ISSN: 2708-7123 | Volume-02, Issue Number-01 | March-2021
LC INTERNATIONAL JOURNAL OF STEM
Web: www.lcjstem.com | DOI: 10.5281

ASSESSMENT OF OXYGEN GAS CYLINDER AND ITS SAFETY MEASUREMENT IN PRIVATE MEDICAL CARE AT PESHAWAR, PAKISTAN

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Abstract

Medical gas delivery equipment is a potential source of patient injury. Recent attention in health care has been on the architecture design of operation theater including equipment, technology, and patient safety. Oxygen cylinder failure is a rare but potentially cataphoric event that can affect the care of patients. Anesthetic gas delivery devices are a concern because they exhibit several basic features that may predispose to critical events and subsequent patient injury**.** This cross-sectional study was conducted among a sample of 267 from different private medical care centers in Peshawar through a convenience sampling technique from March 2018 to August 2018. A pretested questionnaire proforma was used for data collection. Ethical approval obtained from the head of the institute and a consent form was also signed from concern. Semi government and government hospital, central pipeline supply system was excluded from this study. Data were analyzed through SPSS version 22**.** A total of 267 oxygen cylinders were observed in which (n=165, 61.7%) cylinders were properly color-coded and the rest (n=102, 38.3%) were not. Of total, (23, 8.6%) cylinders were tested for compliance while 244 (91.3) were not tested, valve cap was present on (n=89, 33.3%), and rest of (n=178, 66.6%) were missing. Lifting (48%), was the major transport process. The least process was rolling (n=28, 10%). we concluded that all the ignorance which has been predominant in private medical care centers may pose a constant threat to the patient's life and for the operating room team**.**

Keywords; Color coding, Cylinder system, Medical gas, Safety measurements.

I. INTRODUCTION

The term medical gas cylinder is commonly used to describe the pressurized container used for medical gas transport and storage. Both in the cylinder and pipeline oxygen supplied under high pressure [1]. Medical air, oxygen, and nitrogen are usually supplied through a pipeline system while helix and Entonox are supplied in portable cylinders and some hospital via pipeline system [2]. However, the oxygen cylinder available in different sizes and with different storing capacities with a color-coded system. The cylinder color-coding system guaranteed the safe usage of the medical gases. In the safety system, one of them is the pin index safety system (PISS). This system was introduced to avoid unintentional placement of the cylinder into the hanger yoke of the anesthesia machine which is designed for another cylinder. Although this system minimizes the error it does not eliminate the possibility of administration of other gases [3].

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II.LITERATURE REVIEW

Several cases published of PISS failure resulting in patient injury and deaths. In 1983 a case reported by Pauling a patient died after accidentally using 100% nitrogen during the whole case instead of oxygen using [4]. Intra-operative hypoxia and death are common due to bulk oxygen delivery system contamination. There are many guidelines for the purity of oxygen gas supplies, every anesthesiologist should know the delivery system of medical gases and troubleshoot mechanisms [5,6]. A case of oxygen gas supplies contamination was reported. After induction of general anesthesia suddenly decrease in the fraction of inspired oxygen concentration FIO_2 (18%) and a decrease in patient oxygen saturation. After inspection of this whole scenario, they noted that the oxygen cylinder was labeled as a nitrogen cylinder [7]. Most deaths were reported which are related to color-coding system failure. In 1983 a case was reported in Alfred Hospital. The patient died with 100% nitrogen administration in the whole surgical procedure. This case happened due to the inadvertent crossing of nitrous oxide with oxygen pipelines during repairing [8]. In modern anesthesia machine safety features have been designed to prevent hypoxia via a minimal flow of oxygen flow and inhibit the flow of other inhalational agents. The diameter index system ensures adequate oxygen flow through appropriate tubing. However, the presence of these safety feature dentists and anesthetists reported many cases of incidental hypoxia involving incorrect equipment installation, correction, and damage [9,10]. The certified anesthetists are familiar with oxygen supply failure troubleshooting. But training medical officer (TMO) deprived of these basic techniques. A study revealed that the majority of anesthesia residents are lacked with knowledge of oxygen cylinder changing. Maintenance of anesthesia machine by Peri-operative personal (anesthesia technologist, technician and respiratory therapist created a gap of knowledge which resulted as inadequate training of anesthesia resident [11]. The routine checking, maintenance of anesthesia machine and gas machine were assigned to non-physician [12].

A study concludes that the click stop flowmeter is not completely accurate. Failure of the oxygen delivery cylinder can easily be overlooked because of their new design [13]. A case reported of contamination oxygen cylinder during transport ventilation of a hospitalized patient. And demonstrated that serious complications can result from contamination [14]. The risk with an oxygen gas cylinder is a sudden blast due to environmental changes in pressure and temperature. Several cases were reported with an oxygen cylinder blast [15]. A case report stated that accidentally administration of carbon dioxide to child because of the unauthorized filling of carbon dioxide instead of oxygen. Cardiac arrest ensued but early detected and treated. No neurological deficient was detected after complete recovery [16]. Labeling plays a major role in decreasing the accident of hypoxia and other morbidities perioperative. During the procedure, two patients develop hypoxia and hypercapnia due to owing to the nitrous oxide cylinder being filled with carbon dioxide [17].

This study aimed to find out the assessment and its safety system of the oxygen cylinder in the private hospital and medical care center.

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III.METHODOLOGY

This descriptive cross-sectional was completed in a duration of six months (March to August 2018). This study was conducted in a private medical care center of Peshawar Pakistan. The total sample size of 267 oxygen cylinder was observed during this study. Data was collected from all private medical care through a convenience sampling technique. This study was conducted after approval from university and hospital ethical committee.

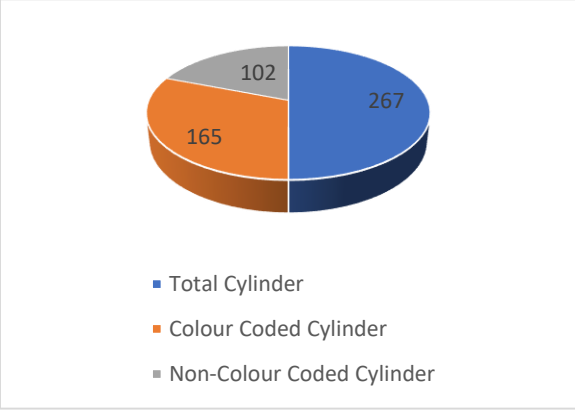
IV.DATA ANALYSIS & RESULTS

Pretested proforma was deemed appropriate to cover all aspects related to the delivery of medical gas in the operation theater (OT), after the approval of the research proposal from the graduate committee. Ethical approval was obtained from the research ethics committee. After taking consent from the concern of private medical care center. Data was collected personally through a questionnaire. Private institutes who are willing to participate in our and fulfilling the inclusion criteria were included in this study. Semi government, unauthorized hospital from Health Care Commission (HCC), and government hospital and central pipeline supply system were excluded from this study. Data were analyzed through SPSS version 22. Percentage and frequencies are used to present data and graphically represented via charts.

RESULT

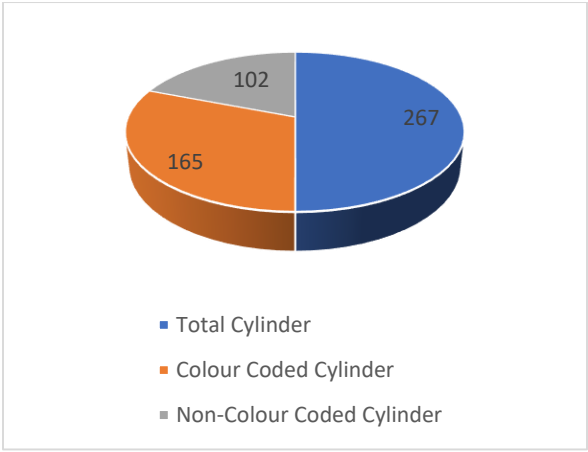
There were 267 oxygen cylinders observed during this study. Of the total, 165 (61.7%) cylinders were properly color-coded as mentioned in international standards. Of the total, 102 (38.3%) falls in the category of non-color coded and difficult to differentiate from other cylinders (air, carbon dioxide, and nitrous oxide) which are shown in figure 01.

Figure 01 Color Coding of Oxygen Cylinder.



Of the total, 165 (61.7%) were labeled and 102 (38.3%) were not labeled. Twenty-three (8.6%) cylinders were tested for compliance while 244 (91.3) were not tested. Of the total, 89 (33.3%), 178 (66.6%) have valve caped applied and valve caped were missing, respectively as shown in figure 02.

Figure 02: Cylinder Labeling, Test, and Valve cape.



There were four methods of transport mechanisms studies in our study, (dragging, lift, trolley, and rolling). Of the total, 68 (25%) used the dragging

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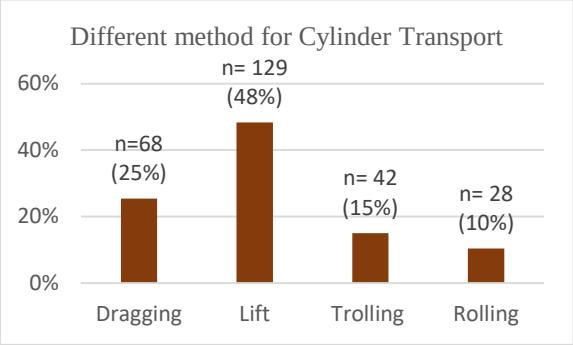
method for cylinder transport while 129 (48%), 42 (15%), 28 (10%) used lifting, trolling, and rolling respectively as shown in figure 03. Among respondent's majority prefer lifting methods over the rest of other methods. The main reason behind these mechanisms hole sole depends upon the location of the operation theater and its height from the ground.

Figure 03: Mechanism of Cylinder Transportation



Of the total, noncolor-coded cylinders 39(38%) were returned to the factory for repair and replacement. Among random hundred cylinders one selected for compliance test. The percentage of compliance test among our selected cylinder (267) was 84 (31%). Nonfunctional and emergency-based cylinders were stored in separate area 23 (8.6%). The marking cylinder (empty, nonworking) could decrease the incidence of complications related to the cylinder supply system. The number of cylinders was mentioned in our study were 34(12.7%). The factor that contributes to the cylinder safety system includes a regulator and secured from any hazard factor or environment) were 122 (42%), 87 (32.5%) respectively as shown in Table no 1.

Table 1: Assessment Factors for cylinder System

S.NO	Measuring Parameter	Percentage	Total Sample
1	Returning the non-colored and corroded cylinder to manufacture company	38.20% (n=39)	102
2	Test for Compliance performed (1 in 100)	31.40% (n=84)	267
3	No of Cylinder stored in Separate storage	8.61% (n=23)	267
4	Marking empty cylinders (at time of study)	12.73% (n=34)	267
5	Cylinder Firmly secured	32.58% (n=87)	267
6	Regulator fitted	42% (n=122)	267

The corrosive cylinder among labeled was (15) while (21) falls in the category of non-labeled cylinders. Of the total, non-corrosive (150) (81) were mentioned in labeled and non-labeled cylinders respectively. As shown in figure 04.

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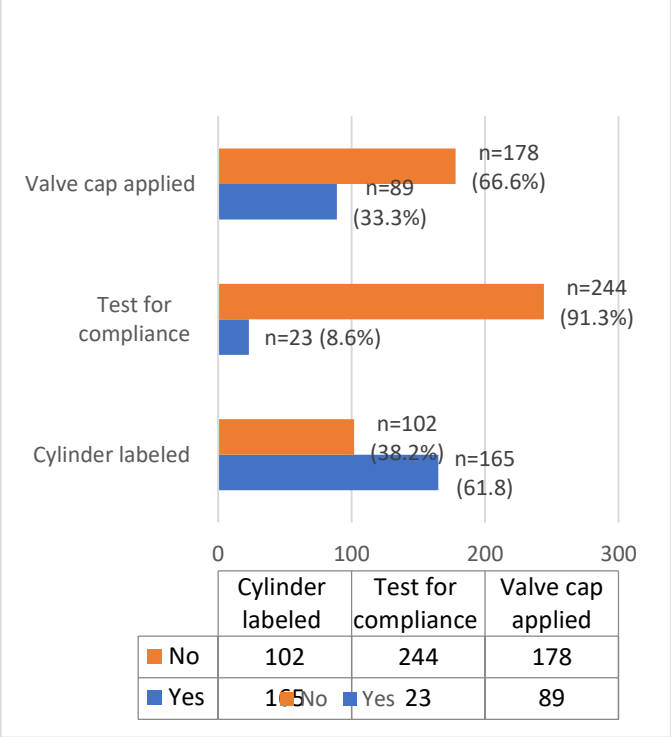
Figure 04 Comparison of corrosion among labeled and non-labeled Cylinders



V. DISCUSSION

Medical gas delivery equipment is a potential source of patient injury. Improvement in medical gas safety management will decrease the risk of complications. Patient safety is the principal concern in installing, architecting, and services of the anesthesia gas supply system. Previous literature concludes that medical gas delivery equipment is associated with (n=72, 2%) of the total (3,791). Mortality and permanent damage (brain death) accounted for (55) (76%) [18]. Oxygen is one of the most utilized medical gas intended primarily for anesthesia and life support. In our study, the percentage of the labeled cylinder was reported 165 (61.7%) with 102 (38.3%) in a non-labeled cylinder. This study revealed that all anesthetists in medical care centers would have saved the patient's life through maintain the cylinder safety system. But due to some ignorance which is deviated slightly from the protocol according to the international standard of the organization (ISO) and department of transportation (DOT) for cylinder and anesthesia machines which are directly impacting the patient life. For this purpose, the Australian and New Zealand College of anesthetist has produced guidelines for preoperative testing of medical gas supply and equipment [19,20]. Rarely, the pipeline system of oxygen gas cylinder or manifold system is failed due to the failure of the pipeline supplies some events (Death) occurred. Estimated deaths all over the world (1972 to 1993) in the United States, 45 death from 26 pipeline safety system failure, 13 were reported from crossed pipelines, 8 were related to the non-interchangeable connector, and 5 involved due to the use of other gas instead of oxygen gas has also reported many cases of errors [21]. The color-coding system plays an important role in avoiding mistakes due to human error when properly applied. Confusingly, nitrous oxide, and oxygen both have a green body with slightly different neck colors there is no legal requirement for consistency in body color between different manufactures. Color-coding systems intended for a safety measure to avoid incorrect gas administration and inessential variation can lead to errors (morbidities, mortalities) [19, 22].

The Cylinder system was used in the late '90s and early 20's but advancement in anesthesia and medical gas supply in today's era central pipeline system used. Every system has pros and cons. A study revealed that a lack of well-trained anesthetists and assistants resulted in certain morbidities and mortalities. Untrained anesthetist and anesthetist assistant unaware to troubleshoot the oxygen failure alarm [23]. In this study 23 (8.6%) cylinders were tested for compliance

while 244 (91.3) were not tested. According to protocol every cylinder should be inspected annually and should not be exceeded from 5 to 10 years. Of total n=89 (33.3%) cylinder have cap valve for protection while n=178 (66.7) have missing their protective cap valve [15]. Mechanism of transport has a great impact on the cylinder safety system. A study concluded that equipment misuse (75%) is three-time more common compared with equipment failure (24%). Overall, the gas delivery system (78%) claims that these accidents can be prevented through proper monitoring (Color Coding, avoid the use of corrosive cylinders, cap valve application, regulator fitted), and assessment. Educational and preventable strategies that mainly focus on equipment misuse have great potential in enhancing the safety of a medical gas delivery system [2].

VI. CONCLUSION

From the study, we concluded that all the ignorance which has been prevailing in private medical care centers may pose a constant threat to the patient's life and the operation theater team. The health regularity authority needs to place a pattern of inspection to ensure the safe and sound use of this important equipment to avoid any mishappening before when we lose the time.

REFERENCE

[1] Intraoperative Hypoxia from Nitrogen Tanks with Oxygen Fitting : Anesthesia & Analgesia, 84 Anesthesia and analgesia 225 (1997).

[2] Caplan, R. A., Vistica, M. F., Posner, K. L., & Cheney, F. W. (1997). Adverse anesthetic outcomes arising from gas delivery equipment: A closed claims analysis. *Anesthesiology*, *87*(4), 741–748.

[3] Coveler, L. A. (1989). Contaminated Oxygen Cylinder. *Anesthesia & Analgesia*.

[4] Dobson, G., Chow, L., Flexman, A., Hurdle, H., Kurrek, M., Laflamme, C., Perrault, M. A., Sparrow, K., Stacey, S., Swart, P., & Wong, M. (2019). Guidelines to the Practice of Anesthesia – Revised Edition 2019. *Canadian Journal of Anesthesia*, *66*(1), 75–108.

[5] Donaldson, M., Donaldson, D., & Quarnstrom, F. C. (2012). Nitrous oxide-oxygen administration: When safety features no longer are safe. *Journal of the American Dental Association*, *143*(2), 134–143.

[6] Gilmour, I. J., McComb, R. C., & Palahniuk, R. J. (1990). Contamination of a hospital oxygen supply. *Anesthesia and Analgesia*, *71*(3), 302–304.

[7] Greilich, P. E., Greilich, N. B., Froelich, E. G., & Johnson, C. T. (1995). Intraabdominal fire during laparoscopic cholecystectomy. *Anesthesiology*, *83*(4).

[8] Gupta, S., & Jani, C. B. (2009). Oxygen cylinders: “Life” or “death”? *African Health Sciences*, *9*(1), 57–60. /pmc/articles/PMC2932522/?report=abstract Hogg, C. E. (1973). Pin-indexing failures. *Anesthesiology*, *38*(1), 85–87.

[9] Jawan, B., & Lee, J. H. (1990). Cardiac arrest caused by an incorrectly filled oxygen cylinder: A case report. *British Journal of Anaesthesia*, *64*(6), 749–751.

[10] Koka, R., & Philip, J. H. (2008). Understanding Anesthesia Equipment, 5th ed. *Anesthesia & Analgesia*, *107*(6), 2098.

[11] Lorraway, P. G., Savoldelli, G. L., Joo, H. S., Chandra, D. B., Chow, R., & Naik, V. N. (2006). Management of simulated oxygen supply failure: Is there a gap in the curriculum? *Anesthesia and Analgesia*, *102*(3), 865–867.

[12] Malamed, S. F., & Clark, M. S. (2003, May 31). *Nitrous oxide-oxygen: a new look at a very old technique - PubMed*. Journal of Claif Dental Association. .

[13] McVey, F. K., & Streets, C. A. (2009a). Oxygen delivery failure from faulty portable cylinder. *Anaesthesia*, *64*(10), 1150–1151.

[14] McVey, F. K., & Streets, C. A. (2009b). Oxygen delivery failure from faulty portable cylinder. *Anaesthesia*, *64*(10), 1150–1151.

[15] Pauling, M., & Ball, C. M. (2017). Delivery of anoxic gas mixtures in anaesthesia: case report and review of the struggle towards safer standards of care. *Anaesthesia and Intensive Care*, *45*(7), 21–28.

[16] Ringbæk, T., Lange, P., & Viskum, K. (1999). Compliance with LTOT and consumption of mobile oxygen. *Respiratory Medicine*, *93*(5), 333–337.

[17] Runciman, W. B., & Merry, A. F. (2005). Crises in clinical care: an approach to management. *BMJ Quality & Safety*, *14*(3), 156–163.

[18] Shipton, E. A., Roelofse, J. A., & van der Merwe, C. A. (1983, October 29). *Accidental severe hypercapnia during anaesthesia. Case reports and a review of some physiological effects - PubMed*. S Afr Med J.

[19] Sprague, D. H., & Archer, G. W. (1975). Intraoperative hypoxia from an erroneously filled liquid oxygen reservoir. *Anesthesiology*, *42*(3), 360–362.

[20] Srivastava, U. (2013). Anaesthesia gas supply: Gas cylinders. *Indian Journal of*

Anaesthesia, *57*(5), 500–506.

[21] Taylor, N. J., & Davison, Mtime. (2009). Inaccurate colour coding of medical gas cylinders. *Anaesthesia*, *64*(6), 690–690.

[22] Van Zundert, T. C. R. V., & Brimacombe, J. R. (2010). Colour coding: a must for extraglottic airway devices. *Anaesthesia*, *65*(8), 865–866.

[23] Weller, J., Merry, A., Warman, G., & Robinson, B. (2007). Anaesthetists' management of oxygen pipeline failure: room for improvement. *Anaesthesia*, *62*(2), 122–126.