

Quality control of blood components: A Six-Year Multicentre Retrospective Study in Tertiary Care Hospitals in Bangladesh.

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ABSTRACT

Background

Before prescribing blood components physicians must know the quality of blood that actually fulfil the requirements of patients. In the field of transfusion medicine, blood components therapy is also a standard care therapy globally. In this study we evaluated three hospital data related to quality control of blood components that we prepare and issue.

Objectives

To evaluate compliance of blood components with AABB quality standards.

Materials and Methods

A multicentre retrospective study with 95% confidence interval, the study were done in three tertiary care hospitals in Dhaka, Bangladesh. In which total number of Whole Blood (WB) were 55650, RCC were 45420, SDP were 20124, RDP were 25264 and FFP were 48530. Sampling method was simple random sampling technique. Four of each blood components were analyzed every monthly throughout the study period. All blood units (RBCs, RCCs, RDPs, SDPs and FFP) from donors in Ibn Sina Medical College, Delta hospital and Green Life Hospital blood bank were included in the study with the exclusion of blood units which were not processed in these hospital (Outside Blood), leucocyte depleted blood products and washed blood products. Automated cell counter Sysmex XN-1000, and XN -2000, Stago auto analyser were used to obtain desired parameters.

Results

In our study, 91% of WB, 91% of RCC, 92% of RDP, 95% of SDP and 80% of FFP met the quality compliance with international standard.

Conclusion

The quality control (QC) data generated in this study provides essential insights into the performance of modern blood collection and processing systems. More than 90% studied blood components like WB, RCC, RDP, SDP strictly complied with international standards. However, FFP analysis could not be done according to AABB and international guideline due to financial constrain rather it was surrogate study. Ultimately, establishing a comprehensive QC program, alongside strict adherence to departmental protocols and manufacturer instructions is vital for blood centers to ensure effective and reliable operational outcomes.

Keywords

WB; RCC; SDP; RDP; FFP; Quality Control; PT; APTT; Automated Cell Separator; Sysmex XN 1000; 2000; Trima Accel; Stago auto analyzer; AABB.

INTRODUCTION

Quality control (QC) protocols are essential for monitoring manufacturing process variations and verifying that final product satisfy international acceptance standards. While blood component therapy is universally practiced, QC requirements range from highly rigorous to baseline mandates depending on the region. Quality control (QC) of blood components represents the foundation of contemporary transfusion medicine, ensuring the delivery of highly efficacious products while mitigating recipient risks. As a cornerstone of laboratory quality assurance, Internal Quality Control (IQC) comprises structured, continuous evaluation protocols that monitor daily operations and validate performance metrics. In blood banking, strict adherence to these benchmarks is critical to minimizing adverse transfusion events. Regular auditing of blood components enables institutions to track manufacturing variations, preserve product integrity, and confirm that processing phases comply with statutory regulatory mandates. Ultimately, modern QC frameworks—governed by international standards such as the Association for the Advancement of Blood & Biotherapies¹ and the Council of Europe (CE)² guarantee the availability of safe, standardized blood products that optimize therapeutic outcomes. In Bangladesh quality control (QC) practices

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in blood centers remain significantly limited; a vast majority of hospital blood banks routinely issue blood components without standard QC evaluations, often due to a lack of specialized on-site equipment. While modern automated separation technologies have boosted production volumes, their impact on component quality remains poorly understood. Currently, there is a distinct lack of published literature benchmarking local internal QC data against international frameworks, such as the AABB, with existing data restricted primarily to basic usage statistics in tertiary care facilities. To address this critical gap, this study evaluates the outcomes of a systematic QC program implemented across three transfusion medicine centers. The retrospective study from January 2016 to December 2021 in three different tertiary care hospitals comprise 55650 whole blood (WB), 45420 Red Cell Concentrate (RCC), 25264 Random Donor Platelet (RDP), 20124 Single Donor Platelet (SDP) and 48530 Fresh Frozen Plasma (FFP). After screening for HBV, HCV, HIV, MP and Syphilis WB was collected from a healthy donor in a single bag (JMS SINGAPORE PTE. LTD), whose capacity was 450 ml and 63 ml CPDA-1 anticoagulant. A triple bag system were chosen which contain 63 ml of CPDA-1 anticoagulant for component preparation. RCC, RDP and FFP were prepared with Rotixa 500 RS cell separator (Hettich Centrifuge Machine, Germany) as per manufacture's guideline. SDP was prepared with automated cell separator (Haemonetics MCS+, USA, Trima Accel®, Terumo BCT, Japan) WB and RCC were stored in refrigerator (Kirsch, Germany) at 2-8 degree C for 35 days. RDP and SDP were stored in Platelet incubator with agitator (Helmer, Hettich, Germany) at temperature between 20-24 degree C for 5 days. FFP was prepared within 6 hours of WB collection, volume 220-280 ml stored at -30 degree C for 1 year.

MATERIALS AND METHODS

The retrospective study done in three tertiary care hospitals, Ibn Sina Medical College Hospital, Green Life Hospital and Delta Hospital Ltd. in Dhaka, Bangladesh from January, 2016 to February 2022 comprised 55650 units of Whole Blood, 45420 units of RCC, 25264 units of RDP, 20124 units of SDP and 48530 units of FFP. RCC, FFP and RDP prepared with Rotixa 500 RS (Hettich) cell separator, SDP prepared with Trima Accel automated blood collection system. **Sampling Units:** 1.5% of WB, 1.9% of RCC, 3.5% of

RDP, 4.4% of SDP and 1.8% of FFP were subjected to Quality Control. As per our SOP 4 units of each component were randomly selected from storage site and subjected to analysis. Blood component units were chosen by simple Random Sampling technique.

Measurement: HCT of WB and RCC were analyzed at the expiry date of each component with Sysmex XN 1000 and 2000 cell counter machine. Platelet count of RDP and SDP was analyzed with Sysmex XN 2000 cell counter. PH of RDP and SDP were analyzed with PH smeter. PT and APTT measured with Stago auto analyzer machine. Blood culture analysis was achieved through the inoculation of samples in solid culture media (Blood Agar). Culture plates were incubated at 37°C in Thermo Scientific incubator. QC data were recorded in individual QC register. Data were presented with charts and tables.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Continuous variables are presented as mean and range (or mean $\pm$ standard deviation where available), while categorical variables are presented as frequencies and percentages. Compliance with the quality control criteria was expressed as the proportion of blood components meeting the predefined acceptance criteria.

Ethical clearance: This original article is approved by local ethic committee.

RESULTS

Blood component units are analyzed on expiry date of every component. Quality control requirements were set according to Advancement of Blood & Biotherapies (AABB) Technical Manual 21st edition, 2023. FFP is generally not used in developed countries but developing countries largely depend on FFPs for various inherited coagulation defects. In view of its limited use, AABB do not recommend any standards for its testing. Below the results are documented sequentially against the AABB QC criteria table. According to AABB, all these requirements should be present in a minimum of 90% of units tested.

Whole Blood: AABB QC Criteria

Parameter	Quality requirement
Volume including anticoagulants	450 +/- 468-558 ml
Hematocrit (HCT)	35%-45 %
Culture Test	No growth

In our study, a total number of 55650 units of WB units were analyzed for volume, HCT and culture test. At the time of expiry, 91% (50641) units fulfil the parameters of reference criteria that means volume was 500 ml, HCT was between 35-45% and culture test was negative.; where as 9% (5009) units did not to fulfil AABB criteria. Results were presented in Table 1.

Table 1. Quality Control Assessment of Whole Blood Units According to AABB Criteria (n = 55,650)

Parameters (Per Unit)	Observed Value	AABB Standard
Volume (mL)	Mean = 470 mL	450 ± 10% (468–558 mL)
	Range: 468–558	468–558 mL
Hematocrit (HCT, %)	Mean = 40%	35–45%
	Range: 35–45%	35–45%
Culture Test	Negative: 50,641 (91.0%)	No growth
	Positive: 5,009 (09.0%)	No growth
Overall Compliance with AABB Criteria	50641/55,650 (91.0%)	Meets all three quality parameters

Red Cell Concentrate (RCC): AABB QC Criteria

Parameter	Quality requirement
Volume including anticoagulants	280 +/- 60 ml (220-340 ml)
Hematocrit (HCT)	55%-75%
Culture Test	No growth

A total number of 45420 units of RCC were analyzed for volume, HCT and culture tests. Out of which 91% (41332.1) units of RCC qualify the AABB criteria;

volume was 240 ml, HCT was 75% and culture shows no growth. Whereas 09% (4088) units of RCC did not qualify AABB criteria. Results were presented in Table: 2

Table 2. Quality Control of Red Cell Concentrate (RCC) According to AABB Criteria

(n = 45,420)

Parameters (Per Unit)	Volume (mL)	HCT (%)	Culture (Negative)
Mean	240	75	41332.1 (91%)
Range	220–340	55–75	Positive: 4088 (09.0%)
AABB Standard	280 ± 60 (220–340)	55–75	No growth

Overall compliance with AABB criteria: 41,332/45,420 (91.0%)

Random Donor Platelet (RDP): AABB QC parameter

Parameter	Quality Requirement
Volume including anticoagulant	40-70 ml
Platelet count	>5.5 x 10 ¹⁰
PH	>6.2
Culture Test	No growth

A total of **25,264 Random Donor Platelet (RDP)** units were evaluated for quality control. Overall, **23,335 (92.0%)** units met all AABB quality criteria, while **1,929 (8.0%)** units failed to meet one or more predefined standards. The mean RDP volume was **60 mL** (range: **40–70 mL**), the mean platelet yield was **6.0 × 10¹⁰/unit**, and the mean pH was **6.8** (range: **6.2–7.8**). Sterility testing demonstrated **no bacterial growth in 92.0%** of units. Result was presented in Table:3.

Table 3. Quality Control of Random Donor Platelets (RDP) According to AABB Criteria (n = 25,264)

Parameters (Per Unit)	Volume (mL)	Platelet Count (×10 ¹⁰ /unit)	pH	Culture (Negative)
Mean	60	6.0	6.8	23,335 (92.0%)
Range	40–70	>5.5	6.2–7.8	Positive: 1,929 (8.0%)
AABB Standard	40–70	>5.5	>6.2	No growth

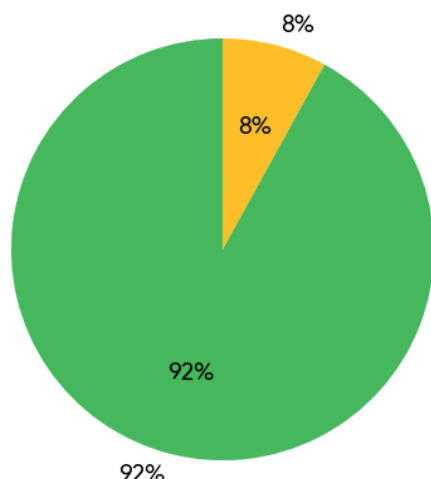


Fig: Pie chart of RDP Quality Control data

Single Donor Platelet (SDP): AABB Quality Control Criteria

Parameter	Quality Requirement
Volume including anticoagulant	200-400 ml
Platelet count	$>3.0 \times 10^{11}$
PH	$>6.2 - 7.4$ at expiry
Culture Test	No growth
	WBC count: $< 5 \times 10^6$ of 95% sample tested

A total of **20,124 Single Donor Platelet (SDP)** units were evaluated for quality control. Overall, **19,118 (95.0%)** units fulfilled all AABB quality control criteria, whereas **1,006 (5.0%)** units failed to meet one or more predefined standards. The mean SDP volume was **300 mL** (range: **200–400 mL**), the platelet yield exceeded **3.5×10^{11} /unit**, and the mean pH at expiry was **6.8** (range: **6.2–7.8**). Residual leukocyte counts were **$<5 \times 10^6$ /unit** in accordance with AABB requirements, and **95.0%** of units demonstrated **no bacterial growth** on culture. Results were presented in Table:4

Table 4. Quality Control of Single Donor Platelets (SDP) According to AABB Criteria (n = 20,124)

Parameters (Per Unit)	Volume (mL)	Platelet Count ($\times 10^{11}$ /unit)	pH	WBC Count ($\times 10^6$ /unit)	Culture (Negative)
Mean	300	>3.5	6.8	<5.0	19,118 (95.0%)
Range	200–400	>3.0	6.2–7.8*	<5.0	Positive: 1,006 (5.0%)
AABB Standard	200–400	>3.0	>6.2 at expiry	$<5 \times 10^6$ (95% of units tested)	No growth

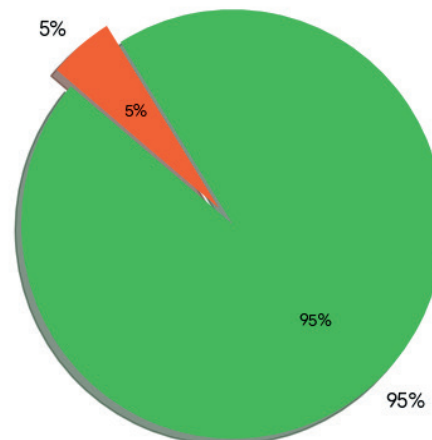


Fig: Pie chart of SDP Quality Control data

Fresh frozen Plasma (FFP): Surrogate QC Criteria

Parameter	Quality requirement
Volume including anticoagulants	220-300 ml
PT	12 Sec
APTT	35-45 Sec
Culture Test	No Growth

A total number of 48530 units of FFP were tested for reference volume, PT, APTT and culture test. Out of which 80% (38530) units fulfil the reference criteria. 20% (9706) units of FFP did not pass the reference criteria. Results were presented in Table:5.

Table 5. Quality Control of Fresh Frozen Plasma (FFP) According to Surrogate Quality Control Criteria (n = 48,530)

Parameters (Per Unit)	Volume (mL)	PT (sec)	APTT (sec)	Culture (Negative)
Mean	250	12	40	38,824 (80.0%)*
Range	220–300	12–14	35–45	Positive: 9,706 (20.0%)
Reference (Surrogate QC Criteria)	220–300	12–14	35–45	No growth

NB: Values are presented as mean, range, or frequency (%), as appropriate. Compliance was defined as fulfillment of the predefined surrogate quality control criteria for volume, PT, APTT, and sterility

Table 6. Overall Compliance comparison of Blood Components with Quality Control Criteria

Blood Component	Total Units Tested	Compliant Units, n (%)	Non-compliant Units, n (%)
Whole Blood	55,650	50641 (91.0)	5,009 (09.0)
Red Cell Concentrate	45,420	40,878 (90.0)	4,088 (09.0)
Random Donor Platelets	25,264	23,335 (92.0)	1,929 (8.0)
Single Donor Platelets	20,124	19,118 (95.0)	1,006 (5.0)
Fresh Frozen Plasma	48,530	38,530 (80.0)	9,706 (20.0)

Table 7; Demographic and operational characteristics of participating hospitals

Name of Hospital	Demographic Characteristics	Operational Characteristics
Ibn Sina Medical College Hospital	Located in Northern Dhaka, teaching private hospital	Tertiary care hospital, equipped with modern diagnostic equipment, accredited with NABH, India
Delta Hospital Ltd	Located in Northern Dhaka, teaching private hospital	Tertiary care hospital, Specially engaged in oncology.
Green Life Hospital	Located in Southern Dhaka, teaching private hospital	Tertiary care hospital, equipped with all modern diagnostic and clinical services

Table 8: Study sample size from different hospital

Name of Hospital	Number of WB (Units)	Number of RCC (Units)	Number of RDP (Units)	Number of SDP (Units)	Number of FFP (Units)
Ibn Sina Medical College hospital	20550	16140	7620	5250	14320
Delta Hospital Ltd	16360	14220	10120	8420	18440
Green Life Hospital	18740	15060	7524	6454	15770
Total	55650	45420	25264	20124	48530

Table 9: Annual QC compliance trends in different hospitals

Name of Hospital	2016	2017	2018	2019	2020	2021
ISMCH	90%	91%	92%	90%	93%	92%
DHL	90%	90%	91%	92%	90%	90%
GLH	90%	92%	91%	92%	90%	90s%

ISMCH; Ibn Sina Medical College Hospital, DHL; Delta Hospital Ltd, GLH: Green Life Hospital

Table 10: Comparison with Neighboring countries

Parameters	Bangladesh	India	Pakistan
WB	91%	89%	NA
RCC	91%	89.91%	98%
RDP	92%	78.11%	NA
SDP	95%	NA	NA
FFP	80%	95%	NA

NA: Data not available

Table 11: Total compliance of RBC, FFP and RDP units according to the AABB and CE standard requirements

Parameters (per bag)	RBC	RDP	FFP
Current Study	41,332 (91%)	23,335 (92%)	38,824 (80%)
AABB standards requirements (21st edition 2023)	288 (96.0%)	288 (96.0%)	288 (96.0%)
CE standard requirements (21st edition 2023)	280 (93.3%)	280 (93.3%)	282 (94.0%)

CE: Council of Europe

DISCUSSION

Quality control (QC) protocols are essential for monitoring manufacturing process variations and verifying that final products satisfy international acceptance standards. While blood component therapy is universally practiced, QC requirements range from highly rigorous to baseline mandates depending on the region. The implementation of internal quality control

(QC) infrastructure remains paramount in mitigating risks associated with blood component therapy. Over recent decades, the landscape of transfusion medicine has evolved significantly, driven by advanced automation, Good Manufacturing Practices (GMP), and stringent regulatory standards. Recognizing these advancements, we transitioned to a triple bag system integrated with an automated component extractor. Following rigorous validation using AABB (Association of Advancement for Blood and Biotherapy) and European committee of Blood Transfusion and NABH, India guideline³, we processed a total of 55,650 WB units, 45,420 units RCC (Red Cell Concentrate), 25,264 units of RDP (Random Donor Platelet), 20,124 units SDP (Single Donor Platelet), and 48,530 units of FFP (Fresh Frozen Plasma). We subsequently analyzed those blood component units according to AABB QC criteria. A study conducted by Sadia Sultan and others in Southern Pakistan⁴ showed overall compliance and met recommended international standards. Another study conducted by Sudipta Shekhar Das and others in Eastern India⁵ found very good compliance of various blood components against international standard. The system demonstrated good compliance when benchmarked against global standards. 91% of WB units met quality criteria of AABB in respect of volume, HCT and culture test. Similar study conducted by Muhammad Safi^{4,5} complied close to our value. 91% of RCC (Red Cell concentrate) units met QC criteria of AABB in respect of volume, HCT and culture test at the end of 5 weeks expiry period. Similar study conducted by Muhammad Safi and Sudipta Sekhar Das⁵ showed 91.4% of RCC units satisfy the international standard. Another study conducted by Sadia Sultan and co-authors in Southern Pakistan found that, the mean HCT of packed red cells was 69.5 ± 7.24 , and in 98% units, it met the standard ($<80\%$ of HCT). The 09% (5009) of WB and 09% (4088) of RCC had hematocrit below desired range. The failure noncompliance with QC criteria of WB and RCC may be due to improper donor selection with low Hb concentration, technical lacking during separation of plasma during component preparation. Culture of WB and RCC were negative in 91% case, where as 09% cases were positive in initial stage but on repeat test were negative. This variation was may be due to technical error. RDP units were analyzed at the end of 5 days expiry period. It showed 92% of RDP units satisfy the AABB QC criteria in respect of volume, platelet count, PH and culture test.

PH is critical factor regarding platelet viability. 08% of RDP units had platelet count below desired level. This may be due to faulty technique during venipuncture. As during collection of Whole Blood for RDP preparation, 'Non-traumatic venipuncture' is a standard method. Culture of RDP was positive in 08% cases in initial stage but negative in repeat test which excludes bacterial contamination. This variation may be due to technical discrepancy. Study done by Muhammad Safi and Sudipta Sekhar Das⁵ showed 88.1% RDP units complied with AABB standard. SDP units were analyzed at the end of 5 days expiry period and 95% units met AABB QC requirement. Study done by Muhammad Safi and Sudipta Sekhar Das in Eastern India showed platelet recovery were $>95\%$ cases.

Fresh Frozen Plasma (FFP) units were taken randomly at 6th months of storage. As AABB did not recommend any QC criteria for FFP analysis, but other international body like CE (Council of Europe) set QC standard of specific factor Fibrinogen and Factor VIII assay must be done, we could not perform these factors assay due to our limitation. Only surrogate markers were evaluated. In this case we measured Prothrombin Time (PT) and Activated Partial Thromboplastin Time (APTT). Theoretically those two assays reflect Factor I, II, V, VII, VIII, IX, X activity in plasma. 80% of our FFP units showed normal PT and APTT, that means, those unit of FFP contain normal quantity of above-mentioned coagulation factors. Study done by Muhammad Safi and Sudipta Sekhar Das⁵ showed 100% compliance with CE QC criteria in respect of Fibrinogen and Factor VIII assay.

These results align with previous data from S. Sultan et al. (2018)⁶, who analyzed 400 total blood components (100 units each of RBCs, PCs, FFP, and CP). In their study, 98.0% of packed red blood cell (PRBC) units met the AABB hematocrit standards. For random donor platelets (RDPs), the mean pH was 7.5 ± 0.08 (with a 98.0% compliance rate), and the mean platelet yield was $8.87 \pm 3.40 \times 10^9/L$ (94.0% compliance). Although initial bacterial cultures were positive in 3.0% of cases, repeat testing was completely negative, ruling out active contamination. These results consistent with the findings of H. Patel et al⁷, who conducted monthly quality control assessments on 1,302 blood components between December 2019 and November 2021 in compliance with the National Accreditation Board for Hospital and Healthcare. Their study evaluated 473

red blood cell (RBC) units for hematocrit (HCT), 255 platelet concentrates (PCs) for yield, and 484 fresh frozen plasma (FFP) plus 90 cryoprecipitate (CP) units for volume, factor VIII, and fibrinogen levels. Patel et al. reported that 95.0% of RBCs, 95.0% of PCs, and 100.0% of culture samples met the required standards. Furthermore, while 100.0% of both FFP and CP units achieved acceptable fibrinogen levels, the standard for factor VIII was met by 99.2% of FFP units and 91.2% of CP units. Another study published by K. Patel⁸ assessed volume (365.1 ± 53.05 ml), HCT ($62.09 \pm 6.56\%$), Hb (19.22 ± 2.66 g/dl) and RBCs count ($7.20 \pm 1.09 \times 10^{12}$ for RBCs, yield ($7.47 \pm 1.95 \times 10^9$), volume (62.94 ± 5.75 ml), culture (sterile in 100.0%) and swirling (present in 100.0%) for RDPs, fibrinogen and factor VIII level for FFP (271.23 ± 89.32 gm/L and 83.98 ± 16.11 IU/unit respectively) and CP (280.6 ± 69.83 gm/L and 81.83 ± 17.23 IU/unit respectively) with regard to AABB standard and achieved matching with criteria. These findings underscore the necessity of robust Continuous Quality Improvement (CQI) frameworks to mitigate noncompliance in blood component metrics. Effective CQI must span the entire lifecycle of blood collection and processing, anchored by clearly defined, continuously monitored, and systematically documented quality indicators. To strengthen our current quality control (QC) protocols, we propose integrating several critical measures: assessing red blood cell (RBC) hemolysis at the end of storage (calculated as a percentage of total red cell mass), monitoring residual cells in plasma in alignment with AABB guidelines, and conducting routine monthly trend analyses to pre-emptively identify deficiencies. When deviations occur, prompt corrective actions must be deployed. Furthermore, sustainability requires regular staff training and internal audits by qualified, independent personnel. Embracing Statistical Process Control (SPC)—specifically control charts—will facilitate proactive, data-driven oversight. While comprehensive execution remains temporarily hindered by infrastructural and training limitations, establishing these measures is vital to enhancing the compliance, safety, and quality of blood transfusion services.

Limitation of the Study: FFP analysis could not be done according to AABB and CE standard due to financial constrain. Specific factor assay by automated platform

would yield superior quality of our study. Technical operational lacking of technicians during blood component preparation in different hospital blood bank was also observed.

Recommendation: Every standard blood centers should perform Quality Control of blood components to ensure quality blood product to serve the patients. It is also necessary for physicians who might get optimum benefit from blood products supplied from blood centre and thus help to decrease indiscriminate use of Whole Blood. Specific factor I and VIII assay also recommended to obtain better compliance with international standards. Regular training of technicians has been advocated to minimize failure of quality component preparation.

CONCLUSION

In conclusion, the quality control (QC) data and factual evidence established in this study offer critical insights into the performance of commercially available, 91% of WB met the quality requirement of AABB. The vast majority of evaluated Red Cell Concentrate (RCC) units demonstrated compliance, with 91% meeting international benchmarks for hematocrit and hemoglobin,. Furthermore, acceptable platelet yields were achieved in 92% of Random Donor Platelet (RDP) units, 95% of Single Donor Platelet (SDP), while 80% of tested Fresh Frozen Plasma (FFP) units satisfied surrogate quality metrics.

DECLARATION

Consent for publication: Both authors read the edited manuscript and consented to publication.

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Author Contributions

Data gathering and idea owner of this study: Rafiqul H

Study design: Rafiqul H

Data gathering: Rafiqul H, Habibur R, Tahmina S

Writing and submitting manuscript: Rafiqul H

Editing and approval of final draft: Rafiqul H, Habibur R, Tahmina S, Tasminah N L, Daanish A B

REFERENCE

1. Claudia Cohn, MD, PhD; Meghan Delaney, DO, MPH; Susan T. Johnson, MSTM, MT(ASCP)SBB^{CM}; Louis M. Katz, MD; Joseph (Yossi) Schwartz, MD, MPH; <https://www.scribd.com/document/725804903/AABB-Technical-Manual-21st-Ed> <https://www.aabb.org/home/tech-manual-21st-edition>
2. The European Committee on Blood Transfusion. 18th. Strasbourg, France: Council of Europe Publishing; 2015. Guide to the Preparation, Use and Quality Assurance of Blood Components.
3. The Technical Committee. 3rd. New Delhi, India: National Accreditation Board for Hospitals and Healthcare Providers (NABH), Quality Council of India; 2016. Accreditation Standards on Blood Banks/Blood Centers and Transfusion Services
4. S.Sultan, S. et al. Internal quality control of blood products: an experience from a tertiary care hospital blood bank from Southern Pakistan. *J. Lab. Physicians.* 2018;10:064–067. <https://pmc.ncbi.nlm.nih.gov/articles/PMC5784297/>
5. Sudipta Sekhar Das, Mahammad Safi, Rathindra Nath Biswas; An insight to the internal quality control of blood components separated using the latest whole blood collection and processing system experience from a tertiary care hospital blood transfusion service in Eastern India. *Asian Journal of Transfusion Science* 2022;16(2):194-200. | DOI: 10.4103/ajts.ajts_52_21
6. S.Sultan, S. et al. Internal quality control of blood products: an experience from a tertiary care hospital blood bank from Southern Pakistan. *J. Lab. Physicians.* 2018;10: 064–067.
7. Patel, H., Prajapati, P., Shah, R. & Harimoorthy, V. Internal quality control of blood & blood components - Two years study at a standalone blood centre, Ahmedabad. *IP J. Diagn. Pathol. Oncol.* 2022;7(2):95–98. <https://doi.org/10.18231/j.jdpo.2022.022>
8. Patel, K., Ganvit, K., Shrivastav, A. & Parikh, M. Internal quality control of blood products at tertiary health care centre. *Int. J. Dent. Med. Sci. Res.* 2024;6 (1):73–76.