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Comparison of Glucose, AST, and Cholesterol Test Results Using Plain Vacutainer Tubes and Clot Activator Vacutainer Tubes

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ABSTRACT

Laboratory examinations play a crucial role in supporting disease diagnosis; therefore, laboratory test results must be accurate, valid, and reliable. However, errors may occur during various stages of the examination process, including the selection of blood collection tubes, which can influence test outcomes. In clinical chemistry testing, red-capped vacutainer tubes are commonly used, either plain tubes or tubes containing clot activators. The addition of clot activators should not affect the quality of analyte measurements. This study aimed to compare glucose, AST, and cholesterol levels in serum samples collected using plain vacutainer tubes and vacutainer tubes with clot activators. Serum samples were obtained from 16 respondents and analyzed at a primary healthcare laboratory in Surabaya. This study employed an analytic observational method with a cross-sectional and comparative study design. Data normality was assessed using the Shapiro–Wilk test, followed by the Independent t-test for normally distributed data and the Mann–Whitney test for non-normally distributed data. The results showed no significant differences ($p > 0.05$) in glucose, AST, and cholesterol levels between serum collected in plain vacutainer tubes and serum collected in vacutainer tubes with clot activators. Therefore, both types of vacutainer tubes can be used interchangeably for these clinical chemistry examinations.

Keywords: *Vacutainer Tubes, Clot Activator, Glucose, AST, Cholesterol*

ABSTRAK

Pemeriksaan laboratorium berperan penting dalam membantu penegakan diagnosis sehingga hasil pemeriksaan harus akurat, valid, dan dapat diandalkan. Namun, berbagai tahapan dalam proses pemeriksaan laboratorium dapat menyebabkan kesalahan, termasuk pemilihan tabung

pengambilan darah yang dapat memengaruhi hasil pemeriksaan. Pada pemeriksaan kimia klinik, tabung vakutainer tutup merah yang digunakan dapat berupa tabung plain maupun tabung dengan clot activator. Penambahan zat berupa clot activator tidak seharusnya memengaruhi kualitas hasil pemeriksaan kadar analit. Penelitian ini bertujuan untuk membandingkan kadar glukosa, AST, dan kolesterol pada serum yang ditampung menggunakan tabung vakutainer plain dan tabung vakutainer dengan clot activator. Sampel penelitian diperoleh dari 16 responden dan pemeriksaan dilakukan di salah satu laboratorium tingkat pratama di wilayah Surabaya. Penelitian ini menggunakan metode observasional analitik dengan rancangan cross-sectional dan comparative study design. Analisis data diawali dengan uji normalitas Shapiro–Wilk, kemudian dilanjutkan dengan uji Independent t-Test untuk data berdistribusi normal atau uji Mann–Whitney untuk data yang tidak berdistribusi normal. Hasil penelitian menunjukkan tidak terdapat perbedaan yang signifikan ($p\text{-value} > 0,05$) pada kadar glukosa, AST, dan kolesterol antara serum yang ditampung menggunakan tabung vakutainer plain dan tabung vakutainer dengan clot activator. Dengan demikian, kedua jenis tabung vakutainer tersebut dapat digunakan secara bergantian pada pemeriksaan kimia klinik tersebut.

Kata kunci: Tabung Vakutainer, Clot Activator, Glukosa, AST, Kolesterol

INTRODUCTION

Laboratory examinations play a crucial role in medical practice by providing essential information that assists healthcare professionals in establishing accurate and timely diagnoses(1). Therefore, laboratory test results must be accurate, valid, and reliable. Considering the numerous procedures involved throughout the laboratory testing process, errors frequently occur during laboratory examinations. These errors are often difficult to detect and tend to be uncertain because they are more challenging to understand compared to other types of medical errors(2). The highest percentage of laboratory errors occurs during the pre-analytical phase, accounting for approximately 60%–70% of total laboratory errors. Several errors that may occur during the pre-analytical stage include inappropriate test requests, incorrect patient identification, non-specific examination requests, improper selection of sample collection tubes, unsuitable sample volume, and hemolyzed specimens(3). Improper tube selection may significantly affect laboratory test results because the type of tube used during the pre-analytical phase influences subsequent examination procedures.

There are two types of red-capped vacutainer tubes commonly used in clinical chemistry examinations, namely plain vacutainer tubes and vacutainer tubes containing clot activators. Plain vacutainer tubes are vacuum tubes that do not contain any additives. In contrast, vacutainer tubes with clot activators contain additional substances that accelerate the blood clotting process(4). A previous study reported that plain vacutainer tubes require a longer blood clotting time compared to vacutainer tubes containing clot activators(5). Many hospitals in developing countries still prefer using plain vacutainer tubes without clot activators because they are more affordable than tubes containing clot activators. Meanwhile, the use of clot activators may accelerate laboratory turnaround time (TAT), allowing laboratory results to be released more rapidly. Research conducted by Wai-Yoong Ng (2013) demonstrated that plain vacutainer tubes required an average TAT of 69 minutes, whereas vacutainer tubes with clot activators required an average TAT of 47 minutes(6).

One of the substances commonly used as a clot activator in vacutainer tubes is silica. Silica is a non-toxic and biocompatible material generally used in the form of micronized particles. The negatively charged surface of silica may activate the coagulation cascade, thereby accelerating the clotting process. However, the very small clot activator particles may not completely integrate into the blood clot. Residual particles remaining in the serum may interfere with certain laboratory tests or instrument functions(7). On the other hand, the use of clot activator tubes has been shown to shorten turnaround time, thereby maintaining analyte stability and enabling laboratory results to be reported more quickly(6). Nevertheless, the addition of clot

activators should not interfere with the coagulation process or leave residues such as fibrinogen or fibrin monomers that may affect blood specimen quality and laboratory test results(8).

Previous studies have primarily focused on clotting time and turnaround time differences between plain vacutainer tubes and clot activator tubes. However, limited studies have specifically evaluated the effect of clot activator tubes on clinical chemistry analytes such as glucose, AST, and cholesterol. Therefore, this study was conducted to determine the differences in glucose, AST, and cholesterol levels in serum samples collected using plain vacutainer tubes and vacutainer tubes containing clot activators.

METHODS

This study was an analytic observational study conducted to compare differences in laboratory examination results through observation without any direct intervention or treatment. A cross-sectional research design was applied, in which data collection was performed at a single point in time, combined with a comparative study design to compare measurement results between two groups. The study was conducted at a primary clinical laboratory in the Surabaya region in April 2025. Serum samples were used as the test material in this study. The serum was obtained from venous blood collected from 16 respondents. The collected venous blood was divided into two different types of vacutainer tubes, namely plain vacutainer tubes and vacutainer tubes containing clot activators. The blood samples were subsequently centrifuged at 3000 rpm for 5–15 minutes to separate the serum from blood cells(9). The obtained serum samples were then analyzed for random blood glucose, AST, and cholesterol levels using a chemistry autoanalyzer. The examination results were statistically analyzed using the Independent t-test for normally distributed data or the Mann–Whitney test for non-normally distributed data. Prior to hypothesis testing, data normality was assessed using the Shapiro–Wilk test. Statistical analysis was performed to compare glucose, AST, and cholesterol levels between serum samples collected in plain vacutainer tubes and those collected in vacutainer tubes containing clot activators.

RESULTS

A total of 16 respondents participated in this study. Based on the examination results, all respondents had random blood glucose levels within the normal reference range (≤ 200 mg/dL) (10). In addition, AST levels in all respondents were within the normal range of 5–30 U/L (11). For total cholesterol levels, 9 respondents were categorized as normal, while 7 respondents showed elevated cholesterol levels, with the normal reference value being < 200 mg/dL(12).

Table 1. Descriptive Analysis of Glucose, AST, and Cholesterol Levels in Plain Vacutainer Tubes and Vacutainer Tubes with Clot Activator

	N	Plain Vacutainer Tube				Vacutainer Tube with Clot Activator			
		Min.	Max.	Mean	Std. Deviation	Min.	Max.	Mean	Std. Deviation
Glucose	16	71,0	121,0	80,938	12,6358	70,0	120,0	82,313	12,4296
AST	16	11,3	25,9	17,113	3,9072	10,9	26,6	17,256	4,1404
Cholesterol	16	134,0	287,0	202,625	35,1053	137,0	286,0	203,750	34,1340
Valid N	16								

Table 1 shows the descriptive analysis of glucose, AST, and cholesterol levels obtained from serum samples collected using plain vacutainer tubes and vacutainer tubes containing clot activators. The mean values of glucose, AST, and cholesterol levels in serum collected using vacutainer tubes with clot activators were slightly higher than those obtained from plain

vacutainer tubes. However, the observed differences between the two types of tubes were relatively small.

The standard deviation values for glucose levels indicated a relatively broad distribution of data, suggesting variability among respondents. In contrast, AST levels demonstrated a narrower distribution, indicating that the data were more closely clustered around the mean value. Cholesterol levels showed the highest standard deviation among the examined parameters, reflecting greater variability between respondents. This finding indicates that cholesterol levels varied considerably across the study population compared with glucose and AST levels.

Table 2. Statistical Analysis of Glucose, AST, and Cholesterol Levels

No.	Parameter	p-value
1	Glucose	0.650
2	AST	0.920
3	Cholesterol	0.927

The statistical analysis results are presented in Table 2. All examined parameters showed p-values greater than 0.05, indicating that there were no statistically significant differences in glucose, AST, and cholesterol levels between serum samples collected using plain vacutainer tubes and those collected using vacutainer tubes containing clot activators. These findings suggest that the use of clot activator tubes did not significantly influence the measurement results of glucose, AST, and cholesterol in this study.

DISCUSSION

The results of this study demonstrated that glucose, AST, and cholesterol levels in serum samples collected using plain vacutainer tubes and vacutainer tubes containing clot activators did not show statistically significant differences. The slight variations observed in glucose, AST, and cholesterol levels may have been influenced by several factors, including patient condition during sample collection, pre-analytical procedures, and analyte stability during sample handling. Clot activators function by enhancing platelet activation, thereby shortening the time required for blood clot formation(13). This process may reduce the risk of glycolysis, which can decrease blood glucose levels when blood samples are left at room temperature and centrifugation is delayed(14). Delayed serum separation has been reported to significantly affect glucose examination results(15).

In addition, AST enzyme activity is susceptible to decline when examination delays occur, resulting in suboptimal enzyme measurement (16). Immediate serum separation has been reported to result in higher AST levels compared with delayed serum separation(17). Differences in cholesterol examination results may also be associated with lipase enzyme activity in serum. Lipase enzymes hydrolyze ester bonds and fats formed between glycerol and long-chain fatty acids(18). Lipase enzymes function effectively only when fats interact with the water surface. Therefore, reduced water content in serum due to delayed separation may limit lipase activity in breaking down fats (19). Cholesterol levels were found to decrease as a result of delayed examination(20).

To maintain the accuracy of analyte examination results, optimal serum separation procedures are essential. Rapid blood clotting and proper serum separation may contribute to improved stability of laboratory examination results. The use of vacutainer tubes containing clot activators may be considered to accelerate the clotting process, thereby enabling faster serum separation through centrifugation. However, additives used in blood collection tubes should not interfere with analyte measurement results. Based on the findings of this study, clot activators did not produce significant changes in glucose, AST, and cholesterol levels. Therefore, the use of clot

activators may be considered safe without compromising the accuracy of laboratory examination results.

In contrast to the present study, previous research demonstrated statistically significant differences in analyte levels between additive-free glass tubes, gel tubes, and several types of clot activator tubes containing gel separators(21). These findings are consistent with previous reports showing no significant differences in clinical chemistry examination results among various brands of serum clot activator tubes and serum separator tubes(22). These similarities suggest that clot activator tubes generally provide reliable results for routine clinical chemistry examinations without causing clinically significant interference in analyte measurements.

CONCLUSION

Based on the results of this study comparing glucose, AST, and cholesterol examination results using plain vacutainer tubes and vacutainer tubes containing clot activators, it can be concluded that there were no significant differences in glucose, AST, and cholesterol levels between serum samples collected using the two types of vacutainer tubes. These findings indicate that both plain vacutainer tubes and vacutainer tubes with clot activators can be used interchangeably for routine clinical chemistry examinations without significantly affecting laboratory test results. Further studies are recommended using larger sample sizes and additional clinical chemistry parameters to provide broader evidence regarding the effects of clot activators on laboratory examination results. Future research may also evaluate the influence of different storage conditions and delayed examination times on analyte stability in various types of vacutainer tubes.

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