

**Impact on Cost and Laboratory Service for ABG Analysis with Training Related to ABG Collection and Transport****KR Gopala Krishnan<sup>1</sup>, Hina Baraiya<sup>2</sup>, Piyush Tailor<sup>3</sup>, Sapna Patel<sup>4</sup>, Subhankar Jha<sup>5</sup>, Sanjay Parmar<sup>6</sup>**<sup>1,5,6</sup>PG Resident, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India<sup>2</sup>Tutor, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India<sup>3</sup>Professor & HOD, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India<sup>4</sup>Senior Resident, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India

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**Abstract****Introduction:** Arterial blood gas (ABG) analysis is an essential part for diagnosing and management of critical to monitor a patient's oxygenation status and metabolic disorder. The usefulness of this diagnostic tool is dependent on accuracy of analysis for interpret the results as well as unbroken testing service for continue monitoring of patient.**Objective:** To evaluate improvisation on the cost of ABG analysis with sample flow.**Methods:** This study is done retrospectively from data of number of arterial blood gas analysis performed, ABG cartridge utilized and amount of rupees utilized for purchase of ABP cartridge, in period of December 2022 to July 2023. After continued use of these instrument for 3 months, training to reduce pre-analytic error was conducted on 24th February 2023 for resident doctor of medicine department and respiratory medicine department. Data of cartridge utilized were collected from instrument database and verified with laboratory purchase order.**Results:** It is found that in Pre-training each cartridge life was 12.2 days and Af-ter-training, each cartridge lives was increased to 19.83 day. Average ABG sample run in a day was 17 and average ABG Sam-ple run in day is increased to 30. In Post-training aver-age ABG Sample Estimation in Per-centage is increased approximately twice (17 to 30 sample per day, 72% ) in compare to pre-training period.**Conclusion:** Root cause analysis in laboratories is vital for implementing effective corrective actions and preventing recurring issues. Pre-analytical training reduces problems like ABG instrument breakdown and lowers the overall cost per analysis. This approach boosts laboratory efficiency, extends instrument life, and instills clinician confidence in the reliability of testing services.**Keywords:** Arterial blood gas analysis, Cost optimization, Pre-analytic error, Metabolic disorder.

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**Introduction**

Arterial blood gas (ABG) analysis is an essential part for diagnosing and management of critical to monitor a patient's oxygenation status and metabolic disorder. [1] The usefulness of this diagnostic tool is dependent on accuracy of analysis for interpret the results as well as unbroken testing service for continue monitoring of patient. Pre-analytical error does impact on output of the analysis , which include time of collection, site of collection, use of right vacuette with preservatives , method of transportation as well as labeling of collected sample. [2] Arterial blood collection is most often collected with well-trained doctor or

nursing staff only as it needs skill to approach artery and collect the sample from right site, with that appropriate amount of arterial blood in syringe, having appropriate unit/ml of heparin. Due mistake in any of these component of pre-analytical area, it does major change in output of the ABG analysis as well as it can decrease compliance of the clinician towards laboratory service. Most of the clinical biochemistry laboratory does arterial blood gas analysis on ISE based instrument. In case of pre-analytical error like clotted sample , these instrument may get breakdown either due to blockage of the capillary or cartridge failure.[3]

**Aim:**

After training to resident doctor about ABG sample collection and transportation,

- To evaluate improvisation of pre-analytical error in sample collection.
- To evaluate improvisation on average cartridge life.
- To evaluate improvisation on the cost of arterial blood gas analysis
- To evaluate improvisation on laboratory service with sample flow.

**Material and Method:**

These study is done retrospectively from data of number of arterial blood gas analysis performed , number of ABG cartridge utilized and amount of rupees utilized for purchase of ABG cartridge, in period of December 2022 to July 2023. Arterial blood gas analysis was done on ISE based automated instrument Siemens Rapid Point 500, located in Clinical Biochemistry Laboratory, Laboratory Services SIR T Hospital (LSSTH) Bhavnagar, Gujarat. Laboratory started using Siemens Rapid Point 500 for ABG analysis on 2<sup>nd</sup> December 2022. After continues use of these instrument for 3 months, training to reduce pre-analytic error was conducted on 24<sup>th</sup> February 2023 for resident doctor of medicine department and respiratory medicine department. As these department were sending maximum sample for ABG analysis out of total sample received in our laboratory and ABG sample are most of time collected by post-graduate students only.

Component of The Training are

- Proportion of whole blood and heparin in container
- 40 IU heparin per ml of whole blood.
- 1 ml of Heparin in vial is 1000 unit
- So Sample should be in following proportion
  - 0.05 ml Heparin plus 1.0 ml blood (approx conc. 50 IU/ml)
  - 0.1 ml Heparin plus 2.0 ml blood (approx conc. 50 IU/ml)

**Table 1: Impact of Training on Life of ABG Cartridge and Cost per ABG Test**

	Average ABG Cartridge Life in Days	Average ABG Sample Run in Day	Average Total ABG Sample Estimated From Cartridge	Price of Single Cartridge	Cost per ABG Sample	Impact on Cost of ABG Sample Estimation in Percentage
Pre - Training	12.2	17.5	212.33	41437	195.2	-64.4
Post - Training	19.8	30.1	596.17	41437	69.5	

From data of total cartridge utilized, in particular period for sample analysis, it show that laboratory has provided analysis of ABG sample analysis service to approximately 3 times more number of

- Requirement of cold chain
- Appropriate labeling with visibility of the sample to identify the clot before running in instrument.
- Tight shield cap of syringe.

After 4 month of the training, data related to number of arterial blood gas analysis performed , number of ABG cartridge utilized and amount of rupees utilized for purchase of ABG cartridge was collected for a time period of December 2022 to July 2023. Data of cartridge utilized were collected from instrument database and verified with laboratory purchase order. Number of ABG analysis performed is collected from laboratory information system - infodiagnostica. From office purchased order, we got information about cost of ABG cartridge.

**Result**

In this retrospective study, as training was done on 24<sup>th</sup> February 2023, the data of period between December 2022 to February 2023 is consider under “Pre - Training” heading and the data of period between March 2023 to July 2023 is considered under “Post -Training Heading”.

Total number of sample for ABG analysis is received during “pre- training” period is 1274 and during “Post-training period 3577 sample in the LSSTH (Laboratory Services Sir. T. Hospital), Bhavnagar (table-2). It was found that in Pre-training each cartridge life was 12.2 days and After-training, each cartridge life was increased to 19.83 day (Table-1).Pre-training, Average ABG sample run in a day was 17 and Post-training average ABG sample run in a day is increased to 30. (Table 3). It indicates, there increased in ABG cartridge life span for 63.01% and increased average sample run in day for 72.2%.

Price of single cartridge from company is 41,437/-. From the above analysis, It is concluded that, the Cost of single ABG sample is 195.2 Rs before the training and decreased to 69.5 Rs after the training. (Table 1)

samples in post-training period with same number of cartridge utilization (6 ABG cartridge were utilized in both the period ). Even with this increase sample load, it is decrease cost per ABG sample

analysis and effectively decrease total cost of cartridge utilization effectively. (Table-2)

**Table 2: Pre vs Post Training Cost on ABG samples**

Training	Month	Total Days	ABG Sample Estimated Per month	Cost per ABG Sample in Rupees	Average Cost of ABG Estimation in the month in Rupees	Impact of Training on Cost of ABG per Month in Rupees	Impact of Training on Cost of ABG per Month in %
Pre - Training	2nd Dec'22 to 22nd Feb'23	73	1274	195.2	102173	-39496	-39
Post - training	3rd Mar'23 to 9th Jul'23	119	3577	69.5	62678		

In post-training period, due to minimum number of breakdown of ABG analyzer and continuity of laboratory service for arterial blood gas analysis, table-3 data shows that there is significant increase in average sample per day for ABG analysis, which increase approximately twice (17 to 30 sample per day, 72%) in compare to pre-training period.

**Table 3: Impact of Training on ABG Sample Flow (Quality Indicator of Laboratory Work)**

	Period	Total Days of the Periods	Cartridge	No. of sample	Average Sample in a day	Impact of Training on ABG Sample Flow in Percentage
Pre - training	2nd Dec'22 to 22nd Feb'23	73	6	1274	17	72.2
Post - training	3rd Mar'23 to 9th Jul'23	119	6	3577	30	

Table-3 also shows that 6 cartridge were utilized in both the period, but in post- training period, 6 cartridge can run the sample for total 119 days, where it was there for 73 days on in pre-training period)

#### Discussion:

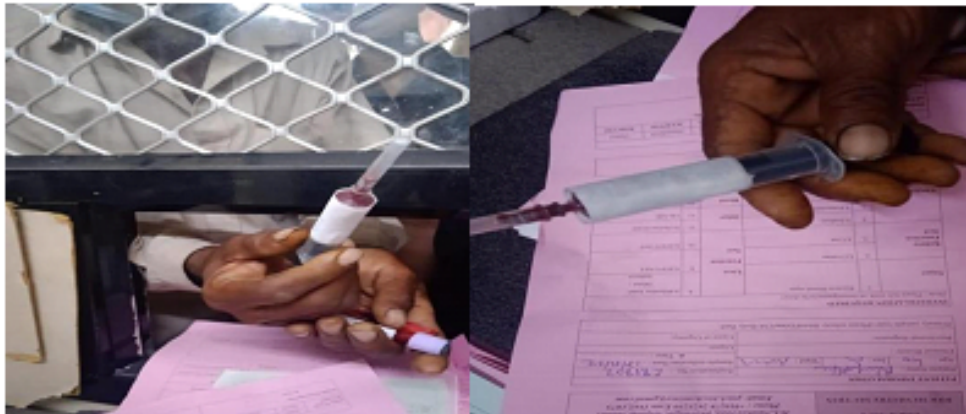
As stated in methodology, clinical biochemistry laboratory, LSSTH, bhavnagar has started ABG analysis in December 2022. Since very early in starting of analysis, we have noticed some problem frequently.

- Frequent breakdown of ABG instrument - Siemens Rapid Point 500

- Frequent failure of ABG cartridge after with in very short time of installation.

- Frequent blockage of ABG analyzer capillary.

Due to all these issue, we were getting very poor compliance from our hospital clinician. In most of scenario, we found that there were either clotted sample due to improper proportion of anti-coagulant and problem with labelling of sample, which unable laboratory technical person to identify clot in received sample. And that clot does either failure of instrument or cartridge. [4-7]



**Figure 1: ABG sample sent without ice-pack, placing label above the syringe which make clots invisible for technicians**

We did root cause analysis of these issue and kept “Training of Post-Graduate Students of Clinical Departments” to minimized pre-analytical error. Major aim is to focus on post graduate students of Medicine and Respiratory medicine departments because majority of the sample received from these department as well as majority of clotted sample also received from them. Reason for same was delay in transporting, inappropriate cold chain maintenance and inadequate heparin proportion.

As enumerated in methodology, training was done to emphasized to implement all important component, which can prevent Pre-Analytical Error of ABG analysis.

Post-training , we noticed with in short time, there were improvisation in sample receive for ABG analysis and drastic reduction in analyzer breakdown.



**Figure 2: Images of sample received Post-training, with appropriate labeling & visibility of sample.**

We can see Improvisation in the result table, which is due to perfect root cause analysis and rightly execution of corrective action.

Due to correction of pre-analytical error,

- ✓ There were significant decrease in clotted sample, received at laboratory
- ✓ Technical person able to identify clotted sample immediately , due to proper labeling
- ✓ Both of these two reason decrease chance of blockage in ABG instrument capillary. Hence, there is reduction in ABG instrument breakdown and ABG cartridge failure.

- ✓ Due to these, Turnaround time for ABG analysis got reduce and clinician compliance got increase to laboratory service for treating critical patients.
- ✓ And Most importantly, Increased sample flow per day improved clinical compliance for Clinical Biochemistry Laboratory, LSSTH, Bhavnagar, Gujarat.

#### **Conclusion:**

- ✓ In laboratory practice, role of root cause analysis is very significant for perfect implantation of corrective action and to prevent recurrence of the problem.

- ✓ Pre-analytical training of appropriate proportion of heparin and whole blood as well as for labeling of sample can reduce significantly
- Breakdown of ABG instrument
- Turnaround time of ABG analysis
- Total cost per analysis of ABG
- ✓ And Can significantly increases
- Sample flow in laboratory
- Profitability of the laboratory
- Instrument and Cartridge life span
- Most importantly. Clinician faith towards continues service of testing.

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