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Comparative Study On Oxygen Concentration Delivered By Medical Oxygen Supply System (MOSS) And Conventional Oxygen Cylinder In Arunachal Pradesh, India

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Abstract

Background: Oxygen is essential for the functioning of the human body. Oxygen is usually stored and delivered in a cylinder. Oxygen concentrator is a device, which concentrates oxygen from ambient air by removing nitrogen to supply an oxygen-enriched product. Various manufacturers of oxygen concentrators with different capacities of oxygen concentration and flow rate have emerged recently. Thus, the primary objective was to assess and compare the medical oxygen supply system (MOSS 450S) and conventional oxygen cylinders for oxygen concentration.

Methods: A prospective observation study of 180 samples taken over a period of three months was equally divided into two groups of 90 each: Group CR- Oxygen concentration measured by conventional oxygen cylinder reading and Group MR- Oxygen concentration measured by a medical oxygen supply system (MOSS 450S). Readings of oxygen concentration were recorded from the anesthesia machine outlet and were compared.

Results: A statistically significant decrease in oxygen concentration in 0,5,20 and 25 min readings ($P < 0.05$) and 10, 15 and 30 min readings ($P<0.001$) in Group MR3. Mean oxygen concentration readings of the group MR1, group MR2, Group CR1 and Group CR1 were comparable and there were no significant differences.

Conclusions: Oxygen concentration from the medical oxygen supply system (MOSS-450) decreases over a period compared with conventional oxygen cylinders, which remains constant.

Keywords: Concentrator, MOSS 450S, Oxygen, Oxygen Cylinder, Pressure

Introduction

All the functions of the human body require oxygen. The low level of oxygen in the blood known as hypoxemia, can have severely adverse effects on the cells that perform important biological processes. When hypoxemia is not quickly diagnosed and addressed, it can lead to death.

The common modes of delivery for oxygen therapy are liquid oxygen, pressurized (cylinder) oxygen and oxygen concentrators [1]. An oxygen concentrator was invented in the early 1970s to eliminate the use of heavy high pressure oxygen cylinder or small cryogenic liquid oxygen system in home-based management of respiratory disease. Oxygen concentrators have become the preferred and most common method for delivering home-based oxygen [2]. Cost effective, efficacy and reliability of oxygen concentrators make them suitable alternatives to

oxygen cylinders for providing oxygen in locations where cylinders may not always be available [3, 4].

Thereafter, large numbers of manufacturers entered the oxygen concentrators market with varying capacity of oxygen purity and oxygen flow rate. Medical Oxygen Supply System-450S (MOSS-450S) is one of the oxygen concentrator manufactured by Calitec Biotechnologies with NF CO., LTD, Busan, South Korea.

In previous studies, the safety and efficacy profile of oxygen concentrator with lower oxygen flow rates has been established and a comparison between oxygen concentrators and wall oxygen in chronic respiratory disease have been evaluated [5, 6]. It seems that the preferred form of long-term oxygen therapy will be the oxygen concentrators [7]. Therefore, we conducted this observational study comparing the oxygen concentration of an oxygen concentrator (medical oxygen supply system - MOSS 450S) and a conventional oxygen cylinder.

Materials and methods

This prospective observational study was approved by an Institutional Research Committee (Letter No.TRIHMS/research/2019-part II, 08/08/2019). In total, 180 readings were taken during the period from December 2019 to March 2020 in the operation theatre of TRIHMS, Naharlagun, Arunachal Pradesh. Inclusion criteria comprised of uninterrupted power supply backup, MOSS placed in a clean and well ventilated room, oxygen cylinders with proper and valid marking of servicing and anesthesia machine without any unacceptable leak. However, any break in power during the period of data recording was excluded from the study.

The samples were equally divided into two groups: Group CR-oxygen concentration measured by conventional oxygen cylinder reading and Group MR-oxygen concentration measured by medical oxygen supply system (MOSS 450S).

Inside the operations theatre, anesthesia machines were tested as per standard protocol and portable gas analyzers (Hemaki Lab services, Model: PGA OC-100) were calibrated with respect to ambient atmospheric oxygen. Readings of oxygen concentration were recorded from the anesthesia machine outlet at an interval of every 5 min over a period of 30 minutes in each episode with a flow rate of 0.5 liter per minute. Two sets of reading in each group were recorded per day for a period of three months.

Statistical analysis:

After transferring the compiled data to a computer on Microsoft offices excel, continuous data was presented as mean and standard deviation (SD). They were evaluated by Minitab Statistical software {(c) 2021 Minitab, LLC}. The Paired t-test was used for continuous data. A p-value of < 0.05 was considered statistically significant.

Results

A total of 180 samples were taken over a period of three months in the study, 90 samples in each group. All the samples were successfully taken during the study and no drop-outs were found. Both the groups were comparable with respect to mean oxygen concentration of 0, 5, 10, 15, 20, 25 and 30 minutes in the conventional oxygen cylinder group. No significant difference was observed. **(Table1).**

Table 2 depicts a comparison of the mean oxygen concentration between two groups in the medical oxygen supply system. They were comparable in all the readings and there was no significant difference that was observed.

Table 3 depicts a comparison of the mean oxygen concentration between two groups of the conventional oxygen cylinder group. They were comparable throughout the reading duration and no significant difference was observed.

Table 4 depicts a comparison of the mean oxygen concentration between the groups in the medical oxygen supply system group. There is a statistically significant drop in oxygen concentration in 0,5,20 and 25 minute readings ($P < 0.05$) and 10, 15 and 30 minute readings ($P < 0.001$) in Group MR3 of the medical oxygen supply system group.

Volume 5, Issue 4; July-August 2022; Page No 637-642

TABLE 1: COMPARISON OF MEAN OXYGEN CONCENTRATION BETWEEN FIRST ONTH (1-30 DAYS) AND SECOND MONTH (31-60 DAYS) IN CONVENTIONAL OXYGEN CYLINDER GROUP

Time (Minute)	CR1 (n=90) Mean ±SD	CR2 (n=90) Mean ±SD	P-value
0	99.46±0.35	99.57±0.29	0.209
5	99.69±0.03	99.67±0.07	0.174
10	99.67±1.15	99.71±0.05	0.186
15	99.65±0.18	99.69±0.01	0.207
20	99.66±0.197	99.69±0.05	0.479
25	99.68±0.07	99.70±0.03	0.281
30	99.68±0.11	99.68±0.05	1

CR1 = 1-30 days and CR2= 31-60 days

TABLE 2: COMPARISON OF MEAN OXYGEN CONCENTRATION BETWEEN FIRST MONTH (1-30 DAYS) AND SECOND MONTH (31-60 DAYS) IN MEDICAL OXYGEN SUPPLY SYSTEM (MOSS 450S) GROUP

Time (Minute)	MR1 (n=90) Mean ±SD	MR2 (n=90) Mean ±SD	P-value
0	92.04±1.39	91.81±1.32	0.520
5	92.11±1.46	91.99±1.15	0.725
10	91.90±1.48	92.12±1.23	0.522
15	92.24±1.76	91.96±1.20	0.475
20	91.71±1.51	91.91±1.25	0.578
25	91.99±1.41	92.22±1.11	0.479
30	91.90±1.51	92.30±1.21	0.261

MR1 = 1-30 days and MR2= 31-60 days

TABLE 3: COMPARISON OF MEAN OXYGEN CONCENTRATION BETWEEN FIRST MONTH (1-30 DAYS) AND THIRD MONTH (61-90 DAYS) IN CONVENTIONAL OXYGEN CYLINDER GROUP

Time (Minute)	CR1 (n=90) Mean ±SD	CR3 (n=90) Mean ±SD	P-value
0	99.46±0.35	99.70±0.03	0.25
5	99.69±0.03	99.71±0.07	0.281
10	99.67±1.15	96.7±16.4	0.320
15	99.65±0.18	99.67±0.14	0.69

Volume 5, Issue 4; July-August 2022; Page No 637-642

20	99.66±0.197	99.69±0.06	0.385
25	99.68±0.07	99.69±0.05	0.848
30	99.68±0.11	96.7±16.4	0.317

CR1 = 1-30 days and CR3= 61-90 days

TABLE 4: COMPARISON OF MEAN OXYGEN CONCENTRATION BETWEEN FIRST MONTH (1-30 DAYS) AND THIRD MONTH (61-90 DAYS) IN MEDICAL OXYGEN SUPPLY SYSTEM (MOSS 450S) GROUP

Time (Minute)	MR1 (n=90) Mean ±SD	MR3 (n=90) Mean ±SD	P-value
0	92.04±1.39	90.23±2.76	**0.002***
5	92.11±1.46	90.79±1.87	**0.003***
10	91.90±1.48	89.80±1.35	**0.000****
15	92.24±1.76	90.57±1.68	**0.000****
20	91.71±1.51	90.64±1.12	**0.003***
25	91.99±1.41	91.04±1.17	**0.006***
30	91.90±1.51	90.57±1.11	**0.000****

*Statistically significant

MR1 = 1-30 days and MR3 = 61-90 days

Discussion

Oxygen is essential for optimal functions of the human body as well as for anesthesia and resuscitation. There are two principal differences between the portable oxygen concentrator(POCs) and liquid oxygen. First, a portable oxygen concentrator does not provide 100% oxygen. The concentration of oxygen ranges between 85% and 95% depending on flow rate, while Liquid oxygen gives pure 100% oxygen at any flow. Second, POCs do not store oxygen, but produce it continuously [2]. The main difference in this therapy is the cost. Liquid oxygen therapy is about four times more expensive when compared with concentrators [8].

The oxygen is normally supplied in cylinders, which are bulky to transport, and occupy a lot of space. In a developing country, transportation of O2 cylinders is difficult, erratic and unreliable. During landslides, floods and other disasters, hospitals may not be approachable by road. This puts the patient at considerable risk and even death [5]. Similarly, the oxygen cylinder is transported via a hilly region of Arunachal Pradesh from a neighboring state. It may give an erratic and unreliable oxygen concentration. Contrary to the above, in our study, there was no statistically significant difference in oxygen concentration between the reading in the first month, second month and third month of a conventional oxygen cylinder

Oxygen cylinders are heavy and present a number of potential hazards, including fire and projectile risks. Liquid oxygen systems provide a large amount of gas with a smaller foot print but are heavy, exhaust gas over time, and may present a burn risk if handled improperly. In addition, the output of both of these oxygen systems are finite and require refilling, which presents logistical issues. Simpler, lighter, and longer lasting oxygen delivery systems are needed. As possible solutions, Thomas C et al evaluated portable oxygen concentrators (POCs) and chemical oxygen generators (COGs) at altitude and temperature extremes. Understanding the performance of these devices under deployed conditions is crucial to safety and effective use [9]. Similarly, the present study

Volume 5, Issue 4; July-August 2022; Page No 637-642

shows no statistically significant difference in oxygen concentration between the reading of the first month and reading of the second month of the conventional oxygen cylinder group.

Our study shows no statistically significant difference in oxygen concentration between the reading of first month and reading of second month of medical oxygen supply system group. This is consistent with previous studies by Johns et al, who have evaluated six oxygen concentrators, like Devilbiss DeVO2, Rimer-Alco Dom10, Mountain Medical Econo 2, Ventronics Hudson 6200, Dragerwerk Permox, and Cryogenic Associates Roomate at continuous flows of 1 to 4 liters. They found that all the devices at 1 and 2 L/min produced oxygen concentrations of greater than 90% and the use of the Free Style (Air Sep Corp., Buffalo, New York) resulted in a lower oxygenation compared to continuous flow of oxygen via compressed gaseous oxygen with or without an oxygen-conserving device [10]. This is further supported by Gould et al, who also conducted a study using three of the concentrators (Mountain Medical Econo 2, De Vilbiss DeVO2, and Cryogenic Associates Roomate) producing similar results [11]. Oxygen concentrators have also shown to be an effective and economical substitute for compressed oxygen cylinders in remote high altitude areas [12, 13].

The present study evaluated oxygen concentrators for a period over 90 days, which shows there is a statistically very significant decrease in oxygen concentration in the third month reading of medical oxygen supply system group. There is a similar finding to that of our study in a study done by Bisharad M et al., which states that percentage of oxygen supplied by the concentrator may not be satisfactory. This may be due to lack of reliable maintenance service causing a breakdown of the concentrator but contrary to our study, Johns et al., found that all the oxygen concentrators produced oxygen concentrations of greater than 90% at 1 and 2 liters per minute, which may be due to the shorter period of assessment time of oxygen concentrator as they assessed each concentrator over a period of 9-28 days only [5, 10].

Limitations

This study has some limitations, such as small sample and only one brand of oxygen concentrators (MOSS-450) was assessed. Therefore, it's observed outcomes cannot be generalized. A few topics for further study are worthy of consideration. Firstly, an assessment of oxygen concentrations with multiple brands of oxygen concentrators at higher flow rates. Secondly, further interventional studies with oxygen concentrators at various altitudes and in various populations.

Conclusion

The study concluded that oxygen concentration from the medical oxygen supply system (MOSS-450) decreased over a period of time as compared to conventional oxygen cylinders, which remained constant. Oxygen concentration from a medical oxygen supply system (MOSS-450) may be improved with regular maintenance services and may act as backup to conventional oxygen cylinders.

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Volume 5, Issue 4; July-August 2022; Page No 637-642

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Volume 5, Issue 4; July-August 2022; Page No 637-642