Survey of Effectiveness of Non-invasive Measurement at Carbon Monoxide Levels in Patients Admitted to Emergency Department of Tabriz Emam Reza Hospital to Detect Hidden Cases of Poisoning with Carbon Monoxide

Hamidreza Morteza Baghi[1], Mehdi Farzmehdi[2]*, Sepehr Taghizadeh[3], Mehdi Haghdoost[3], Sara Sadeghpour[4] and Elnaz Dadashpour[5]

[1]Assistant Professor of Emergency Medicine, Emergency Medicine Department, Faculty of Medicine, Tabriz University of medical sciences, Tabriz, Iran
[2]Pulmonology and Critical Care Medicine Fellowship, Internal Medicine Department, Faculty of Medicine, Tabriz University of medical sciences, Tabriz, Iran
[3]Infectious and Tropical disease research center, Infectious diseases department, Tabriz University of medical sciences, Tabriz, Ira.
[4]Department of Biomaterials, Science and Research branch, Islamic Azad University, Yazd, Iran
[5]Nurse, Sina Hospital of Tabriz, East Azarbayjan Province, Iran

*Corresponding author

KEYWORDS	A B S T R A C T
Emergency Ward, CO Level, Season	CO poisoning was a preventable cause of mortality and morbidity. CO poisoning often present with nonspecific symptoms and the lack of exposure history and check of CO level was helpful to confirm of diagnosis of patients. The aim of this study was determine of effectiveness of non-invasive measurement at carbon monoxide levels in patients admitted to emergency department of Tabriz Emam Reza Hospital to detect hidden cases of poisoning with carbon monoxide. In a cross section and descriptive-analytical study that performed in department of emergency medicine of Emam Reza hospital on patients that referred to this site, the effectiveness of non-invasive measurement at carbon monoxide levels in patients admitted to emergency department of Tabriz Emam Reza Hospital to detect hidden cases of poisoning with carbon monoxide evaluated. 417 of patients was male and 281 of them were female. Mean age of patients was 49.23 ± 29.32 year. Mean Co level of male patients was 7.24 ± 228 and mean Co level of female patients was 6.85 ± 2.17 (P=0.025). Mean Co level of smoker patients was 7.71 ± 2.06 and mean Co level of non-smoker patients was 6.99 ± 2.25 (P=0.005). Mean CO level in patients that referred in Spring was 6.99 ± 2.26, in patients that referred in Summer was 6.98 ± 2.14, in patients that referred in Autumn was 6.94 ± 2.41 and in patients that referred in Winter was 7.42 ± 2.41. Significant difference was not found between CO level of patients that referred in seasons. Results of our study demonstrated that in patients that referred to emergency ward, CO level in several diseases, smoker and non-smoker and patient of two gender were different and also in patients that refereed in winter, CO level was higher than other seasons but this difference was not significant.

Introduction

Every year a large number of patients visit emergency wards complaining about CO (carbon monoxide) poisoning, especially in cold seasons. Unfortunately, some of these patients experience serious complications as a result of poisoning with CO (1).

CO poisoning causes classic signs of poisoning, which may be missed (1). On the other hand, due to the various clinical demonstrations of this condition, clinicians sometimes make mistakes in diagnosis, and this mistake adds to the difficulty of the treatment process.

CO poisoning is a preventable cause of mortality and morbidity (2). These patients may visit emergency wards with symptoms similar to viral infections, coronary diseases, or urological disorders.

CO poisoning usually manifests in the form of non-specific signs and a lack of occurrence history. Measurement of CO levels is also useful for diagnosing the patients (3).

Non-invasive measurement of CO level in the emergency wards of hospitals based on headache is a quick and specific means, because during winter an increase in CO level is observed in 7% of patients visiting emergency wards with headache (4).

Chronic encounter and incidence of CO poisoning usually manifests through non-specific symptoms and latent CO poisoning is one of the causes of headache, which should be considered in differential diagnosis of patients with headache (5).

Particularly, in patients with repeated non-specific headaches it is necessary to consider the latent CO poisoning, which is diagnosed by measuring blood CO and CoHb levels (5).

This study was an attempt to examine an acceptable number of patients with various clinical demonstrations so as to estimate the causes of talent CO poisoning and present solutions for more precise diagnoses.

The aim of this study was to determine the effectiveness of CO measurement for diagnosing latent CO poisoning patients visiting the emergency ward of Emam Reza hospital.

Materials and Methods

In a cross-sectional descriptive analytical study that was performed in Emergency Medicine Department of Tabriz University of medical sciences on patients, the effectiveness of CO measurement for diagnosis of latent CO poisoning in patients visiting the emergency ward of Emam Reza Hospital was examined.

In this research, 700 patients vising the emergency ward were selected based on the inclusion and exclusion criteria. Moreover, using a CO measurement device, the level of CO was measured in participants through triage. The relationship between CO levels and other symptoms demonstrated by the patients was also investigated.

The level of CO may be related to smoking, age, gender of patients, and the month of visit (e.g. autumn and winter months as well as use of heating devices increase the encounter of patients with CO). Hence, these factors were included in the specific goals of this research.

In this research, which was conducted as a cross sectional descriptive study in Tabriz, the effectiveness of CO level measurements

for diagnosis of latent CO poisoning in patients visiting the emergency ward of Emam Reza Hospital was examined. In addition, the relationship between CO levels in patients visiting the aforementioned emergency ward and clinical signs of patients was also investigated.

In this research, 700 patients vising the emergency ward were selected based on the inclusion and exclusion criteria. Moreover, using a CO measurement device, the level of CO was measured in participants through triage. The relationship between CO levels and other symptoms demonstrated by the patients was also investigated.

Research Exclusion Criteria

- Traumatic patients
- Intubated patients
- Patients under MV
- Patients with preliminary complaints of convulsion
- Patients with background cardiopulmonary diseases
- Patients with clear jaundice
- Pregnancy

Ethical Considerations

No invasive measure was taken in this study and no change was caused to the treatment of patients. Moreover, no additional expense was imposed on the patients for CO measurements and all of the patient information will remain confidential.

Statistical Analysis

The collected data were analyzed by SPSS-17 statistical software. The collected data were expressed as percentage and mean ± SD. Continuous (quantitative) variables were compared by Independent samples and Paired t test. Categorical (qualitative) variables were compared by contingency tables and Chi-square test or Fisher's exact test. P-value ≤0.05 was considered statistically significant.

Results and Discussion

In this study, 700 patients visiting the emergency ward of Emam Reza Hospital of Tabriz were examined during one year for CO levels and the following results were obtained.

A total of 417 patients were male and 281 were female (Fig. 1).

The mean age of male and female patients was 48.18 ± 20.60 years and 50.79 ± 19.82 years, respectively (P=0.094).

The mean CO level in male and female patients was 7.24 ± 2.28 and 6.85 ± 2.17, respectively (P=0.025).

Moreover, 87 patients were smokers. Of the 87 smokers, 78 were male and 9 were female (P<0.001). The mean age of smokers was 46.95 ± 20.43 years, and the mean age of non-smokers was 49.55 ± 20.30 years (P=0.266).

The mean CO level in smokers and non-smokers was 7.71 ± 2.06 and 6.99 ± 2.25, respectively (P=0.005). The mean CO levels in patients in spring, summer, autumn, and winter seasons were 6.99 ± 2.26, 6.98 ± 2.14, 6.94 ± 2.12, and 7.42 ± 2.41, respectively. No significant difference was observed between mean CO levels in the patients visiting in different seasons. The mean CO levels in patients are shown in Table (1) by season.

The mean CO levels in patients visiting the hospital are shown in Table (2) with regard to their current disease.

CO is a colorless, odorless and tasteless gas that is resulted from fossil fuels burning. CO Poisoning is the most common causes of poisoning-induced mortality in the United States. Although inhalation of CO gas is used as a suicide method in some countries, this type of poisoning is caused by accident in Iran. Moreover, the mortality caused by CO Poisoning is preventable through simple methods, but this is still a cause of death.

In a study by Heckerling et al. it was stated that headache and convulsion occur when CO level is higher than 10%. Examination of 89 patients complaining about headache and convulsion also revealed that the mean CoHb level in the patients was 2.87% (6).

Whincup et al. (2006) conducted a study in St. George University of London. After examining the CoHb levels in old English men they stated that the mean CoHb level in smoking men and non-smoking men was 3.29% and 0.32%, respectively (7).

In our study, the mean CoHb level in smoking men was $7.80 \pm 2.09\%$, which was higher than the level reported by the aforementioned researchers.

Da Silva et al. (2013) carried out a study in the Federal de Goias University of Brazil to examine the levels of CoHb in taxi drivers. They reported that the level of CoHb in taxi drivers was increased (8).

In a study by Buchelli et al. (2014) in the University of Ovideo in Australia, the levels of CoHb were measured in the participants and it was found that the level of CoHb in smoker and non-smokers was 6.7% and 3.2%, respectively (9).

In our research, the mean CO level in smokers and non-smokers was 7.71 ± 2.06 and 6.99 ± 2.25, respectively. The mean CO

level in smoking patients was, therefore, significantly higher than that of nonsmokers (P=0.005).

In 2014, Topacoglu et al. conducted a study in the emergency medicine department of Istanbul University of Turkey to measure the levels of CoHb in carwash workers. These researchers stated that the level of CoHb in the patients at the beginning of their shift was $2.1 \pm 2\%$, while it increased to 5.2 ± 3.3 at the end of their shift. The increase was statistically significant (P<0.001). The same difference was observed between smoking and nonsmoking workers (10).

In a study by Dolan et al., the level of CoHb was measured in patients with flu and it was reported that 23.6% of flu cases had a carboxy-globin level of over 10%. Moreover, no significant difference was observed between CoHb levels in the smoking and nonsmoking patients. In patients who used wood stoves for heating purposes, the level of CoHb was significantly higher than other patients (11).

In our research, the level of CO in 9 patients (12.5%), who visited the hospital with pneumonia symptoms, was over 10.

In their research, Heckerling et al. concluded that headache was an initial sign of latent CO poisoning. In this research, of the 37 patients who visited the center in winter with headache, 7 (8.9%) had CoHb levels of over 10% and the mean CoHb level in the patients was 14% (12).

In our study, of the 97 patients who visited the hospital with headache, the level of CO was higher than 10% in 22 patients, and the mean CO level in patients with headache was 8.08 ± 2.28. This mean CO level was significantly higher than the mean CO level in other patients.

Table.1 CO Level of Patients Based on Referring Month

	CO Level			
	Mean ± Std Deviation	Percentile 25	Percentile 75	Percentile 95
January	7.44 ± 2.08	5.80	8.45	11.94
February	7.44 ± 2.48	5.07	9.03	12.71
March	7.43 ± 2.67	5.30	8.77	12.80
April	6.92 ± 2.19	5.00	8.13	11.06
May	7.39 ± 2.49	5.78	8.43	12.85
June	6.69 ± 2.08	5.07	7.43	10.76
July	6.52 ± 1.83	5.10	7.30	10.41
August	7.13 ± 2.23	5.50	7.93	12.04
September	7.30 ± 2.31	5.48	8.90	12.52
October	7.25 ± 2.32	5.30	8.27	12.70
November	6.83 ± 2.14	5.10	7.65	12.41
December	6.70 ± 1.87	5.33	7.39	10.76

Table.2 Patients Gender and Diseases

	Gender		Total
	Male	Female	
Renal Failure	55	33	88
Sepsis	35	24	59
Drug Poisoning	28	18	46
DKA	31	14	45
Headache	61	36	97
CVA	67	41	108
Dizziness	53	37	90
Pneumonia	38	34	72
COPD	35	32	67
Liver Diseases	16	12	28

Table.3 CO Level of Patients based on Patient's Diseases

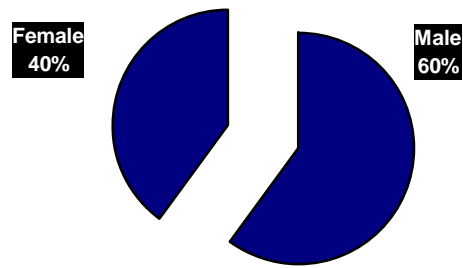|	CO Level			
	Mean ± Std Deviation	Percentile 25	Percentile 75	Percentile 95
Renal Failure	8.30 ± 2.34	6.33	10.10	12.72
Sepsis	6.01 ± 1.61	4.80	7.00	8.50
Drug Poisoning	5.23 ± .80	4.68	5.48	7.00
DKA	5.96 ± 1.38	4.80	6.85	8.80
Headache	8.08 ± 2.28	6.40	9.80	12.80
CVA	6.48 ± 2.03	5.10	7.13	11.04
Dizziness	7.58 ± 2.35	5.80	9.20	12.79
Pneumonia	7.09 ± 2.18	5.50	8.32	11.53
COPD	7.52 ± 2.30	5.80	9.00	12.80
Liver Diseases	6.70 ± 1.74	5.60	7.39	11.81

Chart.1 Gender Distribution of Patients
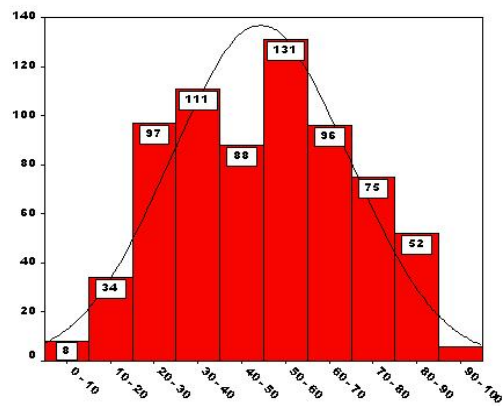

Chart.2 Age Distribution of Patients

Chart.3 CO Level Distribution of Patients between Two Genders
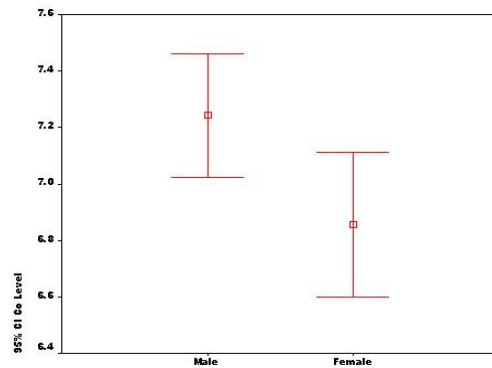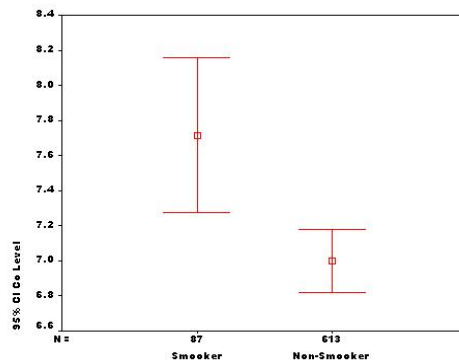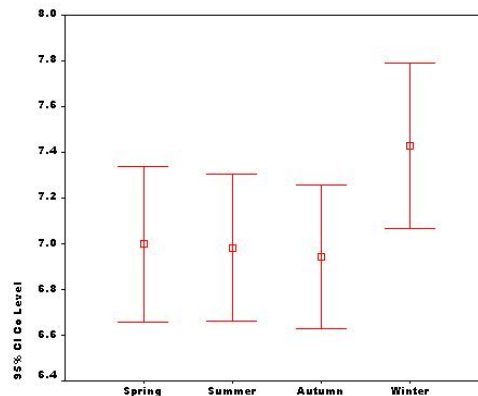

Chart.4 CO Level Distribution of Smooker and Non-smoker Patients

Chart.5 CO Level Distribution of Patients based on Referring Season

In a study by Heckerling in the University of Illinois (Chicago, USA), neurologic patients visiting the emergency ward were examined for latent poisoning. It was reported that the total CoHb mean level was 3.1%, and no significant difference was observed between CoHb levels in patients with different neurologic diseases. Of the patients under study, only 3% had CoHb levels of higher than 10% (13).

Eberhardt et al. (2006) conducted a study for non-invasive examination of CO levels in patients with headache, who visited the emergency centers. They stated that the level of CO increased in 7.1% of patients with headache, and this result was significantly higher than the level of CO in the control group (1%) (4).

In an investigation by Clarke et al. in 2012, it was reported that the levels of CO in patients visiting the emergency centers with various diseases were different. That is to say, the levels of CO in patients with COPD, headache, flu, chest pain, and convulsion were 7.5%, 6.3%, 4.3%, 3.3%, and 2.1%, respectively (1).

Similar to the results of the above study, in our research the level of CO in patients with COPD, headache, pneumonia signs, and CVA was $7.52 \pm 2.30\%$, $8.08 \pm 2.28\%$, $7.08 \pm 2.18\%$, and $6.47 \pm 2.02\%$, respectively.

In another research by Heckerling et al. on patients with neurologic diseases, who visited emergency wards, it was reported that the high CO levels in patients with neurologic signs was an important issue especially in winter (14).

In our study, although the level of CO in patients visiting the center in winter was higher than other seasons, the difference was not statistically significant.

In a study by Aksu et al. on patients with CO poisoning, the relationship between vital signs with CO poisoning was studied. It was stated that clinical signs cannot be used a prognostic factors, but the patients have to be exposed to closed monitoring procedures (15).

Jaslow et al. examined patients visiting emergency centers to measure the levels of CO in the patients. They concluded that routine measurements of CO levels in patients visiting emergency centers are

effective for diagnosing latent CO poisoning cases (16).

Zorbalar et al. studied patients visiting emergency wards in winter with headache complaints and stated that CO poisoning should be considered a cause of headache in patients visiting emergency centers in winter. Moreover, according to these researchers, measuring CO levels in such patients can be effect and of diagnostic use (17).

Conclusion

Results of our research suggest that in patients visiting the emergency ward, the level of CO differed based on disease as well as in smoking or nonsmoking patients and patients of the two genders. Moreover, the level of CO was higher in patients visiting the center in winter, but the difference was not statistically significant.

Suggestions

In view of the research results, it is recommended to include CO measurement in the clinical examination of patients and to measure CO levels.

References

1. Clarke S, Keshishian C, Murray V, Kafatos G, Ruggles R, Coultrip E, Oetterli S, Earle D, Ward P, Bush S, Porter C; Carbon Monoxide in Emergency Departments (COED) Working Group. Screening for carbon monoxide exposure in selected patient groups attending rural and urban emergency departments in England: a prospective observational study. BMJ Open. 2012 Dec 13;2(6). pii: e000877. doi: 10.1136/bmjopen-2012-000877. Print 2012.

2. Keleş A, Demircan A, Kurtoğlu G. Carbon monoxide poisoning: how many patients do we miss? Eur J Emerg Med. 2008 Jun;15(3):154-7. doi: 10.1097/MEJ.0b013e3282efd519.

3. Suner S, Partridge R, Sucov A, Valente J, Chee K, Hughes A, Jay G. Non-invasive pulse CO-oximetry screening in the emergency department identifies occult carbon monoxidetoxicity. J Emerg Med. 2008 May;34(4):441-50.

4. Eberhardt M, Powell A, Bonfante G, Rupp V, Guarnaccia JR, Heller M, Reed J. Noninvasive measurement of carbon monoxide levels in ED patients with headache. J Med Toxicol. 2006 Sep;2(3):89-92.

5. Ares BM, Casais JL, Dapena D, Lema ML, Prieto JM. Headache secondary to carbon monoxide poisoning. Rev Neurol. 2001 Feb 16-28;32(4):339-41.

6. Heckerling PS, Leikin JB, Maturen A, Perkins JT. Predictors of occult carbon monoxide poisoning in patients with headache and dizziness. Ann Intern Med. 1987 Aug;107(2):174-6.

7. Whincup P, Papacosta O, Lennon L, Haines A. Carboxy-haemoglobin levels and their determinants in older British men. BMC Public Health. 2006 Jul 18;6:189.

8. da Silva LA, Robazzi ML, Terra Fde S. Relation between workplace accidents and the levels of carboxyhemoglobin in motorcycle taxi drivers. Rev Lat Am Enfermagem. 2013 Sep-Oct;21(5): 1119-26.

9. Buchelli Ramirez H, Fernández Alvarez R, Rubinos Cuadrado G, Martinez Gonzalez C, Rodriguez Jerez F, Casan Clara P. Elevated Carboxyhemoglobin: Sources of Carbon Monoxide Exposure. Arch Bronconeumol. 2014 May 5. pii: S0300-2896(14)00117-3. doi: 10.1016/j.arbres.2014.03.005. (Epub ahead of print)

10. Topacoglu H, Katsakoglou S, Ipekci A. Effect of exhaust emissions on carbon monoxide levels in employees working at indoor car wash facilities. Hippokratia. 2014 Jan;18(1):37-9.

11. Kirkpatrick JN. Occult carbon monoxide poisoning. West J Med. 1987 Jan;146(1):52-6.

12. Kales SN. Carbon monoxide intoxication. Am Fam Physician. 1993 Nov 1;48(6):1100-4.

13. Heckerling PS, Leikin JB, Terzian CG, Maturen A. Occult carbon monoxide poisoning in patients with neurologic illness. J Toxicol Clin Toxicol. 1990;28(1):29-44.

14. Heckerling PS, Leikin JB, Terzian CG, Maturen A. Occult carbon monoxide poisoning in patients with neurologic illness. J Toxicol Clin Toxicol. 1990;28(1):29-44.

15. Aksu NM, Akkaş M, Çoşkun F, Karakiliç E, Günalp M, Akküçük H, Ataman DK, Özcan H, Özmen MM. Could vital signs predict carbon monoxide intoxication? J Int Med Res. 2012;40(1):366-70.

16. Jaslow D, Ufberg J, Ukasik J, Sananman P. Routine carbon monoxide screening by emergency medical technicians. Acad Emerg Med. 2001 Mar;8(3):288-91.

17. Zorbalar N, Yesilaras M, Aksay E. Carbon monoxide poisoning in patients presenting to the emergency department with a headache in winter months. Emerg Med J. 2013 Oct 15.