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## Original Research Article

## Increased preanalytical errors during Covid-19 Pandemic

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## ABSTRACT

**Background:** The clinical laboratories worldwide have faced numerous obstacles due to the COVID-19 pandemic. In the midst of this outbreak, mistakes that occur during the preanalytical phase of sample collection, transportation, and processing can result in unfavorable clinical outcomes. Therefore, the aim of this investigation was to ascertain and contrast the rate at which blood specimens are rejected by a clinical laboratory and to analyze and compare the types of preanalytical errors during the pre-pandemic and pandemic periods.

**Materials and Methods:** The present retrospective study was done in Chhatrapati Shivaji Subharti Hospital; India. Information was gathered from two distinct time periods - the pre-pandemic phase, which spanned from December 30th, 2019 to March 22<sup>nd</sup>, 2020, and the pandemic phase, which ran from March 23th to November 30<sup>th</sup>, 2020. The rate of rejection for blood samples was established by determining the percentage of blood collection tubes containing preanalytical mistakes out of the total number of tubes received.

**Results:** A total of 102,000 blood samples were examined, out of which 40,800 (40%) were collected during the pandemic. The pandemic phase witnessed a significantly higher rate of rejection of blood samples (4%) as compared to the pre-pandemic phase (1%) ( $P < 0.001$ ). In both phases, the most common preanalytical error was the clotting of samples. There was a significant increase in improperly labeled samples during the pandemic, while there was a notable decrease in hemolyzed samples.

**Conclusion:** Given the prevailing situation of the Corona pandemic, altered logistics have led to a significant surge in preanalytical errors and consequent rejection of blood specimens in clinical laboratories. Therefore, it is imperative to take corrective measures at different levels to minimize preanalytical errors, which would ultimately enhance patient care and optimize the utilization of resources.

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## 1. Introduction

Since the World Health Organisation announced the pandemic on March 11th, 2020, it has presented numerous difficulties in different areas. Despite the COVID-19 pandemic, clinical laboratories worldwide have adjusted to uphold the utmost quality of patient care. Diagnostic laboratories have always been worried about preanalytical errors, which cause imprecision and inaccuracies in

results.<sup>1–5</sup>

Amid the current pandemic, healthcare professionals must wear personal protective equipment (PPE) when caring for patients. Additionally, logistics for collecting and transporting specimens have changed from pre-pandemic times.<sup>6,7</sup> The effect of these altered collection, packaging, and transport protocols on the incidence of preanalytical errors is uncertain. We propose that during this ongoing pandemic, the frequency and nature of preanalytical errors may differ from those in the pre-pandemic era. Understanding these disparities can aid in developing

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strategies to prevent preanalytical errors during future pandemics and similar emergencies. Therefore, the aim of this investigation was to ascertain and contrast the rate at which blood specimens are rejected by a clinical laboratory and to analyze and compare the types of preanalytical errors during the pre-pandemic and pandemic periods.

## 2. Materials and Methods

The present retrospective study was done in Chhatrapati Shivaji Subharti Hospital; India. Information was gathered from two distinct time periods - the pre-pandemic phase, which spanned from December 31st, 2019 to March 22nd, 2020, and the pandemic phase, which ran from March 23rd to November 30th, 2020. The rate of rejection for blood samples was established by determining the percentage of blood collection tubes containing preanalytical mistakes out of the total number of tubes received.

### 2.1. Sample collection

The BCTs containing potassium EDTA and sodium citrate are utilized for complete blood count and coagulation profile, respectively. To conduct biochemical and immunological tests, the serum separator tube with silica clot activator, polymer gel, and silicone-coated interior (manufactured by Becton Dickinson, Franklin Lakes, USA) is employed. Due to the ongoing pandemic, the hospital delivers the bar-coded blood collection tubes to the laboratory manually, unlike the pre-pandemic era when pneumatic shoots were utilized.

### 2.2. Statistical analysis

The information and data so collected were subjected to statistical analysis. Mean, standard deviation, Students (t) test were applied. P value < 0.05 & < 0.01 was considered to be statistically significant.

## 3. Results

A total of 102,000 blood samples were examined, out of which 40,800 (40%) were collected during the pandemic. The pandemic phase witnessed a significantly higher rate of rejection of blood samples (4%) as compared to the pre-pandemic phase (1%) ( $P < 0.001$ ). In both phases, the most common preanalytical error was the clotting of samples. There was a significant increase in improperly labeled samples during the pandemic, while there was a notable decrease in hemolyzed samples.

## 4. Discussion

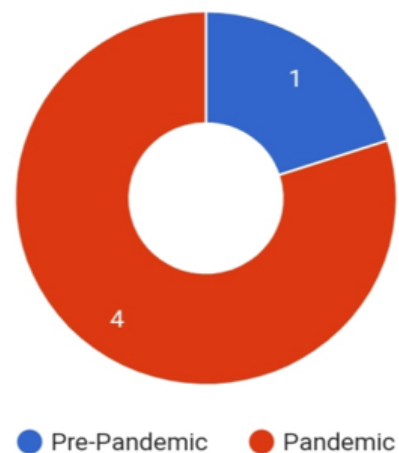
The primary discovery of our investigation revealed that the rate of specimen rejection increased significantly during the pandemic phase, compared to the pre-pandemic phase. Conversely, other studies that have compared preanalytical

**Table 1:** Total number of blood samples received in the pandemic phase

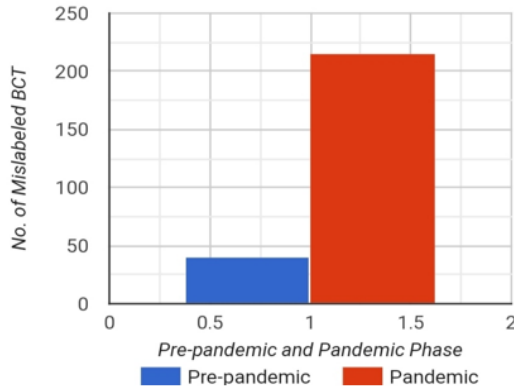
Pandemic Period	Total Blood Specimens Received
March 2020	710
April 2020	800
May 2020	1124
June 2020	2310
July 2020	4360
August 2020	5120
September 2020	7242
October 2020	8862
November 2020	10,272
Total	40,800

**Table 2:** Rejection rate of blood samples and depiction of preanalytical errors in pre-pandemic and pandemic phase

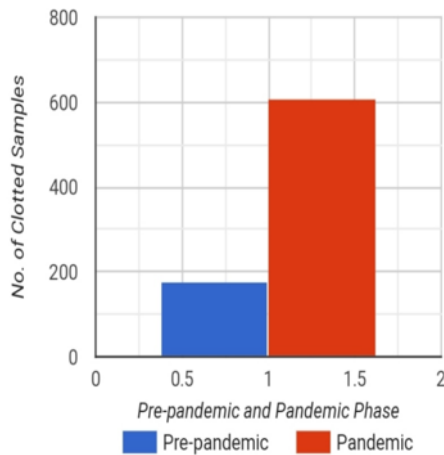
Parameters	Pre-Pandemic Phase (n= 61,200)	Pandemic Phase (n= 40,800)
Blood Specimen Rejection Rate	1%	4%
Total Blood Collection Tubes rejected	750	1330
Depiction of Preanalytical errors in the Pre-Pandemic and Pandemic Phases respectively:		
Mislabeled Blood Collection Tubes	40	215
Clotted Samples	175	610
Haemolysed Samples	250	90



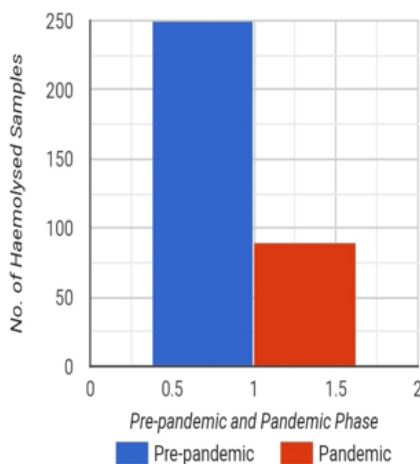
**Fig. 1:** Blood specimen rejection rate



**Fig. 2:** Frequency of mislabeled BCT during Pre-pandemic and pandemic phase



**Fig. 3:** Frequency of clotted samples during pre-pandemic and pandemic phase



**Fig. 4:** Frequency of Haemolysed samples during pre-pandemic and pandemic phase

errors occurring before and during the pandemic have not reported any changes in the frequency of such errors during the pandemic phase.<sup>8,9</sup> Nevertheless, the overall rate of rejection observed in our study was consistent with pre-pandemic studies.<sup>10–14</sup>

The rise in preanalytical errors can be attributed to three main factors. Firstly, there has been an increase in the number of healthcare workers handling patient specimens on a daily basis in both wards and intensive care units. This can be attributed to shorter duty shifts and the frequent rotation of healthcare workers on a biweekly/monthly basis due to mandatory quarantine periods. Additionally, healthcare professionals from both clinical and non-clinical backgrounds are involved in phlebotomy, leading to an increased number and diversity of healthcare workers working in a single day, which may have affected the quality of sampling. Secondly, the use of PPE by all healthcare personnel has made specimen collection more challenging. The reduced field of vision, decreased manual dexterity, and heightened mental stress while managing infectious patients are potential reasons for the increase in preanalytical errors.<sup>15–17</sup> Lastly, the high patient load and shortage of time for healthcare professionals may have also affected the specimen collection process. The appointment of a trained and dedicated team of phlebotomists may help to reduce preanalytical errors and ease the burden on healthcare professionals involved in the clinical care of patients.

Our research revealed that the largest share of preanalytical errors, both in pre-pandemic and pandemic phases, was constituted by samples that had clotted (QI-5). This issue persisted significantly throughout the pandemic period. Usually, blood clotting in anticoagulated BCT can occur due to improper mixing after blood collection or an incorrect ratio of blood-to-anticoagulant. Tubes filled with citrate that are either under-filled or over-filled, with an inappropriate sample-anticoagulant ratio (QI-4), even if they do not have visible clots, can adversely affect test results and, consequently, patient care.<sup>18</sup> This finding of our study may be attributed to varying levels of knowledge and awareness among healthcare professionals about proper phlebotomy practices, as well as the number of inversions recommended to ensure proper mixing of anticoagulant and blood. The added stress of maintaining stringent infection control measures could also have contributed to an increase in this error.

In laboratory medicine, the most frequently occurring preanalytical error is typically in-vitro haemolysis (QI-6). However, our research demonstrates that during the pre-pandemic phase, it was the second most common error, while during the pandemic period, it was the fourth most common. Haemolysis can occur when blood is collected and dispensed into tubes under high pressure or when exposed to extreme temperatures or vigorous shaking during

transport.<sup>19</sup> In the past, blood samples were primarily transported via a pneumatic shoot, with hospital attendants delivering them by hand only occasionally. Due to the urgency of receiving reports quickly, attendants may have deviated from proper specimen handling protocols during transport. However, with the implementation of additional measures and safety protocols for handling blood specimens from COVID-19 patients, specimens are now transported in bio-hazard ziplock bags inside a dedicated blood transport box. This change in practice may have contributed to a reduction in the frequency of haemolysed samples. Standardising the specimen transport protocol and strictly enforcing it could potentially reduce this error even outside of pandemic times in the future.<sup>20</sup>

Our research indicates that the COVID-19 pandemic has resulted in an escalation of preanalytical mistakes due to logistical alterations. As per Supplementary Table 2, this issue demands additional vigilance. The majority of these errors can be rectified by educating healthcare personnel and receiving regular reminders from specialists regarding the correct method of withdrawing samples, the sequence of drawing, the recommended number of inversions for appropriate mixing of anticoagulants and blood, and the standardized volume to be dispensed into each blood collection tube, based on established international protocols.<sup>21–23</sup>

## 5. Conclusion

Given the prevailing situation of the Corona pandemic, altered logistics have led to a significant surge in preanalytical errors and consequent rejection of blood specimens in clinical laboratories. Therefore, it is imperative to take corrective measures at different levels to minimize preanalytical errors, which would ultimately enhance patient care and optimize the utilization of resources.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.


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