia (PaO_2 >100 mm of Hg) in 17.3% patients. During ICU stay, > 50% patients were hyperoxygenated. In expired patients, before death, hypoxemia was seen in 54.8% patients and hyperoxaemia in 35.5%. Focusing on PaO_2, in surgical ICU, mortality was shown to be had a U-shaped relationship with PaO_2. Both hypoxemia and hyperoxaemia are independently associated with high mortality in surgical ICU patients. Further studies are needed to find if this association is causal or merely a reflection of differences in severity of illness.

KEY WORDS: Oxygenation, Hypoxemia, Hyperoxaemia, Surgical ICU

INTRODUCTION

Pulmonary gas exchange refers to transfer of O_2 from atmosphere to blood stream (oxygenation) and CO_2 from blood stream to the atmosphere (CO_2 elimination). The state of arterial blood oxygenation is determined by the PaO_2. PaO_2 that is less than expected indicates hypoxaemia.[1]

Hypoxemia refers to any state in which the oxygen content of arterial blood is reduced. It is identified by a low PaO_2 (<10.7 kPa; <80 mmHg).[1] The term 'hyperoxaemia' may be defined as high blood oxygen tension PaO_2> 100 mm of Hg.[2]

Mild to moderate hypoxemia is common in the postoperative period. Early post-operative hypoxemia is due to anaesthetic factors. The later onset hypoxemia is due to alterations in

functional residual capacity (FRC) and factors that affect the patient's ability to inspire deeply or cause the patient to be immobilised in bed.[3]
The type of surgical insult contributes greatly to the development of hypoxemia. The site of surgery is most important factor in predicting the overall risk of postoperative pulmonary complications. The rate of complication is inversely related to the distance of the surgical incision from the diaphragm.[4]

Hyperoxaemia is thought to harm tissues through the production and accumulation of reactive oxygen species (ROS).[5] Hyperoxia may increase the risk of nosocomial pneumonia by altering the tracheal flora in favour of potentially virulent bacterial species such as Pseudomonas.[6] Through a variety of mechanisms hyperoxia may leave the lungs vulnerable to atelectrauma – a key risk factor for the development of ARDS.[7]

The aim of the present study was to determine whether outcome of ICU patients was affected with hypoxemia and hyperoxemia.

MATERIALS AND METHODS

The present study is a prospective observational study conducted on the patients admitted in Surgical ICU over a period of eighteen months (January 2014 - June 2015) in Department of Surgery, Mathura Das Mathur Hospital attached to Dr. S. N. Medical College, Jodhpur.

- All patients admitted in the surgical ICU were selected. The study group was informed regarding the aim of study and informed consent was taken. Information was taken through the prepared proforma.
- To obtain PaO_2 values, arterial blood gas (ABGs) were performed at different times (at the time of admission in ICU, after 24 hours, after 48 hours, after 72 hours and at the time of shifting to general ward in survivors and before death in expired patients). PaO_2 values were compared in survivors and nonsurvivors.

The data of all patients was collected on prepared proforma and was analysed by using appropriate statistical tests. In all analysis a p value of 0.05 was considered to represent a statistically significant difference.

RESULT

The study included 167 patients, admitted with various surgical conditions in Surgical ICU. Of the total patients, 44.3% survived and 55.7% expired.

At admission, mean PaO_2 was 82.76±30.14 mm of Hg in survivors and 96.13±61.43 mm of Hg in nonsurvivors. In nonsurvivors mean PaO_2 was more than survivors. Higher mean PaO_2 in expired group can be explained as because of early intubation and mechanical ventilation.

During ICU stay, at 24 hours, 48 hours and 72 hours mean PaO_2 was >100 mm of Hg because most of the patients were on ventilatory support. In survivors mean PaO_2 showed an increase at 24, 48 hours but again decrease at 72 hours, it can be because of early extubation in survivors compared to nonsurvivors.

In survivors at the time of shifting to ward, mean PaO_2 was 93.69±7.27 mm of Hg as most of the patients were on room air or on oxygen mask. In expired patients before death, the mean PaO_2 was 99.44±69.46 mm of Hg. Before death, the mean PaO_2 was low compared to PaO_2 at

48 and 72 hour because of either due to decreased O_2 level in inhaled air or due to heart decompensation or due to lung diseases.

As figure-1 showing, mean PaO_2 was more in nonsurvivors compared to survivors, but there was no significant statistical difference in mean PaO_2 of survivors and nonsurvivors ($P>0.05$).

At the time of admission, PaO_2 was normal (80 – 100 mm of Hg) in 19.2% patients, PaO_2 >100 mm of Hg in 17.3% and PaO_2<80 mm of Hg in 63.5% patients. At 24 hours, PaO_2 was normal in 28% patients, PaO_2 >100 mm of Hg in 50% and PaO_2<80 mm of Hg in 22% patients. At 48 and 72 hours, more than 50% patients were hyperoxaemic and about 20% were hypoxemic. At the time of shifting to ward in survivors, PaO_2 was normal in 90.5% patients, PaO_2 >100 mm of Hg in 1.4% and PaO_2<80 mm of Hg in 8.1% patients. In nonsurvivors, before death, 35.5% were hyperoxaemic and 54.8% hypoxemic. Figure-2 shows that the incidence of hyperoxaemia and hypoxemia was more in nonsurvivors than survivors. This was statistically significant ($P<0.05$).

Table I PaO_2 levels in ICU

PaO_2	**Normal (PaO_2 80 -100 mm of Hg)**	**Hypoxemia (PaO_2 <80 mm of Hg)**	**Hyperoxaemia (PaO_2 >100 mm of Hg)**
	Total	**Total**	**Total**
At Admission	32 (19.2%)	106 (63.5%)	29 (17.3%)
At 24 Hours	46 (28%)	36 (22%)	82 (50%)
At 48 Hours	35 (25.4%)	26 (18.8%)	77 (55.8%)
At 72 Hours	32 (26.4%)	24 (19.8%)	65 (53.7%)
At the time of shifting to ward	67 (90.5%)	06 (8.1%)	01 (1.4%)
Before death	09 (9.7%)	51 (54.8%)	33 (35.5%)

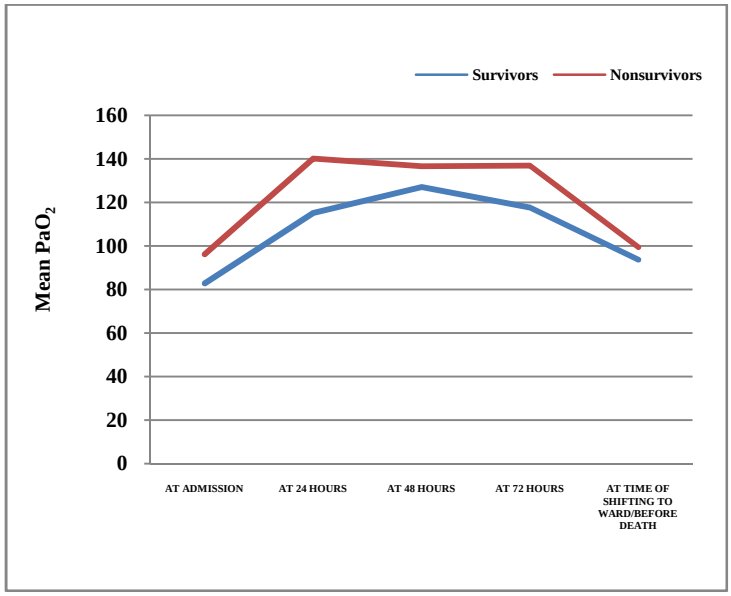

Figure-1 Mean PaO_2 in survivor & Nonsurvivors

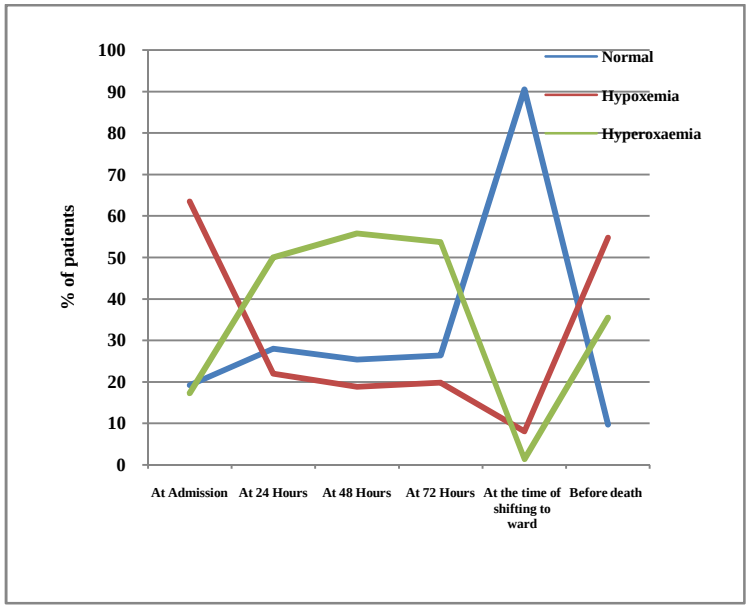

Figure-2 PaO_2 levels in ICU patients

DICUSSION

We found that high and low PaO_2 values in ICU patients are associated with increased ICU mortality. In most patients the achieved PaO_2 values were higher than the targets commonly recommended. Our observations are in accordance with prior experimental studies showing adverse effects of hypoxemia and hyperoxemia. Hypoxemia is common in the postoperative period. It is often unrecognised and its potential to contribute to poor surgical outcome is often underestimated.[3] It may cause loss of gastrointestinal mucosal integrity results in bacterial translocation into the circulation, leading to sepsis.[8] Decreased cognitive function with moderate levels of hypoxemia has also been demonstrated.[9]

Administration of supplemental oxygen can cause lung damage. Exposure to hyperoxia leads to diffuse pulmonary damage characterised by an extensive inflammatory response and

destruction of the alveolar-capillary barrier leading to oedema, impaired gas exchange and respiratory failure.[10]

There was a U shaped association between achieved PaO_2 and mortality with higher mortality in patients with either a very low or high PaO_2. That mortality is higher in patients with very low PaO_2 and it is possibly related to ischaemia or to selection of the sick patients. Mortality associated with high PaO_2 values, suggest the possibility of systemic oxygen toxicity.

There are limitations to this study. Most importantly, it was an observational study and the association between mortality and oxygenation is not necessarily causal.

CONCLUSIONS

Hypoxemia and hyperoxaemia are associated with increased mortality in surgical ICU patients. Actually achieved PaO_2 values in surgical ICU patients are higher than the PaO_2 targets.

Further studies are necessary to find out whether the association between outcome and oxygenation is causal and to provide evidence-based guidelines on oxygenation targets.

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