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The comparison of blood gas analysis (BGA) parameters in samples transported by the pneumatic tube system and manual transport at Dr. Soetomo Hospital, Surabaya, Indonesia



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ABSTRACT

Background: Pneumatic Tube System (PTS) can reduce the time needed to transport laboratory samples, thus resulting in faster turn-around time. Blood gas analysis (BGA) is a critical laboratory examination, and it would benefit from sending the sample using PTS. Some studies showed the effect of PTS on BGA's parameters, so the laboratory should validate the usage of PTS before delivering the samples. This study aims to determine the comparison of BGA parameters in Sample Transported by Pneumatic Tube System and Manual Transport at Dr. Soetomo Hospital, Surabaya, Indonesia.

Method: A cross sectional analytic study was conducted among 31 blood patients and divided into two syringes. One syringe was delivered by PTS as well as the other was transported by courier.

The delivery distance was 250 meters for both transportations. Both samples then were examined by qualified laboratory analyst. The pH, pCO₂, and pO₂ were compared. Data were analyzed using SPSS version 17 for windows.

Result: The result of pH, pO₂ and pCO₂ in PTS samples was not significantly different compared to manual transportation (p=0,799; p=0,955 and p=0,856 respectively). Bland-Altman plot was found a good agreement between both types of transportation method.

Conclusion: The result of this study showed no significant difference in BGA's parameters sent by PTS or manual transportation. PTS can be used to replace manual transportation in delivering blood gas samples to the central laboratory.

Keywords: Blood Gas Analysis, Pneumatic Tube System, Sample Transportation, Turn-Around Time

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INTRODUCTION

Pneumatic tube system (PTS) has been broadly used in hospitals as rapid sample transportation to the central laboratory. This system can reduce delay in laboratory examination and Turn-Around Time (TAT).¹ One of laboratory assessment which needs a critical result is Blood gas analysis (BGA). BGA is one of the laboratory examinations which needs a quick result. The result is urgently required by the clinician for therapy decision. The examination often checked in the critical patient condition which needed urgent treatment. Before PTS was developed, blood gas samples were sent by courier. The utilization of PTS can reduce transportation time for laboratory evaluation. In order to make blood samples in a stable situation, BGA needs an anaerobic condition to avoid parameter changes. This anaerobic condition can be affected by the sample's transportation process or any other external factors.² Pressure change during the sample's transportation process using PTS need to be considered in blood gas analysis' (BGA) pre-analytical stage.

A study conducted by Collinson et al. showed that PTS usage for delivering blood gas samples

could affect oxygen's partial pressure (pO₂) significantly.³ He stated this effect could be eliminated by using a pressure-tight container for delivering blood gas samples.³ In addition, a study conducted by Peter et al. also founded an increment of pO₂ in samples transported using PTS.¹ Several factors which significantly alter this pO₂ parameter in PTS transportation are air bubbles and velocity changes.^{1,2}

Based on the explanation above, there is still a lack of studies to determine the difference between PTS and manual method transportation towards BGA parameter. So, this study aims to figure out the comparison of BGA parameters in samples transported using PTS and manual transportation at Dr. Soetomo Hospital, Surabaya, Indonesia.

METHOD

Characteristic of Samples

An analytical observational study using cross-sectional design was carried out in Dr. Soetomo hospital from May-August 2018 among 31 respondents in the different clinical parameter. Arterial blood gas samples were taken from inpatient and examined

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using GEM Premier 3500 Blood gas analyzer (Instrumentation Laboratory, Bedford, US). The inclusion and exclusion criteria was used prior to analyzed samples. The inclusion criteria were blood volume of more than 2 cc and sampling-to-examination time was less than one hour. And the exclusion criteria were blood clotted on samples.

Blood Gas Analysis

The samples for blood gas analysis (BGA) was divided into two prefilled heparin syringes (BD, Franklin Lakes, US). One of the syringes was put in the container and sent to the satellite laboratory using PTS (Aerocom, GmbH, Germany). The diameter of PTS' pipe was 200 mm and the velocity between 4 to 6 meter/seconds.³ The other syringe was put in the same container and delivered by courier. The distance from the central laboratory to satellite laboratory was 250 meters. Both syringes then were examined by qualified laboratory analyst using the same blood gas analyzer. The result of pH, pCO₂ dan pO₂ between both types of transportations was compared and analyzed in numerical data.

Statistical Analysis

Before the study, the ethical committee of Dr. Soetomo Hospital has approved the protocol of the study. Statistical analysis was performed using SPSS version 17.0 and the agreement between both types of transportations was analyzed using Limit of Agreement (LOA) of Bland Altman Plot. Normality test was conducted using the Kolmogorov – Smirnov test. Data were presented in mean and standard deviation for normally distributed variables. A P-value of less than 0.05 was considered statistically significant

RESULT

Thirty-one arterial blood gas samples were included in this research. Patient's age ranged from

18 to 35 years (mean 54 years). Mean pH from PTS and manual were 7,37 and 7,38 respectively. Mean pO₂ from PTS and manual were 128,77 and 128,58 mmHg. Mean pCO₂ PTS and manual were 33,68 and 33,55 mmHg (Table 1 and 2).

Difference of pH was not in normal distribution ($p < 0,05$), while PO₂ and PCO₂ were in normal distribution ($p > 0,05$). Therefore, a difference of pH in PTS and manual was tested using Wilcoxon Sign Rank while a difference of PO₂ and PCO₂ were tested by paired t-test. The result of Wilcoxon Sign Rank test showed no significant difference between PTS' pH and manual's pH. ($p > 0,05$) (Table 1). Paired t-test's result showed no significant difference between pO₂ and pCO₂ parameters in both types of transportations ($p > 0,05$) (Table 1 and 2). Agreement between both types of transportations was seen in the Bland Altman Plot (Figure 1 and 2) Mean difference of pH (PTS and manual bias) was -0.0032 (dashed line). Limit of Agreement (LOA) 1.96 SD was -0.072 to 0.065 which is marked by red lines (Figure 1). Mean difference in pO₂ was 0.19 mmHg. LOA 1.96 SD was -36.57 mmHg to 36.95 mmHg (Figure 2). Mean difference in pCO₂ was 0.129 mmHg. LOA 1.96 SD was -7.542 to 7.799 mmHg (Figure 2).

DISCUSSION

Many factors can influence blood gas analysis' turnaround time (TAT) from pre-analytical, analytical, and post-analytical.⁴ One of the pre-analytical factors is sample transportation to laboratory.⁴ Clinical & Laboratory Standards Institute (CLSI) stated that blood gas sample transportation by courier is generally acceptable.⁵ PTS can reduce sample transportation time, but some studies founded an increment of pO₂ in samples transported by PTS.^{1,2} Other study showed PTS did not influence blood gas parameters.⁴

Table 1 The difference in pH and pO₂ between PTS and Manual

Variable	n	Median (Min-Max)	Median Difference (IQR)	P	Mean±SD	Mean Difference	P
PTS	31	7.37 (7.16-7.51)	0.00 (0.05)	0.799	128.77 ± 38.436		
Manual	31	7.38 (7.14-7.52)			128.58 ± 43.260	0.194 ± 18.755	0.955

Table 2 The difference in pCO₂ between PTS and Manual

Transportation	n	Mean	Mean Difference	p value
PTS	31	33.68 ± 11.113	0.129 ± 3.914	0.856
Manual	31	33.55 ± 10.302		

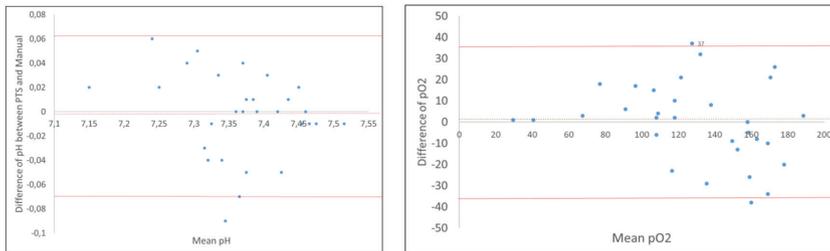


Figure 1 Bland Altman plot for pH and pO₂ between samples transported by PTS and Manual

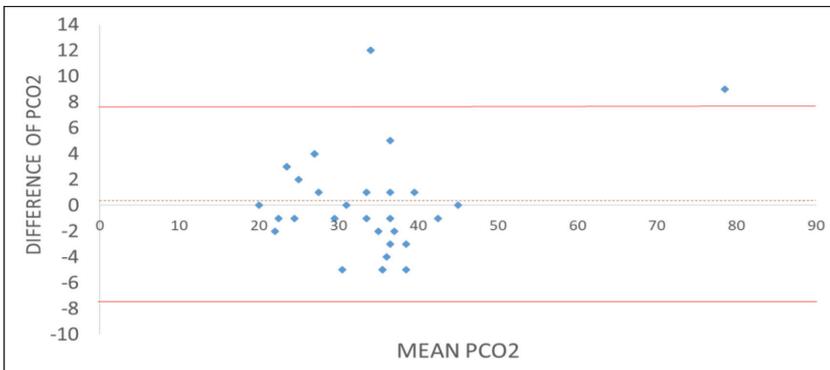


Figure 2 Bland Altman plot for pCO₂ between samples transported by PTS and Manual

Collinson⁶ found that samples sent by PTS can be vigorously shaken and exposed to pressure changes.⁶ The pressure change could alter oxyhemoglobin dissociation in blood, especially when there were air bubbles in the sample. Air bubble should be expelled before sample sent by PTS to avoid pO₂ alteration.⁷ Streichert² didn't find a significant change in pressure, temperature and humidity in samples transported by PTS and courier.² Difference between both transportations was acceleration, which can lead to sample hemolysis.³ Our result showed that PTS did not alter blood gas sample quality (no clotted or lysed sample after delivered by PTS).

We found an increment of pO₂ in samples sent by PTS (PTS' was 128.77 compared to manual 128.58) but it was not statistically significant. The result of pH and pCO₂ also did not show a significant difference between both types of transportation (p>0.05). Bland-Altman plot of pH, pO₂ and pCO₂ also showed agreement between both types of sample transportation. This result can validate the usage of PTS for delivering blood gas samples. We did not study the PTS' effect on TAT, but research about PTS in reducing TAT has been documented in various research.^{1,4,7,8}

Further research with more samples and additional PTS' actual data about pressure, acceleration, temperature, and humidity is needed to evaluate factors influencing sample transportation. Each PTS' installation is unique, where distance,

acceleration, and pressure can give a different result on a sample.^{9,10} This research was limited to specific PTS' installation in Dr. Soetomo General Hospital, so the result of this research might be limited and could not be generalized to other hospitals.

CONCLUSION

PTS can replace manual transportation in delivering blood gas samples. Every PTS installation needs to be validated and periodically evaluated to maintain blood gas sample's quality during the transportation process.

CONFLICT OF INTEREST

The authors have no conflict of interest in this study.

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AUTHOR'S CONTRIBUTION STATEMENTS

Hantoro Gunawan, Ferdy Royland Marpaung conceived and designed the study's method. Hantoro Gunawan performed the study. Hantoro Gunawan and Ferdy Royland Marpaung analyzed the data. Hantoro Gunawan wrote the paper.

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