Case Report

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Use of Hospital-Based Blood Gas Analyzer for Diagnosis of Carbon Monoxide Poisoning in Medicolegal Autopsy Cases: An Experience from Series of Cases

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Abstract

Cases of carbon monoxide (CO) poisoning are challenging for toxicology laboratories, on the other hand immediate confirmation of CO poisoning is sometimes very essential for investigating agencies. Though autopsy findings are self-sufficient for this confirmation, a laboratory validation adds more weightage. Currently, in many of our Regional Forensic Science Laboratories (RFSL), spectrophotometric analysis is used for the detection of Carboxy-haemoglobin (COHb). However, samples being susceptibile to alterations of optical state and degradation during sampling, transport and storage pose difficulties in analysis. Secondly reports from RFSL are received after much longer durations. However, hospital-based blood gas analyzers with CO-oximetry, provide automated spectrophotometric measurement of concentration of total haemoglobin (ctHb) in blood along with that of other four haemoglobin derivatives and COHb levels, that too immediately and at a low cost. Over the background of delayed reporting from RFSL, we hereby discuss five cases of CO poisoning, confirmed with the help of hospital-based blood gas analyser.

Keyword: Postmortem blood sample, Hospital-based ABG machine, COHb, CO-oximetry, Spectrophotometry.

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Introduction

Carbon monoxide (CO) is considered one of the most abundant atmospheric pollutant, which is increasing in concentrations with an exponential rate.[1] Apart from being a common environmental contaminant, CO is also commonly encountered among death cases in Forensic Practice.[2]

Though it has been reported as a common method opted for suicide in the West, it is quite rare in India, where accidental cases are more in number.[3] Coflagaration in large commercial or household buildings is found to be the common

cause of accidental CO poisoning causing mass deaths in India.[2]

Even though many of the typical CO poisoning cases encountered during medicolegal autopsy are diagnosed based on typical postmortem features, at times we face situations where due to extreme charring of bodies, due to dark skin color or severe anemia the confirmation about CO poisoning cannot be given. Secondly, antemortem nature of burns cannot be established instantly, posing further problems for investigation. In such cases laboratory confirmation of CO poisoning is important.

The hospital based blood gas analysers, utilizing CO-oximetry working on the principle that each haemoglobin derivative have unique absorbance spectrum, is widely used in clinical set-ups. It offers automated, immediate, and cost-effective measurement of total haemoglobin (ctHb) concentration and other haemoglobin derivatives like Oxyhemoglobin (O_2Hb), Reduced hemoglobin (HHb), Methemoglobin (MetHb), Sulfhemoglobin (SulfHb), Carboxy-hemoglobin (COHb) along with total hemoglobin (ctHb).

In this case series we are presenting five cases where CO poisoning was instantly validated using a hospital based blood gas analyser along side typical autopsy findings, highlighting the utility of Hospital-based Blood Gas Analysers in expediting CO poisoning confirmation.

Case presentation

Out of five cases, two were brought with alleged history of found dead in bathroom, each in different set up, having gas gyser connections in bathroom. Others were found in burnt and nearly charred state, subsequent to alleged accidental fire incidence in kitchen of a hotel.

In first two cases, external features and internal features at the postmortem examination were consistent with typical CO poisoning i.e Cherry red coloration of skin, lividity, mucous membranes, blood, tissues and internal organs with signs of suffocation in the form of cyanosis, fluid blood and petechial hemorrhages over lungs and heart.

In remaining three cases the external findings were of variable degrees of deep burns with charring at places. On internal examination cherry red discoloration was noted of mucous membranes, blood, tissues and internal organs.

In all these cases, while performing routine autopsy procedure, the blood was collected in heparinized syringe, from the inferior vena cava and was immediately sent for Blood Gas Analysis at NABL accredited hospital based laboratory through proper channel. The ABG machine used for analysis was ROCHE Cobas B 221. (Fig. 1)

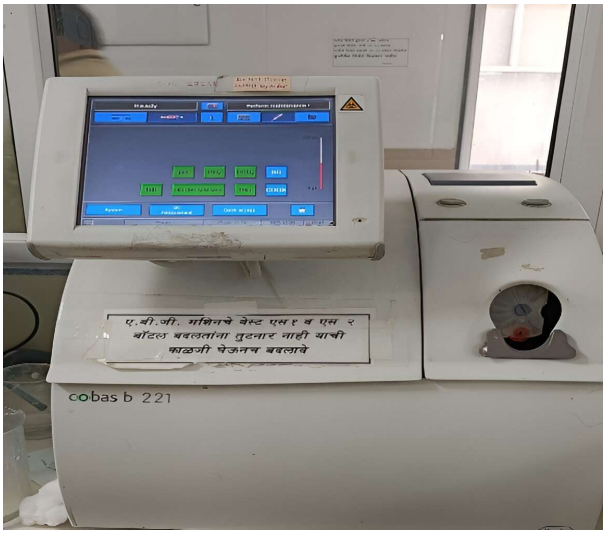

Fig. 1: Hospital-based Blood Gas Analysis Machine. (ROCHE Cobas B 221)

In all cases, one more blood sample, coated with liquid paraffin was sent to RFSL in packed, sealed and labelled bottle through proper channel for necessary chemical analysis.

Analysis using the hospital based blood gas analyser revealed elevated COHb levels in all five cases (Table 1).

Discussion

Table 1: Showing percentage of COHb and respective values of CtHB in all five cases.

Case NO	1	2	3	4	5
% COHb	62.9	81.8	48.9	40.5	46.9
ctHb(g/dL)	15.32	6.28	12.61	10.51	14.97

As per communication with the Regional Forensic Science Laboratories, Pune, presence of carboxyhemoglobin is determined with spectrophotometer analysis using λ-max values i.e manual spectrophotometer method. In this method, the suspected blood is first treated with reducing agent. This helps to convert O2HB and MetHb to HHb. However this does not affect COHb. The reference is considered to be normal hemoglobin

showing λ-max at about 576.2 nm and 542 nm and COHb showing - max at 568.3 nm in 0.04% aq NH4OH.[4]

However, it is important to note that the reports will not give percentage values of COHb and will just mention presence or absence of COHb as it is a qualitative estimation. Also, needless to say that reports will be generated after a much longer duration. (Table 2)

In Gas Chromatography method, the CO liberated from the treated sample is directly measured. This method, being widely considered as reference method, is found to be most sensitive, precise and accurate.[5] However, it is time consuming, expensive and needs technical expertise. Also separate measurement of ctHB is required while using this method.[6]

Table 2: Showing turn around time (TAT)of RFSL in reporting.

Case no	1	2	3	4	5
TAT	3 years	1 year 2 months	4 months	4 months	4 months
Report*	COHb present	COHb present	COHb present	COHb present	COHb present

*Only qualitative analysis reports are issued hence percentage COHb values not available.

On the other hand, hospital based ABG machine work on principle of Automated Spectrophotometry (CO-Oximetry). This employs automated instruments to measure absorbance or transmittance of light by a sample. In this method samples are loaded onto a robotic platform and measurements are performed automatically according to predefined protocols. This is précise and accurate method compared to manual spectrophotometry. It reduces risk of human error, is highly efficient and affordable, easy to use and gives result within minutes. Secondly ctHB measurements are part of the analysis, overcoming the challenges of Gas chromatography.

Blood contains trace amount of COHb (<1-2% of ctHb), due to catabolism of heme. While in regular smokers COHb is found to be higher (5-13%) when compared to non-smokers.[7,8] In the present case series the values of COHb are much higher and above 25% i.e. the toxic levels mentioned in literature.[3]

If ctHb value is <3-4 g/dL, precision in measurement of hemoglobin derivatives is said to be unacceptable.[9,10] Similarly results from the study comparing CO-oximetry and gas chromatography have shown that CO-oximetry is reliable method of measuring postmortem COHb, as long as ctHb of sample is >1g/dL, even if the sample is putrefied.[10] In all five cases in the current case series the values of ctHb were more than 4 g/dl. (Table 1).

Now the question remains about the acceptability of such results obtained from hospital based laboratories in the court of law.Here, we feel that, when the results obtained from similar set up are acceptable and guiding clinicians for treatment, then as long as the chain of custody of sample to be tested is maintained, the results from accrediated hospital based laboratories should be considered valid in the court of law even in medicolegal autopsy cases.

Conclusion

Hospital based blood gas analysers employing CO-oximetry offer a rapid and reliable method for confirming CO poisoning. The use of analyzers for COHb percentage determination can help investigation agencies, aiding in the timely resolution of cases.

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