

EVALUATION OF INTERNAL QUALITY CONTROL PRACTICES IN A BLOOD CENTER AFFILIATED TO A TERTIARY CARE HOSPITAL: COMPLIANCE WITH WHO AND NACO STANDARDS

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ABSTRACT

BACKGROUND:

Blood transfusion is indispensable in trauma, surgery, cancer therapy, and anemia management. Because transfusion carries the risk of infection and immune reaction, blood banks must maintain strict quality control (QC).

OBJECTIVE:

To evaluate the quality control performance of a tertiary care blood bank and determine its compliance with World Health Organization (WHO) and National AIDS Control Organization (NACO) standards.

METHODS:

A one-year observational study was performed at the Blood Bank, Sree Balaji Medical College and Hospital. Data were collected from donor screening, component preparation, infectious-disease testing, storage, equipment monitoring, and transfusion-reaction surveillance. QC was assessed according to NACO (GSR 166-E, 11-03-2020) domains: infrastructure, donor screening, post-phlebotomy, test processing, bag quality, bag thawing, and discard.

RESULTS:

During the three - month study period, 250 donors were screened, of whom 5 (2%) were deferred based on NACO donor selection criteria. A total of 245 blood units were collected and processed into blood components. One hundred quality control (QC) samples comprising packed red blood cells (PRBCs), random donor platelets (RDPs), and fresh frozen plasma (FFP) were evaluated. Serological screening revealed HBsAg positivity of 2.3%, HCV positivity of 0.7%, syphilis positivity of 0.3%, and no HIV-reactive donations. Among the QC samples, 98% of PRBCs, RDPs, and FFPs complied with WHO/NACO quality standards. Storage temperatures remained within recommended limits, all equipment passed scheduled calibration, and only mild transfusion reactions (2%) were observed.

CONCLUSION:

Comprehensive QC practices in this blood bank achieved 97.5 percent compliance with WHO/NACO requirements. Effective infrastructure, donor screening, and component monitoring ensure high product quality and safe transfusion outcomes.

KEYWORDS

blood transfusion, quality control, NACO, WHO, PRBC, platelet concentrate, fresh frozen plasma

INTRODUCTION

Blood transfusion remains a cornerstone of modern medical care essential in trauma, obstetrics, oncology, and chronic anaemia management. The safety of transfusion, however, relies entirely on the quality of blood components produced and stored by blood banks. Globally, the World Health Organization (WHO) has set stringent norms for ensuring quality and safety in transfusion services, requiring systematic quality control (QC) programs for all components. In India, the National AIDS Control Organization (NACO) and the National Accreditation Board for Hospitals and Healthcare Providers (NABH) have adopted these recommendations, mandating that at least 1 % or a minimum of four units per component each month undergo QC testing [3,4].

Recent Indian studies affirm that structured QC programs and automation significantly improve component quality. Das et al. (2022) from a tertiary center in Eastern India reported that 98–100 % of PRBC, platelet, and plasma components met WHO specifications after implementing automated extraction and quadruple bag systems [1]. Similarly, Patel et al. (2022) observed that two years of structured QC monitoring in Ahmedabad yielded consistent compliance across all blood components [3].

Across India, findings have been largely encouraging. Upadhyay & Pangtey (2016) in Uttarakhand and Akhtar et al. (2021) in Aligarh both found QC conformity above 95 % for PRBC and platelets, demonstrating reproducibility across regions and institutions [2,4].

Moreover, innovations in component processing like the top-and-bottom or buffy coat extraction systems have shown to enhance leukocyte removal and hematocrit uniformity [5,10]. Bhardwaj et al. (2021) compared triple versus quadruple bag systems and found the latter produced higher plasma yields and platelet recovery, aligning with WHO performance benchmarks.

These findings collectively underscore that rigorous QC implementation is both feasible and essential in Indian blood banks. This study builds on that evidence by assessing the QC outcomes at the blood bank of Sree Balaji Medical College and Hospital, Chennai, and comparing them with WHO, NACO, and published Indian data.

MATERIALS AND METHODS

STUDY DESIGN

Descriptive cross-sectional study conducted for three-months at the tertiary care blood bank.

QC Domains and Protocol (NACO GSR 166-E 11-03-2020) and Process

Internal quality control was performed in accordance with the National AIDS Control Organization (NACO) Standards for Blood Centres (GSR 166(E), 2020). Approximately 5–10 quality control samples were evaluated each week, depending on blood component production, resulting in a total of 100 quality control samples comprising Packed Red Blood Cells (PRBC), Random Donor Platelets (RDP), and Fresh Frozen Plasma (FFP) during the three-month study period. Overall, 100 QC samples comprising PRBC, RDP, and FFP units were analyzed during the three-month study period. The quality control process was evaluated across the following domains:

- Infrastructure
- Donor screening and selection
- Post-phlebotomy procedures
- Laboratory testing and component processing
- Blood bag quality
- Component thawing and storage

- Blood component discard procedures

INFRASTRUCTURE

The blood centre consisted of approximately 1,200 sq ft dedicated to whole blood collection and 650 sq m allocated for component preparation, storage, and quality control activities. Dedicated areas were available for donor registration, counselling, blood collection, component separation, storage, record maintenance, stores, and washing and sterilization.

DONOR SCREENING AND COLLECTION AREAS

Separate screening and phlebotomy zones with pre-donation medical examination forms.

STUDY POPULATION

A total of 250 prospective blood donors who fulfilled the donor eligibility criteria according to the National AIDS Control Organization (NACO) guidelines were screened during the three-month study period. Of these, 5 donors (2%) were deferred because of temporary medical or behavioural risk factors, including anaemia, recent medication use, and travel history. Consequently, 245 blood units were collected and processed for component preparation.

BLOOD COMPONENT PREPARATION

Whole blood was collected using CPDA-1 quadruple blood bags and processed by the Platelet Rich Plasma (PRP) method using refrigerated centrifugation. Blood components prepared included Packed Red Blood Cells (PRBC), Random Donor Platelets (RDP), and Fresh Frozen Plasma (FFP). Component preparation and quality assessment were performed according to institutional Standard Operating Procedures (SOPs), WHO recommendations, and NACO Standards for Blood Centres (GSR 166(E), 2020).

EQUIPMENT

The blood centre was equipped with blood collection monitors, refrigerated centrifuges, plasma extractors, blood bag tube sealers, ELISA and CLIA analysers, platelet incubators with agitators, blood bank refrigerators, plasma freezers, and calibrated temperature monitoring systems.

TESTING PROCEDURES

1. Donor screening for infectious risk.
2. Serological testing for HIV, HBsAg, HCV, syphilis.
3. Component separation by centrifugation and QC for hematocrit, platelet count, and fibrinogen.
4. Storage at PRBC 2–6 °C, RDP 22–24 °C with agitation, FFP –40 °C to –80 °C.
5. Compatibility testing by ABO/Rh typing and crossmatching.
6. Reaction monitoring for every transfusion.

INTERNAL LABORATORY PARAMETERS

PT 11–13.5 s, aPTT 21–35 s, Fibrinogen 200–400 mg/dL, Hematocrit (M 40–54%, F 36–48%).

MICROBIOLOGICAL QC

Culture on nutrient agar, blood agar, and MacConkey agar for sterility.

DATA ANALYSIS

Data were entered into Microsoft Excel and analysed using descriptive statistical methods. Continuous variables are presented as mean $\pm$ standard deviation, whereas categorical variables are expressed as frequencies and percentages. Quality control compliance was calculated according to WHO and NACO quality standards for blood components.

QUALITY CONTROL STANDARDS

Internal quality control was performed according to the National AIDS Control Organization (NACO) Standards for Blood Centres (GSR 166(E), 2020) and World Health Organization (WHO) Guidelines.

The quality criteria adopted were:

- PRBC hematocrit: 55–70%
- RDP platelet yield: $\geq 5.5 \times 10^{10}$ /unit
- RDP pH: ≥ 6.2
- FFP fibrinogen: ≥ 200 mg/dL
- Factor VIII: ≥ 0.7 IU/mL
- PRBC storage: 2–6°C
- RDP storage: 20–24°C with continuous agitation
- FFP storage: $\leq -30^\circ\text{C}$
- Quality control frequency: minimum 1% or four units/component/month

RESULTS

The results highlight a comprehensive evaluation of the blood bank's internal quality control system, with each QC domain meeting or exceeding WHO/NACO benchmarks. The following section synthesizes these quantitative outcomes and interprets their significance in the context of blood transfusion safety and operational excellence.

DONOR SCREENING AND SEROLOGICAL SAFETY

A total of 250 prospective blood donors were screened, of whom 5 (2%) were deferred because of temporary medical or behavioural risk factors, primarily anaemia, medication use, or travel history. Consequently, 245 blood units were collected and subjected to mandatory transfusion-transmitted infection (TTI) screening.

The serological profile obtained from laboratory records indicated HBsAg positivity of 2.3%, HCV positivity of 0.7%, and syphilis positivity of 0.3%, while no HIV-positive donors were detected.

TABLE 1: DONOR SCREENING AND INFECTIOUS TESTING

Parameter	Total Samples Tested (n)	Result	Comment
Total donors screened	250	—	Prospective blood donors
Donors deferred	250	5 (2%)	Deferred for temporary illness or risk history
Blood units collected	245	245	Eligible donations
HBsAg positive	245	2.30%	Reactive units discarded
HCV positive	245	0.70%	Reactive units discarded
Syphilis positive	245	0.30%	Reactive units discarded
HIV positive	245	0%	None detected

These findings mirror the infection burden reported by other Indian tertiary centers such as those in Ahmedabad and Uttarakhand [2,3,8]. The absence of HIV reactivity reflects the success of stringent pre-donation screening and confidentiality protocols. The low rates of TTI positivity demonstrate an effective donor deferral and counseling program, ensuring that only low-risk donors contribute to the blood supply.

COMPONENT QUALITY CONTROL

Internal quality control was performed **monthly** according to NACO guidelines. The number of QC samples evaluated each month varied between **5 and 15**, depending on blood component production. During the study period, **100 QC samples** comprising PRBC, RDP and FFP were analysed.

The analysis revealed that **98% of PRBCs, 98% of RDPs, and 98% of FFPs** met WHO/NACO criteria.

- PRBCs consistently achieved hematocrit between 55–70%, indicating adequate red cell recovery following **Platelet-Rich Plasma (PRP) method** component preparation.
- RDPs maintained platelet yield above **5.5 × 10¹⁰/unit** with optimal pH (6.2–7.4).
- FFPs demonstrated satisfactory fibrinogen and Factor VIII levels, confirming preservation of coagulation factors during freezing.

TABLE 2: COMPONENT QUALITY CONTROL

Component	Parameter	Compliance (%)	Remarks
PRBC	Hematocrit 55–70%	98	2% discarded for low hematocrit
RDP	Platelet yield ≥5.5 × 10 ¹⁰ /unit; pH ≥6.2	98	All units showed swirling
FFP	Fibrinogen ≥200 mg/dL; Factor VIII ≥0.7 IU/mL	98	No deterioration seen
QC frequency	Monthly	—	5–15 samples/month
Total QC samples	100	—	PRBC, RDP and FFP

Overall component compliance – 98 %.

These outcomes indicate stable component production efficiency. The marginal 2% discard rate suggests minimal technical variability during centrifugation or bag sealing. The high compliance also reflects skilled staff operation and timely QC testing.

STORAGE AND EQUIPMENT MONITORING

All three major components were maintained within prescribed storage temperatures (PRBC 2–6°C, RDP 22–24°C, FFP –40°C to –80°C). Equipment logs showed no temperature excursions, and calibrations were validated monthly.

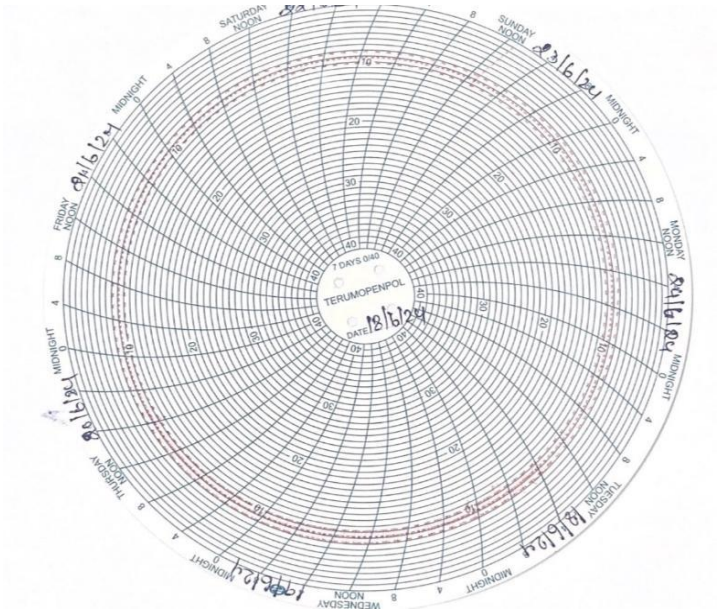
TABLE 3: STORAGE AND EQUIPMENT MONITORING

Component	Temperature Range	Observation	Compliance
PRBC	2–6 °C	Within range	100%
RDP	22–24 °C (agitated)	Stable	100%
FFP	–40 to –80 °C	No fluctuations	100%

All equipment was calibrated monthly with no failures.

Maintaining stable storage conditions is critical to prevent hemolysis, pH drift, and platelet deterioration. The 100% compliance underscores robust cold-chain management and well-maintained infrastructure. This finding confirms that both environmental and technical control systems function optimally, matching WHO standards for blood storage.

FIGURE 1: TEMPERATURE CHART



COMPATIBILITY TESTING

All donated blood units underwent forward and reverse ABO blood grouping, Rh(D) typing, antibody screening, and major crossmatching before issue according to institutional standard operating procedures. Crossmatch compatibility was assessed by concordance between donor and recipient ABO/Rh blood groups, absence of agglutination or haemolysis during crossmatching, and successful completion of compatibility testing before transfusion. During the study period, all compatible units were correctly matched, and no ABO/Rh mismatches, incompatible crossmatches, or acute haemolytic transfusion reactions were recorded, resulting in 100% compatibility accuracy.

TABLE 4: COMPATIBILITY TESTING AND CROSSMATCHING

Parameter	Observation
Forward ABO grouping	Performed for all donations
Reverse ABO grouping	Performed for all donations
Rh(D) typing	Performed for all donations
Antibody screening	Performed before issue
Major crossmatch	Performed for all issued units
ABO/Rh mismatch	None detected
Incompatible crossmatch	None detected
Acute haemolytic transfusion reaction	None observed
Compatibility accuracy	100%

The perfect compatibility record demonstrates the precision of testing and adherence to SOPs. This is a critical indicator of transfusion safety, as crossmatch accuracy directly affects patient outcomes. Compatibility accuracy was determined

by the absence of ABO/Rh discrepancies, negative incompatible crossmatch results, and the absence of haemolytic transfusion reactions among all issued blood units during the study period.

ADVERSE REACTION MONITORING AND LABORATORY

Among 245 transfusions monitored, 5 (2%) produced mild adverse reactions, including three (1.2%) febrile non-haemolytic reactions and two (0.8%) allergic urticarial reactions. No haemolytic or anaphylactic events occurred. Internal laboratory parameters, including hematocrit, PT, aPTT, and fibrinogen, remained within normal ranges, and all bacterial cultures (nutrient agar, blood agar, and MacConkey agar) were sterile.

TABLE 5: ADVERSE REACTIONS

Reaction Type	Frequency (%)	Severity	Outcome
Febrile non-haemolytic	1.2 (3/245)	Mild	Resolved
Allergic urticaria	0.8 (2/245)	Mild	Resolved
Haemolytic/Anaphylactic	0	None	None

Total adverse reaction rate – Total adverse reaction rate: 5/245 (2%), all mild and self-limited.

The low incidence of transfusion reactions (2%) mirrors global data, where reaction rates typically range between 1–3% (10,14). The absence of severe reactions demonstrates the safety of the transfusion process and the precision of pre-transfusion compatibility testing. The sterile culture results validate aseptic processing, while normal coagulation parameters confirm component stability and the reliability of internal quality systems.

INTERNAL QUALITY PARAMETERS

Across all QC domains, the overall compliance rate was 98%. Donor screening and infectious testing achieved near-total compliance (98–100%), component QC maintained between 96–98%, and equipment and storage domains achieved 100%. Laboratory QC remained stable, and adverse reactions were minimal.

TABLE 6: INTERNAL QUALITY PARAMETERS

Parameter	Reference Range*	Result	Interpretation
Hematocrit (M)	40–54%	Within range	Normal
Hematocrit (F)	36–48%	Within range	Normal
PT	11–13.5 s	12.8 ± 0.5	Normal
aPTT	21–35 s	28.6 ± 2.1	Normal
Fibrinogen	200–400 mg/dL	312 ± 18	Normal
Culture	Blood, Nutrient and MacConkey agar	No growth	Sterile

*Reference ranges adapted from the World Health Organization (WHO) Laboratory Quality Management System Handbook (2011), National AIDS Control Organization (NACO) Standards for Blood Centres (2020), and Clinical and Laboratory Standards Institute (CLSI) guidelines. [11,12,17,18]

Internal quality control parameters were evaluated using representative quality control samples from Packed Red Blood Cells (PRBC), Random Donor Platelets (RDP), and Fresh Frozen Plasma (FFP). Hematocrit was assessed in PRBC units,

coagulation parameters including fibrinogen were evaluated in FFP units, while microbiological sterility testing was performed on representative blood component samples using nutrient agar, blood agar, and MacConkey agar.

TABLE 7: OVERALL QC SUMMARY

QC Domain	Compliance (%)	Remarks
Donor Screening	98	Effective deferral
Infectious Testing	100	TTI risk minimized
Component QC	96–98	Within WHO limits
Storage & Equipment	100	Fully compliant
Compatibility Testing	100	No mismatch
Adverse Reactions	2	Mild only
Lab QC	100	All within normal range
Overall Compliance	98%	Meets WHO/NACO standards

TABLE 8. COMPARISON OF PRESENT STUDY FINDINGS WITH WHO/NACO STANDARDS

Parameter	WHO/NACO Standard	Present Study
Donor screening	Mandatory	Performed for all donors
TTI screening	Mandatory	Performed for all collected units
PRBC hematocrit	55–70%	98% complied
Platelet yield	$\geq 5.5 \times 10^{10}$ /unit	98% complied
FFP fibrinogen	≥ 200 mg/dL	98% complied
PRBC storage	2–6°C	100% compliant
RDP storage	20–24°C with agitation	100% compliant
FFP storage	$\leq -30^\circ\text{C}$	100% compliant
Equipment calibration	Monthly	Monthly
QC frequency	Monthly	Monthly
Overall QC compliance	$\geq 95\%$	98%

The consolidated compliance rate of 98% exceeds NACO's minimum threshold of 95% and aligns with reports from Surat [8] and Eastern India [1], confirming that structured internal QC programs are both effective and reproducible. This high

level of conformity demonstrates institutional maturity in transfusion governance, ensuring both product quality and patient safety.

SUMMARY

The synthesis of these results reveals a blood transfusion service that performs at an advanced level of quality assurance, achieving near-perfect alignment with WHO and NACO standards.

Key interpretations include:

- High component compliance (98%) confirms robust technical capacity.
- Stable storage and equipment function (100%) prove infrastructural reliability.
- Minimal TTi positivity (3.3% combined) demonstrates successful donor selection.
- Low reaction rate (2%) validates safe transfusion practice.
- Sterility of all components highlights effective infection control measures.

Overall, the data confirm that Sree Balaji Medical College and Hospital's Blood Bank operate as a model for national transfusion safety, integrating automation, staff competence, and documentation discipline to achieve sustainable quality.

DISCUSSION

In the present study, the blood bank demonstrated a high level of compliance with WHO and NACO quality standards across all quality control domains. Overall quality control compliance was **98%**, with PRBC, RDP, and FFP compliance rates of **98%, 98%, and 98%**, respectively. These findings indicate effective donor screening, blood component preparation, storage, compatibility testing, and haemovigilance practices.

DONOR SCREENING AND TTIS

The 2.3 % HBsAg and 0.7 % HCV positivity rates are consistent with data from Uttarakhand and Ahmedabad centers [2,3,8]. Zero HIV positivity and complete discard of reactive units demonstrate effective screening practices aligned with national guidelines [4].

COMPONENT QUALITY AND AUTOMATION

PRBC compliance (98 %) matches that reported by Das et al. [1] and Bhardwaj et al. [5], who attributed improved hematocrit and yield to quadruple bag automation. Platelet quality (98 %) was comparable to results by Sahoo et al. [6] and Warke et al. [9], confirming that buffy-coat and PRP methods can achieve WHO standards when agitation and pH are maintained. Plasma quality (98 %) aligned with Bala et al. [7], who observed >95 % compliance for Factor VIII and fibrinogen.

STORAGE AND CALIBRATION

No temperature excursions and routine equipment validation ensured component stability, similar to findings by Patel et al. [3] and Akhtar et al. [4]. These studies underline that monitoring systems and periodic maintenance are vital for sustained quality.

ADVERSE REACTIONS

The 2 % reaction rate corresponds to international data [10,14], with only febrile and mild allergic responses reported. This reflects effective cross-matching and antibody screening protocols.

MICROBIOLOGICAL QC

The absence of bacterial contamination across all media confirms aseptic collection and processing. Routine culture testing adds credibility to internal sterility assurance [11,12].

OVERALL PERFORMANCE AND COMPARISON

A 98 % compliance rate places this center within the top range of Indian transfusion services. Integration of automated systems and continuous training has made quality monitoring routine practice. These results affirm that well-structured IQC frameworks can maintain global-standard safety [1,3,5,6,8,9,13].

CONCLUSION

The findings indicate that the blood bank maintained a structured internal quality assurance programme and achieved a high level of compliance with WHO and NACO standards during the study period. Automation, effective donor screening, and continuous monitoring produced safe and reliable blood components while minimizing transfusion risks.

RECOMMENDATIONS

1. Maintain monthly QC audits following NACO guidelines.
2. Strengthen automation and data recording systems.
3. Conduct regular calibration and staff training programs.
4. Expand hemovigilance reporting and digital traceability.
5. Participate in external quality assurance programs for benchmarking.

LIMITATIONS

This study was limited to a single center and did not include molecular-level TTI screening. External QC participation and multicentric comparison would strengthen generalizability.

ETHICAL CLEARANCE

Approved by the Institutional Ethics Committee, Sree Balaji Medical College and Hospital (**Ref: SBMC/IEC/2023/Path-021**). All procedures complied with WHO ethical standards.

Artificial intelligence tools were used exclusively for proofreading and improving linguistic clarity. AI did not influence the study design, data extraction, analysis, interpretation, or conclusions. All scientific judgments and final content remain entirely the authors' own.

CONFLICT OF INTEREST

No conflicts of interest declared.

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References

1. Das S, Biswas R, Sardar T, Safi M. An insight to the internal quality control of blood components separated using the latest whole blood collection and processing systems: Experience from a tertiary care hospital blood transfusion service in Eastern India. *Asian J Transfus Sci.* 2022;16(2):194–200. doi:10.4103/ajts.ajts_52_21
2. Upadhyay S, Pangtey T. Quality analysis of blood component (PRBC and platelet concentrates): A study from a tertiary care teaching hospital of Kumaon region of Uttarakhand. *J Evol Med Dent Sci.* 2016;5:1210–1212. doi:10.14260/JEMDS/2016/282
3. Patel H, Prajapati P, Shah RJ, Harimoorthy V. Internal quality control of blood & blood components – Two years study at a standalone blood centre, Ahmedabad. *IP J Diagn Pathol Oncol.* 2022. doi:10.18231/j.jdpo.2022.022

4. Akhtar K, Arora R, Malik U, Parashar A, Ahmad M, Prasad S. Internal quality control in blood and component bank in a tertiary healthcare center in Northern India. *IP J Diagn Pathol Oncol*. 2021. doi:10.18231/J.JDPO.2021.025
5. Bhardwaj G, Tiwari A, Aggarwal G, Pabbi S, Sharma J, Luthra A, Upadhyay A. Evaluation of quality matrix when practice changed from triple bags to quadruple (top and bottom) bags: In vitro analysis of blood components. *Asian J Transfus Sci*. 2021;15:30–36. doi:10.4103/ajts.AJTS_87_19
6. Sahoo D, Toora E, Kulkarni RG, Manivannan P, Sastry AS, Basavarajegowda A. Quality assessment of platelet concentrates prepared by platelet-rich plasma, buffy-coat, and apheresis methods in a tertiary care hospital in South India: A cross-sectional study. *Asian J Transfus Sci*. 2022;17:239–245. doi:10.4103/ajts.ajts_73_22
7. Bala G, Suri V, Chhabra S, Shaffy S, Gupta R. Quality control of fresh frozen plasma using factor VIII and fibrinogen levels as measure: One year study in a tertiary care hospital. *Int J Contemp Med Res*. 2019. doi:10.21276/ijcmr.2019.6.8.28
8. Modh R, Taviyad A, Nayan N, Patel J. Internal quality control of blood components: A five-year experience of hospital-based blood centre of Surat. *Int J Sci Res*. 2023. doi:10.21275/sr231226155925
9. Warke AS, Bharambe B, Halgale M, Dhokane SS. Quality control of red cell concentrates: An insight into the effective functioning of the blood centre. *Ann Pathol Lab Med*. 2024. doi:10.21276/apalm.3412
10. Das S, Zaman R, Biswas D. Era of blood component therapy: Time for mandatory pre-donation platelet count for maximizing donor safety and optimizing quality of platelets. *Transfus Apher Sci*. 2013;49(3):640–643. doi:10.1016/j.transci.2013.07.007
11. World Health Organization. Laboratory quality management system: handbook. Geneva: World Health Organization; 2011.
12. National AIDS Control Organization. Standards for Blood Centres. New Delhi: Ministry of Health and Family Welfare, Government of India; 2020.
13. World Health Organization. Blood cold chain: guide to the selection and procurement of equipment and accessories. Geneva: World Health Organization; 2017.
14. World Health Organization. Screening donated blood for transfusion-transmissible infections: recommendations. Geneva: World Health Organization; 2010.
15. National AIDS Control Organization. Guidelines for Blood Transfusion Services in India. New Delhi: Ministry of Health and Family Welfare, Government of India; 2017.
16. World Health Organization. Guidelines on assessing donor suitability for blood donation. Geneva: World Health Organization; 2012.
17. Clinical and Laboratory Standards Institute. Collection of diagnostic venous blood specimens. 7th ed. Wayne (PA): Clinical and Laboratory Standards Institute; 2017.
18. Clinical and Laboratory Standards Institute. Procedures for the handling and processing of blood specimens for common laboratory tests. Wayne (PA): Clinical and Laboratory Standards Institute; 2010.