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Compliance of Hospitals in Saudi Arabia with National and International Medical Gas Pipeline System Maintenance Guidelines

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ABSTRACT

The aim of this study has two folds. Firstly, to investigate the extent to which hospitals in Saudi Arabia adhere to CBAHI (Saudi Central Board for Accreditation of Healthcare Institutions) standards regarding maintenance of medical gas pipeline systems (MGPS). Secondly, to determine if different hospitals implement the MGPS check-points required by CBAHI in a similar manner with respect to timeframe of performing the check-points. A cross-sectional survey was conducted during field visits to 11 hospitals biomedical engineering offices. A paper-based questionnaire was developed to collect all the relevant information. The study results showed that 99% of the check-points specified by CBAHI are implemented fully by all the 11 hospitals. There was only one hospital that failed-short of checking the system alarm of the pipeline system, and another hospital that failed-short of checking for leak-signs in joints of liquid oxygen plant. There were large variations in time-periods of actually performing the required check-points among hospitals. The study suggests modification on CBAHI standards regarding maintenance and operation of MGPS that incorporate timeframe for performing each check-point to guarantee an efficient and safe MGPS.

Keywords: Saudi Arabia, Medical Gas Pipeline Systems, British Department of Health, CBAHI.

INTRODUCTION

The medical gas pipeline system (MGPS) plays a fundamental and pivotal role in the efficient delivery of healthcare in hospitals as a reliable supply of medical gases in operating theaters, intensive care wards, patient rooms and outpatient clinics (1-4). Oxygen, nitrous oxide, medical air and vacuum are crucial for various medical procedures (5). To ensure patient safety in the hospital, and a constant dependable supply of medical gases throughout the hospital clinical spaces, the design and installation of the medical gas pipeline system must comply with strict design standards and regulations (6-8), whether in relation to the nature of the gases present in each clinical space, the pressure of the gases in the pipeline system, outlet flow, or even other design aspects in the gas station.

In addition, the operation and maintenance of the MGPS are also subject to specific standards and guidelines adopted by regional and international regulatory health authorities with the aim to unify the mechanism for ensuring the readiness and safety of the medical gas network with the intention of reducing the risk of cross-contamination, gas leaks and shortage, and other risks that could compromise patients' comfort, safety and care (9-11). Moreover, equipping the MGPS with advanced real-time monitoring systems of gas pressure and levels may reduce catastrophic health complications (12-16) and ensure that the MGPS functions correctly and delivers the appropriate gas dose to the patient (17-21).

In Saudi Arabia, the governmental body responsible for setting guidelines and standards for testing and operating the medical gas pipeline system is the Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI). The CBAHI has developed detailed standards for steps and point of checks of the MGPS to ensure its proper and reliable operation with no scheduled timeframe for performing each check point. All government and private hospitals of all sizes and specialties are obligated to follow these standards and guidelines. One of the criteria for these hospitals to obtain CBAHI accreditation is their commitment to these standards for operating, maintaining and inspecting the MGPS.

The aim of this study has two folds. Firstly, to investigate the extent to which hospitals in Riyadh, Saudi Arabia, adhere to these CBAHI standards. Secondly, to determine if different hospitals implement the MGPS check-points required by CBAHI in a similar manner with respect to timeframe of performing the check-points. To that extent, this study incorporates the MGPS of British Department of Health (BDH) guidelines considering that it takes into account a timeframe of performing the required check points.

METHOD

A cross-sectional survey was conducted during in-person visits to the biomedical engineering office at Riyadh hospitals, Kingdom of Saudi Arabia. A check-list type paper-based questionnaire was developed to collect all the information relevant, with the aim of determining hospitals' level of adherence to MGPS operation and maintenance standards set by Saudi CBAHI and guidelines set by the BDH. The questionnaire, which includes the purpose and instructions was handled to the engineering officer responsible in the biomedical engineering department at the respected hospital. The study covers eleven hospitals in the Riyadh area three of them are teaching hospitals. As shown in Table 1, the questionnaire contains a check list of all items required to be checked by the operation and maintenance engineer according to the Saudi CBAHI standard as well as with the BDH guidelines.

Table 1: The study questionnaire contains a check list of all items required to be checked according to the Saudi CBAHI standard and with the BDH guidelines.

		Checked?		Who is Responsible?		How Often?				Remarks
		Yes	No	Biomedical Unit	Contractor	Daily	Weekly	Annually	Other	
Pipeline System (General Tasks)	System Pressure									
	Pipeline Labeling									
	Outlet Labeling									
	System Leaks									
	System Alarms									
	Pressure Gauges									
	Shutoff and Main Valves									
	Cylinders' Leakage									
Vacuum Plant	Pump Alarms									
	Plant Panel Alarms									
	Pump Leakage									
Compressed Air Plant	Plant Panel Alarms									
	Compressor Leaks									
	Dryer Status/Alarms									
	Purity and Humidity of Compressed Air									
Liquid Oxygen Plant (if Applicable)	Sings of Leaks in Joints									
	Vessel Pressure									
	Plant Output Pressure									
Is the Gas Station in a safe and Secure Place?	Yes ☐ No ☐									

RESULTS

The questionnaire was filled out by the engineers responsible for MGPS operation and maintenance in 11 hospitals in the Riyadh region during field visits to these hospitals. Figure 2 shows all the questionnaire data for the 11 visited hospitals. The table shows all the check-points that are required to be implemented according to the Saudi CBAHI standard. The numbers shown in Table 2 represent number of hospitals that implement each check-point in the periodic time-period shown.

Table 2: Distribution of the 11 studied hospitals over the actual time-periods at which the respected MGPS check-point was performed (gray shaded cells). The listed check-points are those required by Saudi CBAHI standard; a standard that does not specify a time-period for performing each check-point. The bold-bordered cells denote the time-period specified by the BDH guidelines for performing each check-point.

Time-periods of actually performing the required check-points	Not Checked

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		Daily	Weekly	Monthly	Every 3 Months	Every 6 Months	Annually	On Delivery	On Modification	On Installation	Randomly	
Pipeline System (General Tasks)	System Pressure	9		1		1						
	Pipeline Labeling	1				1	4		1	4		
	Outlet Labeling	2			1	1	3	1	1	2		
	System Leaks	6		3	1		1					
	System Alarms	6		3			1					1
	Pressure Gauges	6		2	2		1					
	Shutoff and Main Valves	4		2	2		2				1	
	Cylinders' Leakage	6						5				
Vacuum Plant	Pump Alarms	7		2	1		1					
	Plant Panel Alarms	6		1	3		1					
	Pump Leakage	8		2			1					
Compressed Air Plant	Plant Panel Alarms	7		3	1							
	Compressor Leaks	9		2								
	Dryer Status/Alarms	9		2								
	Purity and Humidity of Compressed Air	5			1	1						
Liquid Oxygen Plant	Sings of Leaks in Joints	9		1								1
	Vessel Pressure	9		1	1							
	Plant Output Pressure	9		1	1							

As for the engineering office responsible for implementing or supervising the implementation of check-points, the questionnaire showed that 62.1% of the hospitals had assigned these tasks to the technical engineering staff in the hospital's biomedical engineering office, while 37.9% of hospitals had assigned the tasks to an external technical contractor and supervised by the biomedical engineering office. There was complete consensus in all hospitals that the location designated for the medical gas station is located, as required by CBAHI, in a safe and secure place. Regarding the compliance with the CBAHI standards in terms of specific check-points and the necessity of their implementation; even though CBAHI do not mention specific time-periods for their implementation, the results of the questionnaire (Table 2) showed that 99% of the check-points specified by CBAHI are implemented fully by all the 11 hospitals. There was only one hospital that failed-short of checking the system alarm of the pipeline system, and another hospital that failed-short of checking for leak-signs in joints of liquid oxygen plant (shown in rightmost column of Table 2). As for the time-periods at which check-points are implemented, the questionnaire showed large differences between hospitals, and between hospitals and the time-periods set by the BDH guidelines. The cells with bold borders in figure 2 show the time-period recommended by the BDH guidelines for implementing each check-point. From the data shown in Table 2, it appears that only 17.3% of the check-points are implemented according to the BDH guidelines, while the majority of check-points (82.7%) are implemented at very

different time-periods for each check-point; ranging from daily periods to annual and random periods.

DISCUSSION

The finding of this study indicates that Saudi Arabia hospitals are in great compliance with Saudi CBAHI standards related to the maintenance and operation of medical gas pipeline system (11). The compliance reached 99% in term of performing all required check-points with only two hospitals failed perform one check-point each. However, considering that CBAHI does not specify time-periods of performing the check-points, there were large variations in time-periods of actually performing the required check-points among hospitals. This reality indicates that maintenance of MGPS is not standardized among hospitals, which may not ensure the same quality and performance of the medical gas pipeline system. Such large variations in the timetable of performing the maintenance check points may result in the risk of cross-contamination, gas leaks and shortage, and other risks that could compromise patients' comfort, safety and care (9, 11). The study also found a considerable 82.7% deviation in the time-periods of performing check-points away from the timed guidelines of BDH standard (6).

CONCLUSION

The present study shows excellent compliance of Saudi Arabia hospitals with National CBAHI standards regarding maintenance and operation of MGPS, but the required maintenance tasks were performed at widely different time periods which could jeopardize the efficiency and readiness of MGPS. A suggested modification on CBAHI standards regarding maintenance and operation of MGPS that incorporate timeframe for performing each check-point may prove a be good tool to reduce the notice variations and hence guarantees an efficient and safe MGPS.

Data Availability

The data used to support the findings of this study are available from the author upon request.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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