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Original Article

Transfusion Medicine Section

Analyses of Key Performance Indicators of the Blood Centre at a Tertiary Care Referral Teaching Hospital in Southern India: A Cross-sectional Analytical Study

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ABSTRACT

Introduction: Blood transfusion services play a crucial role in patient healthcare management. The quality of blood and blood components, as well as their judicious use, directly impacts healthcare outcomes. Ensuring high-quality transfusion services can be achieved through the implementation of a Quality Management System (QMS). QMS performance can be monitored using performance measures known as Key Performance Indicators (KPI). This study was planned to assess the quality standards of our blood centre through evaluation of KPI.

Aim: To analyse the quality performance of the blood centre through evaluation of KPI.

Materials and Methods: This cross-sectional analytical study was conducted from November 2023 to May 2024 and from September 2024 to January 2025 in the Department of Immuno-Haematology and Blood Transfusion, Sri Venkateswara Institute of Medical Sciences Blood Centre, Tirupati, Andhra Pradesh India. Data were collected systematically, and root causes for any deviations were assessed. Corrective and preventive action measures were implemented accordingly. The key variables required for calculating KPI were extracted from various registers maintained at the blood centre. All KPI were calculated and analysed using the standard formulas prescribed by the National Accreditation Board for Hospitals and Healthcare Providers (NABH).

Results: The KPI observed during the study period were as follows: Donor deferral rate: 11.03%; Adverse donor reaction Rate: 0.128%; Percentage of components prepared: 98.25%; Seroreactivity of donors: 1.24%; Turnaround Time for elective cases: 40.73 minutes; Turnaround Time for emergency cases: 7.27 minutes; Quality control failure rates: 0.62%; Adverse Transfusion reaction rate: 0.024%; Wastage rate of components: 1.21%; Percentage of outdated units: 0.44%. All of these KPI were within NABH benchmarks. However, the seroreactivity for syphilis (0.33%), the percentage of component usage (99.3%), and the percentage of whole blood wastage (5.29%) did not meet NABH benchmarks.

Conclusion: All KPI were within NABH benchmarks except for the seroreactivity rate for syphilis, the percentage of blood component usage, and the percentage of whole blood wastage. These issues can be addressed through effective pre-donation screening procedures, particularly for syphilis. Uniform adoption of national policies across all states can help achieve 100% blood component usage. Additionally, involving adequately trained personnel can reduce instances of under-collection, which was identified as a major contributing factor to whole blood wastage in our study.

Keywords: Benchmark, Preventive measures, Quality indicators

INTRODUCTION

The essence of safe transfusion is administering the right blood to the right patient at the right time and in the right place. The right blood includes the appropriate blood component of the right quality. Transfusion services must ensure optimal usage of blood components and confirm that the components meet regulatory quality standards and carry minimal risk.

The goal of achieving zero-risk blood transfusion has led to the implementation of Quality Management Systems (QMS) [1]. Over the last decade, the pursuit of a safe blood supply has significantly advanced transfusion medicine practices [2]. Quality Indicators (QIs) or Key Performance Indicators (KPI) are essential tools of QMS [2]. KPI are performance measures designed to monitor and assess the quality of the transfusion process [3].

In India, KPI are regulated by agencies such as the National Blood Transfusion Council (NBTC) [4]. In addition, the accreditation agency in India, the National Accreditation Board for Hospitals and Healthcare Providers (NABH), under the Quality Council of India, has framed standards and KPI for monitoring blood centres [5]. By studying KPI, blood centres can improve essential operational measures and ensure compliance with NABH standards. Establishing and maintaining these KPI is now essential for ensuring blood safety from donor vein to patient vein [6].

This study was planned to assess the quality standards of our blood centre using Key Performance Indicators (KPI). The results are expected to serve as a roadmap for assessment, auditing, and implementation of Corrective Action and Preventive Action (CAPA) to meet various quality control parameters defined by NABH [5]. There are limited studies [7,8] assessing the role of KPI in improving the quality standards of blood transfusion services in South India. To the best of our knowledge, this is the first comprehensive study in the region to evaluate all KPI.

MATERIALS AND METHODS

This cross-sectional analytical study was carried out for a period of one year, from November 2023 to May 2024 and September 2024 to January 2025, in the Department of Immuno-Haematology and Blood Transfusion, Sri Venkateswara Institute of Medical Sciences Blood Centre, Tirupati, Andhra Pradesh India. after obtaining Institutional Ethical Committee approval (Roc.No.AS/11/IEC/SVIMS/2017, dated 02.11.2023).

Inclusion criteria: All blood donors who were eligible to donate according to the eligibility criteria laid down by the Drugs and Cosmetic Act, 1940, and rules 1945, 2022 (2nd amendment) [9]. All relevant blood centre records, including blood donor records, donor deferral register, master records for blood and components, Transfusion Transmissible Infections (TTI) register, issue register, component preparation register, cross-matching register, blood wastage register, transfusion adverse reaction records, and quality control records of blood and blood components, were included for the study period.

Exclusion criteria: Donors and patients who were not willing to participate in the study were excluded.

Study Procedure

Key variables required for calculating KPI were extracted from the various registers in the blood centre. The KPI were calculated using the following formulas [5]:

1. Donor Deferral Rate=(Total number of deferrals×100)÷Total number of volunteered donors
2. Adverse Donor Reaction Rate=(Total number of donor reactions×100)÷Total collections
3. Percentage of Components Prepared=(Units subjected for component preparation×100)÷Total collections
4. Seroreactivity of Donors=(Total number of seroreactive units×100)÷Total collections
5. Turnaround Time of Blood and Blood Components=(Sum of the time taken for all cross-matched units×100)÷Total number of blood and blood components cross-matched
6. Percentage of Blood Component Usage=(Number of components used×100)÷Number of blood and blood components available
7. Component QC Failures=(Number of particular component QC failures×100)÷Total units sent for QC
8. a) Percentage of Wastage of Blood and Blood Components from Wards=(Number of blood component units wasted among those issued×100)÷Number of blood and blood component units issued from the blood centre

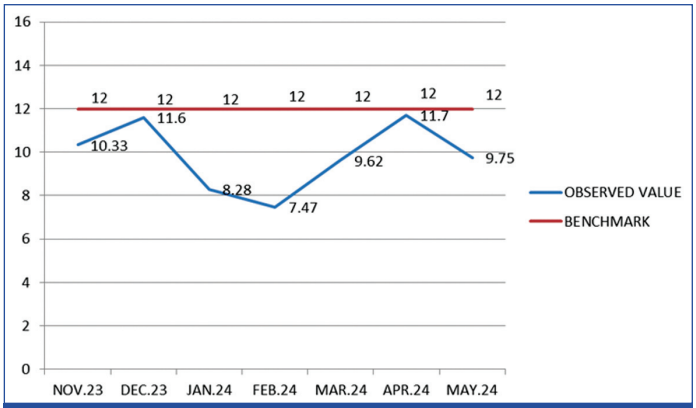
   b) Percentage of Wastage of Blood and Blood Components from Blood Centre=(Number of blood and blood component units wasted at blood centre×100)÷Number of blood and blood component units stored in blood centre
9. Percentage of Outdated Units=(Number of blood and blood component units outdated at blood centre×100)÷Number of blood and blood component units stored in blood centre
10. Percentage of Transfusion Reactions=(Number of transfusion reactions×100)÷Number of units transfused

STATISTICAL ANALYSIS

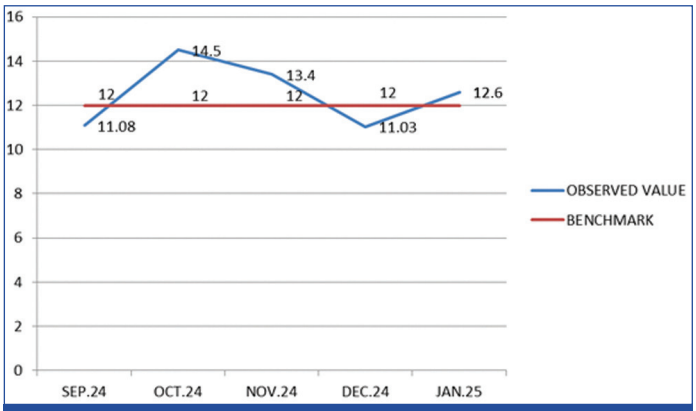
Data were entered in a predesigned proforma using Microsoft Excel. Observed KPI values were compared with standard benchmark values defined by NABH [5].

RESULTS

A total of 8,589 blood donor collections were recorded during the study period. Additionally, 21,173 blood components were prepared, and 21,068 blood component issues were included in the study. The Donor Deferral Rate (DDR) during the study period was 11.03%, which remained within the NABH benchmark of 10-12%, except during October 2024 (14.5%), November 2024 (13.4%), and January 2025 (12.6%), where it exceeded the benchmark [Table/Fig-1a,b]. Low haemoglobin, observed in 781 cases (73.33%), was the leading cause of donor deferral. Other causes included:



[Table/Fig-1a]: Trends of donor deferral rate.



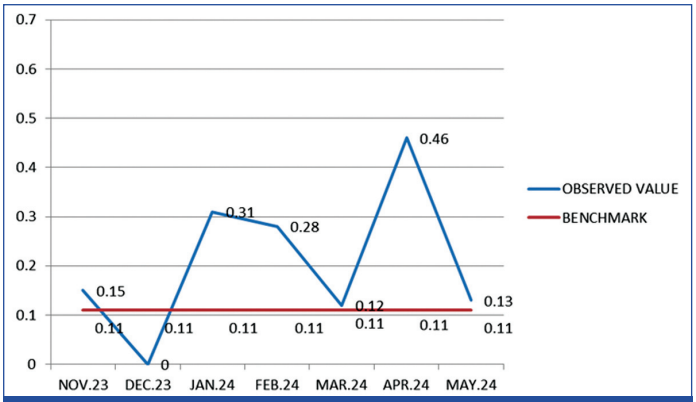
[Table/Fig-1b]: Trends of donor deferral rate.

- High haemoglobin: 132 cases (12.4%)
- Hypertension: 40 cases (3.75%)
- Poor venous access: 17 cases (1.6%)
- Unwillingness to donate: 14 cases (1.31%)
- Presence of tattoo marks: 13 cases (1.22%)
- Underweight donors: 11 cases (1.03%)
- Interval between donations less than three months: 10 cases (0.94%)
- Upper respiratory tract infections: 9 cases (0.85%)
- Open wounds: 9 cases (0.85%)
- Underage donors: 5 cases (0.47%)
- Other miscellaneous reasons: 24 cases (2.25%)

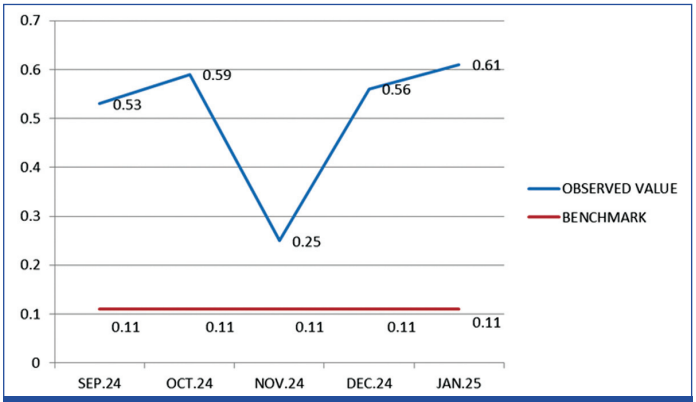
The Adverse Donor Reaction Rate (ADRR) observed during the study period was 0.128%, which was within the NABH benchmark of less than 2%. A total of 11 adverse donor reactions were reported, of which vasovagal reactions were the most common, accounting for 10 cases (90.9%), followed by one case of hematoma formation (9.1%) during phlebotomy.

The percentage of components prepared during the study period was 98.25%, well within the NABH benchmark of more than 85%. The overall seroreactivity of blood donors was 1.24%, within the benchmark of less than 4%. However, the seroreactivity for syphilis was 0.33%, exceeding the NABH benchmark of 0.11%, except in December 2023 when no cases of syphilis were reported [Table/Fig-2a,b].

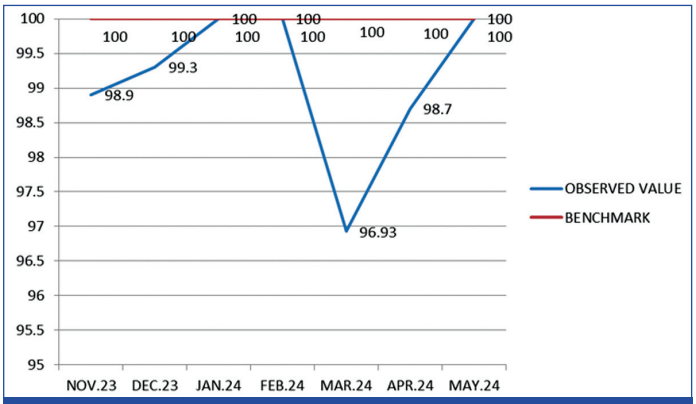
The turnaround time for elective cases was 40.73 minutes, within the benchmark of 120 minutes. For emergency cases, it was 7.27 minutes, which was within the benchmark of 15 minutes. The overall percentage of blood component usage during the study period was 99.3%. Component usage met the benchmark of 100% in most months, except in November 2023 (98.9%), December 2023 (99.3%), March 2024 (96.93%), April 2024 (98.7%), November 2024 (99.3%), and January 2025 (98.8%) [Table/Fig-3a,b].



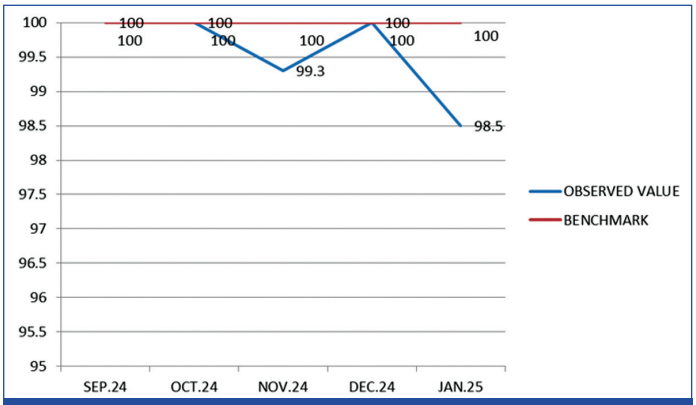
[Table/Fig-2a]: Trends of seroreactivity of syphilis.



[Table/Fig-2b]: Trends of seroreactivity of syphilis.



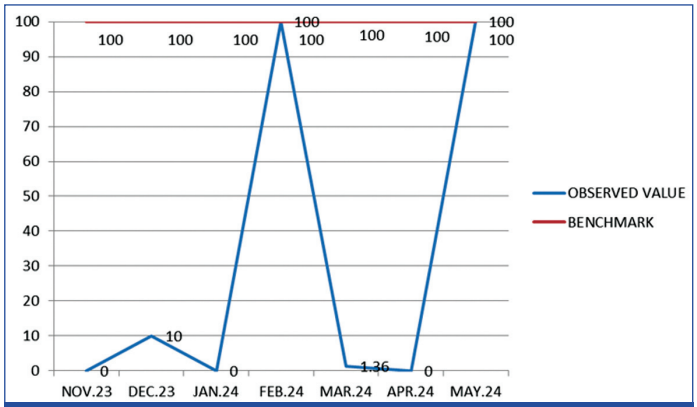
[Table/Fig-3a]: Trends of percentage of blood component usage.



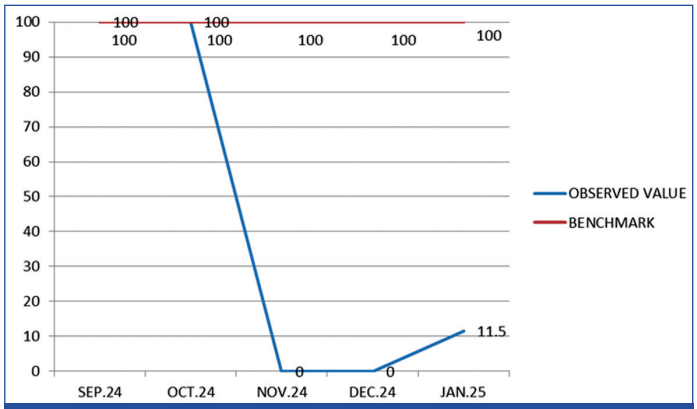
[Table/Fig-3b]: Trends of percentage of blood component usage.

The overall component Quality Control (QC) failure rate during the study period was 0.625%, within the benchmark (at least 75% of components should pass QC standards). Only one QC failure was observed, involving a Fresh Frozen Plasma (FFP) unit that showed culture positivity. The FFP demonstrated growth of Coagulase-negative Staphylococcus at both 22 °C and 37 °C.

The percentage of wastage of blood and blood components from wards was 0.3%, within the benchmark of less than 1%. Wastage from the blood centre was 1.21%, within the benchmark of less than 7%. The overall wastage of whole blood from the blood Centre was 5.29%, which exceeded the bench mark of less than 5%, particularly during December 2023 (10%), February 2024 (100%), May 2024 (100%), October 2024 (100%) and January 2025 (11.5%) [Table/Fig-4a,b].



[Table/Fig-4a]: Trends of percentage of wastage of whole blood from blood centre.



[Table/Fig-4b]: Trends of percentage of wastage of whole blood from blood centre.

There were no outdated units of whole blood, Packed red blood cells (PRBC), FFP, or cryoprecipitate during the study period, meeting the benchmark of less than 1%. For Random Donor Platelets (RDP) and Single Donor Platelets (SDP), the percentage of outdated units was 0.44%, within the benchmark of less than 22%. The overall percentage of transfusion reactions (non-hemolytic) was 0.024%, within the benchmark of less than 2%. No hemolytic transfusion reactions were reported during the study period. [Table/Fig-5] presents a summary of the KPI studied. [Table/Fig-6] presents a summary of KPI deviations, problems identified, and actions taken to achieve benchmark compliance.

DISCUSSION

The present study was conducted to assess the quality of transfusion services in our blood centre using different KPI. KPI data were collected, followed by root cause analysis and implementation of corrective and preventive actions. During the study period, among 9,654 blood donors counseled, 1,065 donors were deferred. The Donor Deferral Rate (DDR) was 11.03%, which was within the NABH benchmark [5] and comparable to the 11.6% reported by Agnihotri N [3]. A study by Malhotra S and Negi G [10] showed a higher deferral rate of 16%. In both studies, low Haemoglobin (Hb) was the leading cause of deferral, accounting for 82.83% and 73.33% in the present study.

The ADRR during the study period was 0.128%, aligning with the KPI standards recommended by NABH [5]. This rate was lower than that reported by Kumari S et al., (0.7%) [11] and Abhishekh B et al., (2.03%) [12]. Among the 11 adverse donor reactions observed, the majority were vasovagal reactions

S. No.	Key performance indicators	Observed value	Bench mark	Remarks
1	Donor Deferral Rate	11.03%	10-12%	Meets the benchmark
2	Adverse Donor Reaction Rate	0.128%	<2%	Meets the benchmark
3	Percentage of components prepared	98.25%	>85%	Meets the benchmark
4	Seroreactivity of donors	1.24%	<4%	Meets the benchmark
	HBsAg	0.73%	3%	Meets the benchmark
	HIV	0.06%	0.28%	Meets the benchmark
	HCV	0.06%	2%	Meets the benchmark
	Syphilis	0.33%	0.11%	Does not meet the benchmark
	Malaria	0%	0.03%	Meets the benchmark
	Sero positive combination	0.06%	No set benchmark	No set benchmark
5	Turnaround time	40.73 minutes	120 minutes	Meets the benchmark
6	Percentage of blood component usage	99.3%	100	Does not meet the benchmark
7	**Component QC failures**			
	PRBC	0%	75% should confirm to quality control standards for each component	Meets the benchmark
	FFP+CRYO	0.625%		
	SDP+RDP	0%		
8	**Percentage of wastage of blood and blood components**			
	Ward side	0.3%	<1%	Meets the benchmark
	Blood centre			
	Whole blood	5.29%	<5%	Does not meet the benchmark
	Whole blood + Components	1.21%	<7%	Meets the benchmark
9	**Percentage of outdated units**			
	Whole blood	0%	<1%	Meets the benchmark
	PRBC	0%	<1%	Meets the benchmark
	FFP+ Cryoprecipitate	0%	<1%	Meets the benchmark
	SDP +RDP	0.44%	<22%	Meets the benchmark
10	Percentage of transfusion reactions	0.024%	<2%	Meets the benchmark

[Table/Fig-5]: Summary of key performance indicators studied.

S. No.	KPI not meeting bench mark	Problem identified by RCA	Action taken
1	Seroreactivity of Syphilis	(1) The reason for high sero reactivity is due to increasing incidence, sensitive tests. (2) Lack of awareness among the younger donors about the high-risk activities.	(1) Deferring high risk behaviour donors. (2) Stringent donor screening. (3) Implementation of a policy on TTI screening before collection of blood especially for Syphilis.
2	Percentage of Blood component usage	As per SBTC guidelines 30% of whole blood collections from Voluntary blood donation camp were issued as whole blood to nearby Government blood centre.	NIL
3	Percentage of wastage of whole blood from blood centre	The causes for wastage of whole blood were under collection and seroreactivity of blood donors	Under collection can be prevented by using calibrated blood collection monitors, proper positioning of the needle, monitoring the flow during blood collection, well trained phlebotomists.

[Table/Fig-6]: Summary of KPI deviations, problem identified and action taken to achieve KPI benchmarks.
*SBTC - State Blood Transfusion Council

(90.9%), comparable to the 82.14% reported by John CA et al., [13] and higher than the 56.56% reported by Abhishekh B et al., [12]. Only one donor (9.09%) experienced hematoma formation during phlebotomy, significantly lower than the 38.29% incidence reported by Abhishekh B et al., [12].

Measures to minimise donor reactions include ensuring adequate pre-donation hydration, encouraging applied muscle tension, creating a comfortable environment for donors, and promptly recognising and managing early warning signs. Proper phlebotomy techniques, educating donors about the procedure, and providing regular staff training can significantly reduce the risk of vein injury and subsequent hematoma formation.

In our study, the percentage of blood component preparation was 98.25%, meeting the NABH benchmark. Among the 8,589 blood collections, 8,538 were whole blood collections, of which 150 units (1.75%) remained as whole blood and 8,388 units 98.24% were subjected to component preparation. The components included PRBC – 8,388 (98.5%), RDP – 3,772 (44.9%), FFP – 8,388 (98.5%), and SDP – 51 (0.59%) collected by apheresis. A study conducted by Simon K [7] reported that among 12,615 whole blood collections, 99.7% were separated into blood components, which is comparable to the findings of the present study.

Among the total 8,589 blood donations in our study, 107 donors (1.24%) were reactive for different Transfusion-Transmissible Infections (TTIs). The overall seroreactivity rate of 1.24% meets the KPI standards suggested by NABH [5], which is similar to the 1.46% reported by Deshmukh et al., [14]. In contrast, Kumar et al., [15] reported a higher seroreactivity rate of 4.57%.

In this study, HBV was the most prevalent TTI (0.73%), within the NABH benchmark, consistent with the study conducted by Dhote SW et al., [16], which reported a prevalence of 0.84%. The prevalence of syphilis in our study was 0.33%, exceeding the NABH benchmark. This was comparable to a study conducted in Bhopal, India, which reported a prevalence of 0.31% [17], but higher than that reported by Dhote SW et al., [16] (0.11%).

The prevalence of HIV in this study was 0.06%, within the NABH benchmark, whereas Thakur SK et al., [18] reported a higher prevalence of 0.201%. Similarly, the prevalence of HCV in our study was 0.06%, within the NABH benchmark, while Pahuja et al., [19] reported a higher prevalence of 0.66%. No cases of malaria were reported during our study period, although Shrivastava et al., [17] reported five cases during their study.

The Turnaround Time (TAT) for elective cases in our study was 40.73 minutes, within the NABH benchmark [5]. Sarkar et al., [20] reported a TAT of 104 minutes for elective cases, which also met the benchmark. However, Varshney L et al., [6] reported a significantly higher TAT of 135.82 minutes, contrasting with our findings. The TAT for emergency cases in our study was 7.27 minutes, within the NABH benchmark, whereas John Gnanaraj et al., [8] reported a TAT of 18.3 minutes for cross-matching emergency PRBC units. Factors such as insufficient samples and the presence of irregular antibodies detected during Indirect Antiglobulin Testing (IAT) can contribute to increased TAT. Therefore, training technical staff to respond promptly to blood requests helped reduce TAT [21].

In our study, the percentage of blood component usage was 99.3%, slightly below the NABH benchmark. This aligns with the findings of Singh M et al., [22], who reported a component utilisation rate of 92.9%, also below the benchmark. In contrast, Bassi R et al., [23] reported a higher utilisation rate of 99.88%. The relatively lower utilisation in this study can be attributed to the State Blood Transfusion Council (SBTC), Andhra Pradesh policy, which mandates that 30% of whole blood collected during voluntary blood donation camps be issued as whole blood to nearby government blood centres. Uniform implementation of NBTC policy across all states may help achieve 100% component utilisation nationwide.

The overall component QC failure rate in our study was 0.62%, within the NABH benchmark. Only one QC failure (2.08%) was observed for FFP, while no QC failures were recorded for PRBC, RDP, or SDP. Whole blood was not subjected to QC, as its utilisation had been discontinued. Bassi R et al., [23] reported QC failure rates of 2.02% for PRBC, 5.37% for RDP, and 8.2% for FFP, with no failures for whole blood.

The QC failure of FFP in our study was attributed to culture positivity for Coagulase-negative Staphylococcus, with growth observed at both 22°C and 37°C. This may have resulted from donor bacteremia or contamination during culture processing. Proper donor screening, comprehensive training of technical staff in component separation, correct segment stripping before QC submission, sterilisation of blood bags under aseptic conditions, and disinfecting culture bottles with 70% isopropyl alcohol prior to processing are essential practices to minimise QC failures and ensure high-quality blood components.

In our study, the percentage of wastage of blood and blood components from the wards was 0.31%, which was within the NABH benchmark. A study by Ravikanth C et al., [24], conducted at the same centre between 2018 and 2020, reported a slightly lower wastage rate of 0.17% compared to the present study. In contrast, Tahmasebi A et al., [25] reported a significantly higher wastage rate of 16.4% for blood components.

The causes of wastage of blood and blood components during the study period included: components not required during surgery - 21 units (33.33%), components not transfused due to patient cardiac arrest or hypercoagulable state - 12 units (19.06%), patient expired before transfusion - 11 units (17.46%), patient complaints such as fever or vomiting before transfusion - 10 units (15.87%), not transfused as repeat Hb improved - 7 units (11.11%), and units issued to the Prime Minister's convoy - 2 units (3.17%).

Among wastage from the blood centre, the percentage of whole blood wastage was 5.29%, exceeding the NABH benchmark [5]. This finding was comparable to studies by Simon K etal., [7] and Sharma DN et al., [26], which reported wastage rates of 7% and 4.46%, respectively. The most common cause of whole blood wastage was under-collection, followed by seroreactivity of blood donors. Out of 27,674 components stored at the blood centre, 335 components were wasted (1.19%), which was within the NABH benchmark and similar to the study by Veihola et al., [27], which reported a wastage rate of 4.5%. Seroreactivity for TTIs was the most common cause of blood component wastage in our study. Roy A and Pal A [28] reported a wastage rate of 9.52%, which contrasts with our findings.

The only outdated blood component during the study period was RDP, with 24 units. The overall percentage of outdated units was 0.08%, and the percentage of outdated RDP was 0.44%, which is within the NABH [5] benchmark. No PRBC, FFP, Cryoprecipitate, or SDP units were outdated during the study period. In a study by Rajkumar A et al., [29], the reported wastage rates were 0.24% for PRBC, 0.25% for FFP, and 46.06% for RDP. Outdated units of PRBC and FFP were within the NABH benchmark, but outdated RDP units exceeded the benchmark.

During the study period, the percentage of transfusion reactions was 0.024%, meeting the KPI standards suggested by NABH and NACO. Gnanaraj J et al., [8] reported a 0.11% rate of adverse transfusion reactions, which correlates with our findings. In contrast, Tadasa et al., [30] reported a rate of 5.7%. In our study, a total of five transfusion reactions (100%) were reported: two (40%) allergic reactions, two (40%) febrile non-hemolytic transfusion reactions, and one (20%) case of transfusion-associated dyspnea. No hemolytic transfusion reactions were observed during the study period.

Limitation(s)

Continuity of data collection throughout the one-year study period was limited, as the Principal Investigator was not present at the study centre due to posting in the District Residency Programme (DRP) as per the academic schedule. However, the study had received ethics committee approval covering this duration.

CONCLUSION(S)

All KPI during the study period were within the NABH benchmark, except for seroreactivity of syphilis, percentage of blood component usage, and percentage of whole blood wastage from the blood centre. Implementation of pre-donation screening, particularly for syphilis, can reduce seroreactivity and further prevent wastage of blood centre resources. Adoption of uniform policies as outlined by the NBTC can help eliminate unnecessary collection and storage of whole blood, thereby facilitating 100% blood component usage. Additionally, involvement of adequately trained nursing staff during blood collection can prevent under-collection, which was the main cause of whole blood wastage in our study.

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