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Assessment of Oxygen Gas Cylinder and its Safety Awareness Among Cylinder Handlers/Operators in Rehman Medical Institute, Peshawar

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Abstract

Background: Different methods are there to supply oxygen in hospital to different suit, one of which is cylinder supply or cylinder manifolds supply. Oxygen being medical drug is also combustible or has high risks when in high concentration in environment, or where there is slight chance of ignition with hyperbaric oxygen environment. Oxygen cylinder material if magnetic could cause projectile accident in MRI suit. On the other aspect, oxygen in cylinder is in high pressure, there must be proper fixation and leak prevention, if not it could be expulsive. For such avoidance AAGBI has provided guidelines for safety, that are in form of color coding, labeling, hazard warning signs, storage, and handling instructions. The objective is to make gross assessment of oxygen cylinders safety feature and access the practice and know-how of the handlers at Rehman Medical Institute Peshawar, KPK, Pakistan. **Methodology:** For this cross-sectional study, Total of 138 cylinders were included, available at RMI, Peshawar, with 5 direct contact handlers, the safety feature of cylinders as per AAGBI were recorded on data sheet, and handlers were interviewed for the relevant safety courses and their practices. The data was then analyzed via SPSS version 22.0. **Results:** It was found that in total of 138, about 99.3% cylinders go under periodic testing and had proper substance

identification code, 98.6% had proper cylinder expiry and substance filling dates engraved, and 97.1% had proper warning signs labeled and applied stickers. **Conclusion:** That handlers that were interviewed were well educated with bachelor's and master's degree, but they lacked relevant safety courses, through their practices were according to AAGBI guidelines. And the cylinders that were evaluated for gross safety features were well according to the standards.

Keywords: Cylinder Supply, medical gas supply system, Cylinder Safety, Cylinder Handling, AAGBI, Color Coding, Oxygen Cylinder

INTRODUCTION

Gases play a key role in many aspects of human's life. Gases and especially oxygen (O_2) is important for a person in order to proceed their life. In case of those patients admitted in hospitals, O_2 plays a role of lifeline for them. Now different hospitals and medical distribution of gases. Their system may distribute gases like O_2, N_2O and medical air. however, the most needed gas is O_2, because of its role in the mechanism of respiration, metabolism and other biochemical functions. Now these gases need to be stored and delivered according to the need of an institute and for the patient. The stored gas can either be in liquid state or vaporous form in cylinders.

Medical gas system of an institute is the combination of several things/components, which include

1. Pipeline
2. Terminal unit
3. Alarm
4. Manifold room
5. Medical Gas Cylinder.(1)

While discussing the component of the medical gas system, they have a channel of distribution pipeline. Pipeline is the source through which the distribution of gases occurs from the central bulk of each part of the hospital we need. In order to prevent the wasting and degradation of gas mostly the pipelines are manufactured from special copper alloy.(2) The system which use in our hospitals is Medical Gas Operating Center (MGOC). Through the MGOC system they observe different medical gases which are needed for the patient in anesthesia, therapy and diagnosis. The system pipeline is managed in such a design that it transports gas from a central source having pipe diameter 42mm and then into a small pipe of diameter 15mm at the end supply point. (3,4) For the risk reduction related to the medical gas supply system, you must maintain and operate the gas supply system correctly. This must be done through professional people. Checking of leaks, wear and other potential deterioration in mechanical integrity

are important for the correct operating of the system. (5) Pressure devices are there to sense gas pressure. They show signals routinely to the control panel to move it to the 2nd cylinder which is full. Best environment where the manifolds can be kept, is a room made of concrete materials. The pipelines are made of copper and alloy having diameter 42mm and narrow pipelines of diameter 15mm, in any given condition the two banks will be used as primary sources to initiate the process. These banks must serve for 4 days and are responsible for 3 days standby supply. (1,6) Low carbon steel is used to assemble medical gas cylinders. They might be composed of lightweight chrome, molybdenum steel, aluminum etc. In the MRI room cylinders are used which are made of Aluminum. The side thickness of aluminum cylinder is 6mm whereas for steel cylinder it is 3mm. The fire fighters, paramedics and emergency first responders use complex cylinders. (7) Each system is provided with proper safety systems for handling as implemented by international communities. Each medical gas is provided with a proper color code by Britain and as well as US for international implementation. USA follows green color for Oxygen, International medical suppliers/users follow white color for Oxygen. It would be much better if an individual health care institute or a hospital follows single color-coding system for a single type of gas. (8,9)

In this study the Oxygen gas cylinders in the Rehman Medical Institutes, Peshawar is to be assessed in terms of their safety and regular quality checks. Also, the hospital staff is to be discussed to evaluate their level of knowledge towards the cylinder safety system among them and bring into their knowledge that how necessary it is and what adverse events could be the result of their negligence.

No such published research regarding the assessment of safety system and protocols followed in the medical setups in Peshawar city are found, making It necessary to work on it. Although the medical Gas cylinders have low probability of hazardous events but can be a nightmare if occurred so. The goal of this study is to assess the cylinders in the Rehman Medical Institute so that we can identify the cylinders which needs to be discarded or tested. Also, the handlers/operators are to be updated of the international guidelines to ensure quality safety and avoidance of consequences (if need be). This will be done via post research session with the concerned department and staff.

MATERIAL AND METHODS

Study Design and Setting: A cross-sectional study conducted at the private sector hospital, Rehman Medical Institute, Hayatabad, Peshawar. The study included the oxygen cylinders at the disposal of RMI in different suits. This study also includes the handlers of cylinder as their knowhow and expertise is to be assessed regarding cylinder handling and safety measure.

Sample Size and Sampling: There are 138 cylinders at disposal of RMI. Total of 5 handlers were included as per record at Oxygen storage suit RMI had 5 direct handlers of cylinders for both single and manifold setups. Cylinders that were prepared for refilling and are to be sent out of hospital for that purpose, and already discarded cylinders were not included. Other than that, all size oxygen Cylinders and their handlers/operators/transporters at different occupation at RMI were included in the study.

Inclusion Criteria: All sizes of oxygen cylinders present within the RMI premises.

Exclusion Criteria: Oxygen cylinders outside the hospital premises.

Data Collection: For data collection, approval was sought from the research committee of Rehman College of Allied Health Sciences, RMI. After committee approval, approach was made to the department of Hospital Quality and Patient Safety, RMI, from where the team was directed to the department of Oxygen gas cylinder delivery and storage department. Approval and consent were obtained from the head of the department, data collection proformas were filled in the supervision of the HOD and the storage suit personnel. Data was collected and stored on the data sheets for each of the cylinder at disposal. Secondary records were also provided by the department Head which included the information of cylinder inflow and outflow of the hospital and the dispatched cylinders to other suits of RMI to be used for patients need. And the records also contained the information of cylinders sent for refilling. Furthermore, handlers' knowledge regarding AAGBI and other safety protocols for oxygen cylinder handling and the risks associated or any possible hazards. Informed consent was obtained from each of the 5 handlers, and their responses were recorded in preformed questionnaires.

Statistical Analysis: Data is analyzed via SPSS Version 22.0, and is represented in form of tables and graphs, displaying the frequencies, percentages, and descriptive statistics of the data.

RESULTS

Based on the data collected for this study, as per Study Setting, total of 138 cylinders were available at Rehman Medical Institute (RMI), Peshawar. In view of observations and ground proof, RMI is utilizing commonly a centralized pipeline supply. The 138 cylinders are used in either manifold system or as backup supply for different suits where theses cylinders are most probably used like MR suit, ICU's Ventilation backup and wards. In these 138 total cylinders, two types were available at RMI which J size and F size by the numbers of are 65 and 73 respectively. Which contribute to percentages for J size to be 47.1% and for F size to be 52.9%. (Figure 1)

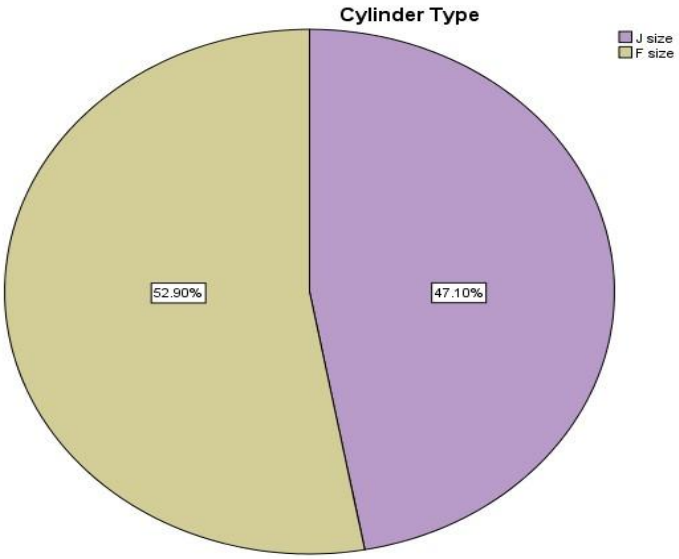

Figure 1: Cylinder types on bases of size

All the J size cylinders, 65 in total, were properly color coded for oxygen (Black body and white Shoulder) but F size had 2 cylinders, about 97.3% out of 73, were not properly color coded for oxygen according to AAGBI codes. (Table 1)

Table 1: *Cylinder Types and their color coding*

Cylinder Type	Frequency	Percent	Color Coded (As per AAGBI)	Percent (in type of Cylinders)
J size	65	47.1	65	100.0
F size	73	52.9	71	97.3
Total	138	100.0	136	98.5%

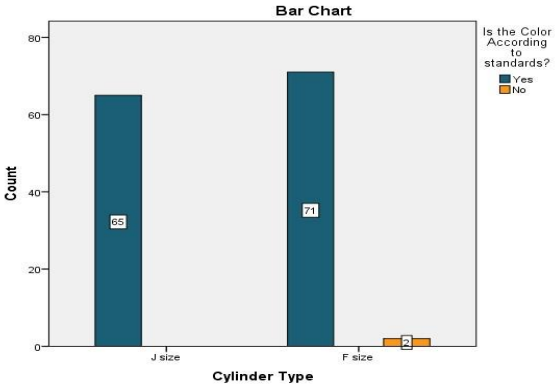

Figure 2: Cylinder types and color codes as per AAGBI

As per cylinders testing, which is to be done periodically, RMI keeps the records of recent cylinder testes performed by the manufacturer and it is also labeled on the cylinders. Out of 138, one cylinder was not recently tested but has exceeded its time of testing, this makes up for 0.7% of total 138, while this single cylinder was of F size. (Table 2)

Table 2: *Periodically tested cylinders*

Does the cylinders go under periodic testing?	Yes	No	Total
J Size	65	0	65
F Size	72	1	73
Total	**137**	**1**	**138**
% Of Total	**99.3%**	**0.7%**	**100%**

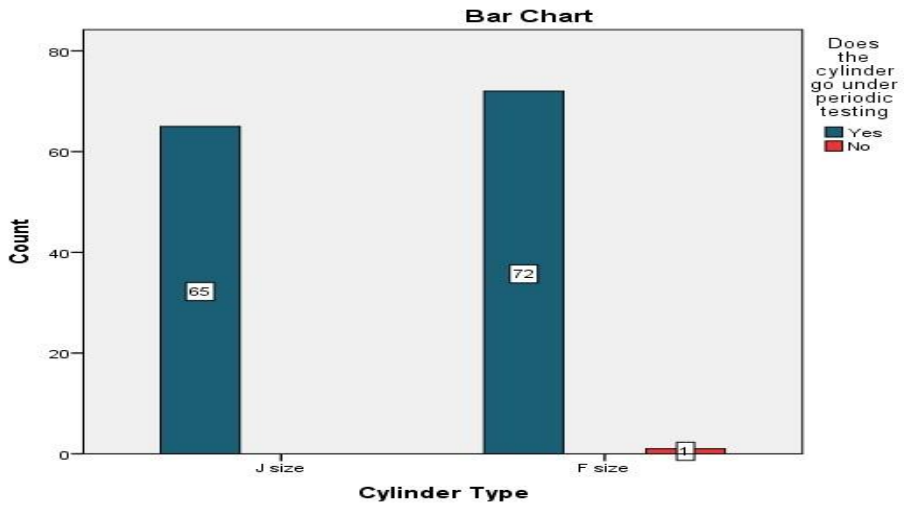

Figure 3: Periodically tested cylinders

As of concern, there should be filling date and as well the expiry date of the cylinder to be mentioned on the cylinder, in the observed data, only 2, J size cylinders had no engravement of filling and expiry dates. 63 J Size, about 45.7% of total 138 and 73 F size cylinders (52.9%) had proper dates mentioned. In total, both F and J size combined, 98.6% had proper mentioned dates for both its previous filling and as well the cylinder material expiry dates. And in contrast 1.4% cylinders had no dates of any sort. (Table 3)

Table 3: *Engraved filling and expiry Dates*

Filling Date/Expiry Date Engraved			Yes	No	Total
Cylinder Type	J size	Count	63	2	65
		% Of Total	45.7%	1.4%	47.1%

	F size	Count	73	0	73
		% Of Total	52.9%	0.0%	52.9%
Total		Count	136	2	138
		% Of Total	98.6%	1.4%	100.0%

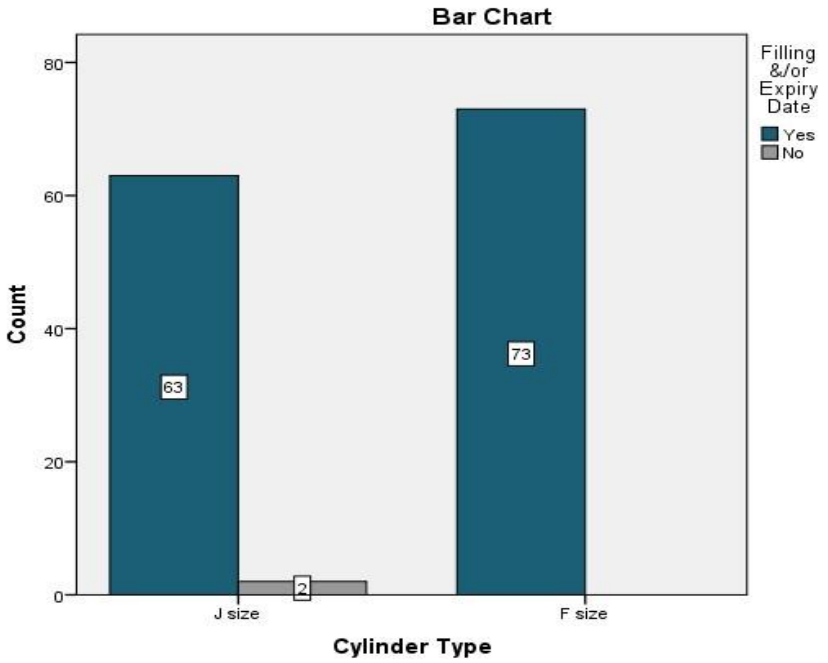

Figure 4: Dates engraved on cylinders for filling and expiry dates

The other thing that is to be mentioned is product identification code, which is mandatory and engraved on shoulder of the cylinder. Total of 137, about 99.3% had proper engravement of proper identification code, only a fraction of 0.7% out of 138, had no engravement regarding product identification code for oxygen. (Table 4)

Table 4: *Product Identification Code on cylinders*

Product Identification Code			Yes	No	Total
Cylinder Type	J size	Count	64	1	65
		% Of Total	46.4%	0.7%	47.1%
	F size	Count	73	0	73
		% Of Total	52.9%	0.0%	52.9%

Total	Count	137	1	138
	% Of Total	99.3%	0.7%	100.0%

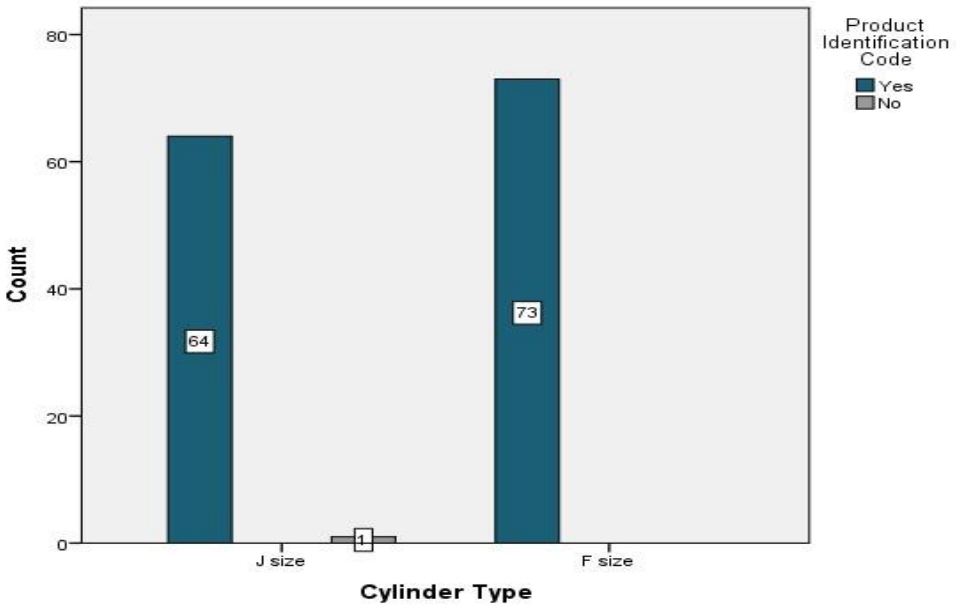

Figure 5: Product identification code on cylinder

Out of 138, in total 134 cylinders, both F and J included, had proper warning signs label via stickers. This contributes about 97.1% in total cylinders with such hazard's signs labelled. Remaining 4 cylinders, of F size, 2.9% of total 138 were missing these signs. All the J Sizes were properly applied with stickers for hazard signs. (Table 5)

Table 5: *Any Hazard warning signs or stickers on cylinders*

Hazard Warning Signs (stickers/Labelled)			Yes	No
Cylinder Type	J size	Count	65	0
		% Of Total 138	47.1%	0.0%
	F size	Count	69	4
		% Of Total 138	50.0%	2.9%
Total		Count	134	4
		% Of Total 138	97.1%	2.9%

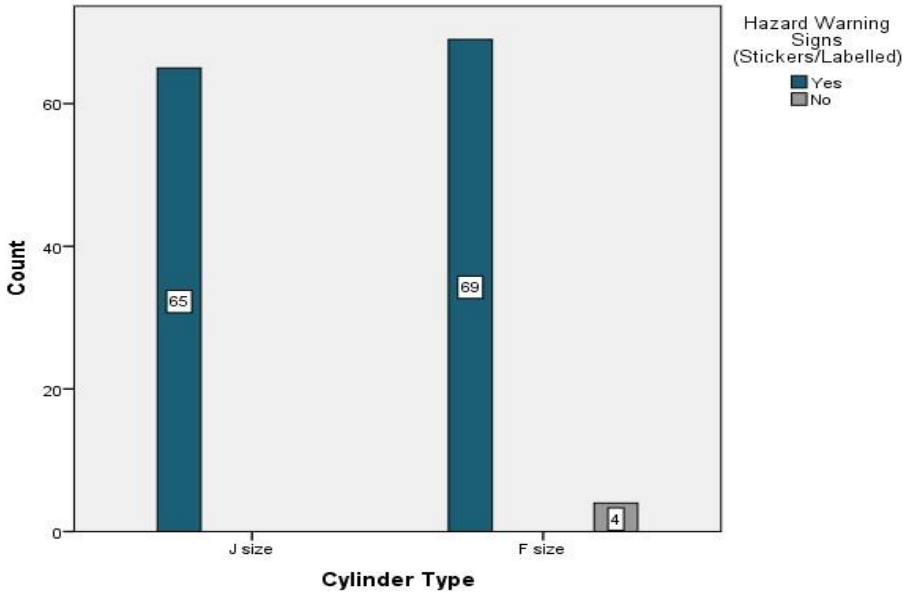

Figure 6: Any Hazard warning signs or stickers on cylinders

It was observed that there were slight damages to the cylinder material and the color paints on them. Which in total of 138, damage and color erosion was found in about 38 of total, that is 27.5%. other 100 Cylinders, both F and J size were, not damaged and are found in good condition. These 100, were comprised of 40% J size and 60% F sizes. (Table 6)

Table 6: *Any sort of damages color removed or dents*

Is Cylinder Damaged?		Yes	No
J size	Count	25	40
	% Of Total 138	18.1%	29.0%
F size	Count	13	60
	% Of Total 138	9.4%	43.5%
Total (138)		38	100
% Of Total		27.5%	72.5%

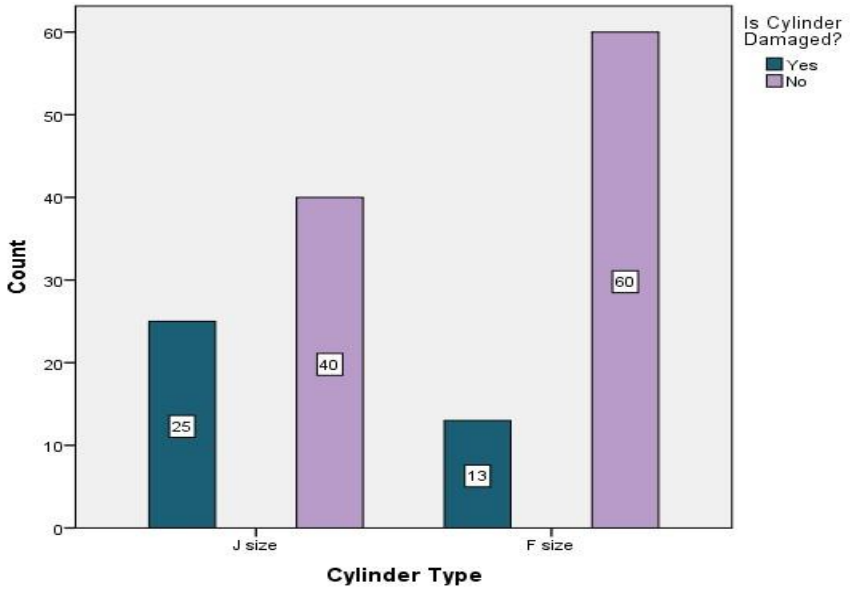

Figure 7: Any sort of damages color removed or dents

Cylinders are to be kept in dry, cold, and fire-resistant environment, separated from electric circuitry and other fire ignitions and such other things. As per observation and data obtained, all the cylinders were found to be at safer place and properly concealed away from any fire hazards.

There was total 5 direct handlers of the cylinders and cylinders manifold at oxygen cylinder storage room. They were interviewed about their knowledge of AAGBI and other safety guidelines though they follow it already. All the handlers were well educated with degrees like B.A., M.A. and BS. With percentages of 60%, 20% and 20% respectively. But they lack the knowledge of AAGBI guidelines and did not have any safety courses like OSHAH. The responses provided for safety of cylinders in occupation were totally based on their practical experience and guidance provided by the supervisor at gas supply department but had no knowledge of modern-day guidelines, and proper safety courses certification. (Table 7)

Table 7: *Handlers Education*

Education	Frequency	Percent	Cumulative Percent
B.A.	3	60.0	60.0
M.A.	1	20.0	80.0
B.S.	1	20.0	100.0
Total	5	100.0	

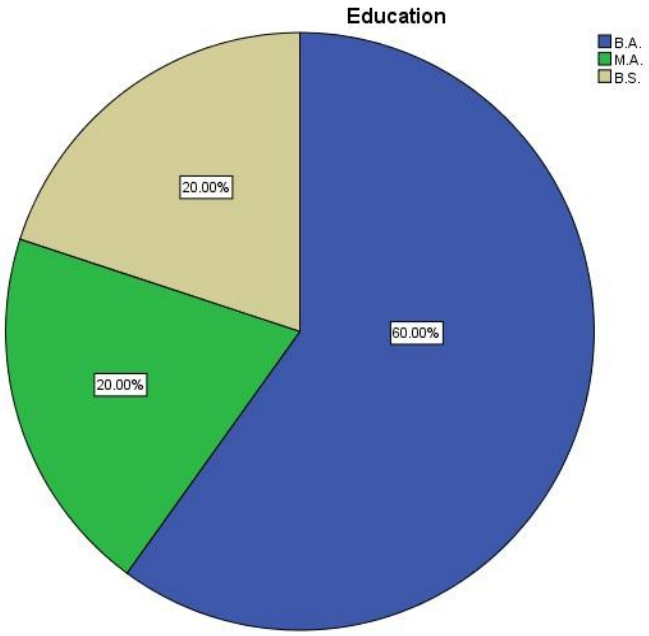

Figure 8: Handlers Education

DISCUSSION

Oxygen being a medical gas, vital for life and abundant drugs in atmosphere is hazards in many ways, one of which is high pressure cylinder storage. As based on the study setting oxygen cylinder and storage at RMI was evaluated for certain guidelines in accordance with AAGBI.

Studies have found and on ground reality most of accidents in hospital suit is because of medical gas cylinder. Uma Srivastava discussed in their study that most of those accident is attributed to oxygen in rich environment. (7)

Guidelines and studies on oxygen cylinders advised that there should be proper labelling of warning signs, identification codes, concentration in the cylinder, labelling periodic testing and date of last test performed. (8)

In our study it was found that almost 99.3% of cylinder that were at RMI disposal go under periodic testing. About 98.6% of cylinder had proper engravement of date regarding filling of cylinder, expiry date of cylinder and the date of last test performed.

A study conducted at Peshawar, which study setting of private medical setup by Irfan Ullah et al. reported 61.7% labelled and 38.3% non-labelled cylinder were being used. (23) compared to our study setting the availability of proper labelled cylinder is of 97.1%.

As per established standards the cylinders are to be kept in dry, cold environment away from electrical circulatory an any other materials or substances that could potentially ignite and cause fire or explosion. In our study setting the cylinders, all of them are kept in such environment which has prevented a lot of risk or accidents from happening.

Color coding of cylinders is another safety feature of preventing usage of wrong medical gas and avoiding potential risks to the patients. Irfan et al. discussed that 5 of the death out of 45 are attributed to usage of wrong gas instead of oxygen. This result reproduced from Taylor et al. study. (23,24)

In the study by Taylor et al. the improper identification due to color damage, non-labeling of product identification leads to mismatch connection and delivering hypoxic gases. (24)

CONCLUSION

It is obvious from the study results, that the study setting is keeping check on the safety systems of cylinders, the handlers are experience through they have no relevant education on safety systems and protocols of handling oxygen cylinders, and they also had no idea of guidelines of AAGBI, but on their experience and practice handlers were in proper follow of safeties. The cylinders at disposal, almost all were in accordance with proper guidelines.

AUTHORS' CONTRIBUTION

Muhammad Shahab: Conceived and designed the study, contributed to the literature review, data interpretation, manuscript drafting, and critical revision of the manuscript.

Tauseef Iqbal: Assisted in study design, data collection, data analysis, interpretation of results, and manuscript review.

Zahoor Rahman: Performed statistical analysis, interpreted the findings, contributed to manuscript writing, editing, and critical revision of the final draft.

Dr Asif Hussain: Conducted the literature review, assisted with data interpretation, manuscript formatting, and language editing.

Dr Asif Hussain (Corresponding Author): Supervised the overall research project, finalized the study design, critically reviewed and edited the manuscript, managed correspondence with the journal, and approved the final version for publication.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ETHICAL APPROVAL

The study was approved by the Institutional Ethical Review Committee of Rehman Medical Institute Peshawar.

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