Original Article

Quality Implications of Regular Versus Overnight Processing of Stored Human Platelets: An Institutional Study

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Abstract

Background: Platelet concentrates (PC) are prepared from random donor platelets (RDP) and single donor platelets (SDP) and the various quality parameters of the PC are multifactorial which includes the preparation techniques, types of bags used, holding period prior to processing, type of anticoagulant used, use of additive solutions, the storage conditions after processing, etc. Extending the holding period before processing and ensuring the absence of deleterious affect on the quality parameters of the PC can be extremely beneficial from operational and logistical reasons to meet the increased clinical demand of PCs, particularly for oncology cases and during dengue epidemic. Aims and Objectives: The comparative evaluation of various quality parameters including morphological, biochemical and molecular aspects of PCs between fresh whole blood (WB) (8 hrs) versus overnight hold blood (24 hrs) on the 0, 3rd and 5th day of storage. **Materials and Methods:** Fifty units of blood were collected and stored overnight (24 hrs) hours at a temperature of 22^{0}C to 24^{0}C and processed subsequently. The other 50 units were processed immediately within 8 hours. All the PCs had undergone mandatory serological testing and all the sero-negative PCs had fulfilled quality control parameters. Sterility confirmation was done on 0, 3rd and 5th day of storage. Morphological, biochemical and molecular aspects for both the categories of PCs were studied. For statistical analysis, *t*-test at 95% confidence interval was done with a *P* value of <0.05 taken as statistically significant. **Results:** All essential quality parameters in both the categories of PCs were within acceptable limits. No adverse impact on quality was noted in the overnight PCs. **Conclusion:** The preserved quality of overnight PCs along with associated logistic benefits should encourage blood bank management to seriously explore the feasibility of undertaking the 24-hours whole blood holding period (overnight) before preparing PCs.

Keywords: *Fresh, overnight, platelet concentrates, quality parameters*

Submission: 16-02-2022,
Decision: 31-03-2022,
Acceptance: 01-04-2022,
Web Publication: 14-06-2022.

Introduction

Platelet transfusion is usually different from various other routine blood transfusion because of certain unique features including the limited shelf life, bacterial contamination and its various mode of collection, preparation and storage. This is because structural characteristics of the platelets along with their biochemical features directly affect the platelet functional qualities and consequently the clinical outcome.[1]

Of all the blood components, platelet inventory management remains a challenge because of the demand–supply scenario. Platelet inventory management is characterized by a limited shelf life and a limited donor base and restricted number of blood donations,

Access this article online

Quick Response Code:

Website: https://journals.lww.com/mjdy

DOI: 10.4103/mjdrdypu.mjdrdypu_137_22

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How to cite this article: Das S, Harendra Kumar ML. Quality implications of regular versus overnight processing of stored human platelets: An institutional study. Med J DY Patil Vidyapeeth 2023;16:410-7.

which gets aggravated by limited donor base particularly in a rural, remote setup similar to us. Continuous improvement of platelet preparation methodologies is required to meet the ever increasing clinical demands and overcome the existing drawbacks.[2] Hence, it is necessary to identify ways and means of newer platelet production techniques which can successfully meet the daily clinical demands, ensured maximum transfusion efficacy without compromising patient safety.

Our study was one such step in this regard as we undertook a comparative evaluation of various quality aspects of platelet concentrates (PC) prepared from fresh whole blood (WB) within 8 hours of collection versus overnight stored blood (24 hours) during storage.

Aims and objectives

- To prepare and comparatively evaluate the morphological features such as platelet count, MPV and PDW across 0, 3rd and 5th days between fresh WB (8 hrs) versus overnight stored blood (24 hrs).
- To prepare and comparatively evaluate metabolic features such as pH and pCO2 across 0, 3rd and 5th days between fresh WB (8 hrs) and overnight stored blood (24 hrs).

Materials and Methods

This is a single center, cross-sectional study which was conducted in the department of Pathology and Blood bank of our institute from December 2019 to August 2020. The approval of the Ethical Committee was obtained before the study (SDUMC/IEC/275/19), Pre-donation counseling and physical examination of donors were done regularly and a donor deferral criterion was adhered to wherever necessary as per the standard operating procedure (SOP) based on Director General of Health Services (DGHS) India criteria.[2]

The blood donation procedure including the adverse events, if any, was explained to the donors and a written consent obtained. The appropriate phlebotomy site was noted and arm disinfection was done to mitigate risk of bacterial contamination of PCs.

Inclusion criteria

The inclusion criteria for donor's selection were body weight >60 to 65 kg, hemoglobin (Hb) more than 12.5 g/dL, platelet count more than 2.5 lac/mm3.

Exclusion criteria

a) Lipemic samples, b) RBC contamination, c) seropositive units, d) bacterial contaminated units. Preferably write in language.

Sample size estimation was calculated based on the study conducted by Singh *et al.*[3] based on 5% probability of contamination of PCs concentrates at 95% confidence level.

$$n = \frac{Z1-\alpha 2(p)\,(q)}{d^2}$$

n = Sample size

Z1-α2 at 95% 1.96 (power)

p = Prevalence = 85.6 (reference) article 2

q = 100-p = 100-85-6 = 14.4

d = Absolute error = 5

n = (1.96) 2 (85.6) (14.4) (5) 2

n = 44.6 = 66 + 10% non-response rate

n = 44 =+6

n = 50.

The donor arm preparation followed by blood collection, processing and storage was done according to the existing SOPs, and 450 ml of blood was collected in triple bags containing CPDA 1 anti-coagulant (HLL, Life Care Limited, Kerala) under medical supervision within 8 minutes. Subsequently, the WB was processed for preparation of PCs as per the SOPs. Blood collected from the donors underwent routine investigation including complete blood count (CBC) and also screening for Transfusion-Transmitted Infections (TTI).

Each of the PC unit was assessed for quality parameters as per the DGHS standards[2] which includes: (i) Platelet concentrate volume; (ii) Swirling; (iii) Platelet count/bag; (iv) White Blood Cell (WBC) count/bag; (v) pH changes; (vi) Metabolic changes like pO2, pCO2, HCO≥;[4] (vii) Mean Platelet Volume (MPV); (viii) Platelet distribution width (PDW); and (ix) Platelet Large Cell Ratio (PLCR), respectively.[1]

Platelet concentrate volume:

$$\text{Volume of PC} = \frac{\text{Weight of full bag - Weight of empty bag}}{\text{Specific gravity}}$$

The specific gravity includes (1.053 for whole blood, 1.03 for (Platelet rich plasma) PRP-PC and 1.06 for BC-PC, respectively).

Swirling: Swirling is a simple test routinely done to asses platelet morphology procedure which, in turn, can be routinely used to assess platelet morphology by holding the PC unit against light source at an interval of 1 hour, 24 hours and 72 hours, respectively.[5]

Score (0)- homogenous turbid and is not changed with pressure,

Score (1)- homogeneous swirling only in some part of the bag and is not clear,

Score (2)- clear homogeneous swirling in all part of the bag,

Score (3)- very clear homogeneous swirling in all parts of the bag.[5]

pH alteration

With the increase in the storage period of PCs, there is a corresponding decrease in the pH value which alters the platelet shape from disc to sphere leading to loss of platelet function.[6] The pH was evaluated by the use of a calibrated portable pH meter (OAKTON pH 700, Oakton instruments, IL, USA), using Standard Operating Procedure (SOP).

Metabolic changes

With the progress in storage period, there are wide ranging metabolic changes including increase in the mean pO2 and decrease in mean HCO3- levels resulting in a significant fall in pH affecting the function, survival and morphology of platelets.[7] The metabolic parameters were analyzed using an Arterial Blood Gas (ABG) analyzer (Siemens corporation Germany Ltd.) to assess the viability of PCs.

White Blood Cell (WBC) count per bag

It is done by multiplying WBC count/µl with whole blood volume using a routinely calibrated automated haematology analyzer (Sysmex XE 2100 analyzer Sysmex Corporation, Japan). WBC is a contaminant which is responsible for Graft Versus Host Disease (GVHD) and Nnon-hemolytic febrile reactions (NHFR) mediated by contaminated PC transfusion.[7]

Platelet count per bag

The platelet count per bag was done multiplying platelet count/µl with product volume using a routinely calibrated automated hematology analyzer (Sysmex XE 2100 analyzer Sysmex Corporation, Japan). The platelet count is variable and is dependent upon methodologies used as PRP-PCs have a lower count as compared to BC-PC and single donor platelet (SDP) because the centrifugation during PRP preparation results in an average of 21% plasma and 19% of the platelets remaining restricted to the infra-natant RBCs.[8]

Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), Plateletcrit (PCT):

Platelet parameters such as MPV, PDW and PCT are important morphological indices which reflect storage-related activation changes over a period of days leading to the development of platelet storage lesion (PSL).[9] MPV is a measure of thrombocyte volume which is expressed in femtoliters (FL). The normal range is 7.2 to 11.7 fL.[2] PDW is an indicator of volume variability in platelets size which is expressed as percentage (%). The normal range is 8.3 to 56.6%.[2] PCT is an indicator of volume occupied by platelets in the blood which is expressed as percentage (%). The normal range is 0.22 to 0.24%.[2] These indices were analyzed using a routinely calibrated automated hematology analyzer (Sysmex XE 2100 analyzer Sysmex corporation, Japan).

Red Blood Cells (RBC) count per bag

RBC estimation was done using a routinely calibrated automated hematology analyzer (Sysmex XE 2100 analyzer Sysmex Corporation, Japan). Presence of RBC during PC preparation is considered as a contamination which can cause serious adverse reactions to the recipients. The permissible range of RBC count per bag is from traces to 0.5 mL.[2]

Flow cytometry estimation of CD62 expression

Platelet activation was measured by noting the level of CD62P expression on days 1, 3, and 5 by flow cytometer (Epics XL; Beckman Coulter).[10] During platelet activation and onset of PSL, P- selectine (CD62) stored in α-granules of resting platelets gets trans located from the intra-cellular compartment to the surface of the PCs.[1] This surface expression of CD62 acts as a biomarker of PSL.[3]The expression of CD62 on platelet surface indicates a fall in the quality of stored PCs.[2]

For each sample, disposable control and test tubes were taken into each tube, 10 µl of the diluted platelets were added, to yield a final platelet count of 500×10^3 per tube. To the control tube, 5 µl of the PE-conjugated isotypic antibody control and 5 µl of the FITC-conjugated isotypic antibody control were added (clone 679.1Mc7; Beckman Coulter) (IgG1 isotype).

To the test tube, 5 µl of CD62P — PE-conjugated antibody (clone CLB-Thromb/6; Beckman Coulter) (IgG1 isotype) and 5 µl of CD61 — FITC of conjugated antibody (clone SZ21; Beckman Coulter) (IgG1 isotype) were added (labeling with anti-CD61 was used for precise identification of platelets). This was followed by gentle mixing of the samples.

Dark room incubation was done at room temperature for 30 minutes followed by addition of 1 ml of PBS to each tube and mixed gently per each tube, a total of 10,000 platelet events were acquired on the flow cytometer. A gate was set on an intact platelet population defined by characteristic forward and side scatter. Out of the gated cells, the cells positive for CD61 and CD62P represent the activated platelets.

Statistical analysis

Statistical analysis of the data was done using the SPSS 16 software package under the Windows Vista operating system (SPSS Inc. Chicago, IL, USA). For comparing two independent samples, student *t* test was done and for comparison of paired samples a paired *t* test was done. *P* value was used to determine 'statistical significance' with a *P* value less than 0.05 being considered significant and a *P* value less than 0.01 being considered as highly significant.

Results

Table 1 shows comparison of platelet count, RBC count, WBC count, PDW, MPV of overnight PC versus fresh PC. The results of the comparison show that the above-mentioned parameters of the overnight PC are well within the acceptable limits.

There was no marked variation in the platelet count among the PCs produced from the fresh WB versus the overnight WB.

RBC contamination: In our study, no units had visible RBC contamination. The cause of RBC contamination could be multifactorial including (i) failure to tap the red cells from the tubing of the top end of the bags and (ii) contamination during hard spin centrifugation during PC preparation.[3] But some degree of RBC contamination will always be there even in the most refined PC preparations which can cause iso-immunization among the Rh Negative pregnant females. However, in a study conducted by Buetler and Kuhl found that low RBC and WBC count appears to have no effect on the glucose consumption lactate production, or fall in pH.[4]

Most blood banks including ours have a policy of using ABO incompatible PCs which can cause minor incompatibility-associated hemolytic transfusion reaction, particularly those from group O donors.[1] If compatible PCs are not available, the plasma should be removed by centrifugation and replaced by saline or albumin. Alternatively, isoagglutinin titers for group O PCs should be performed before transfusion, in suspected incompatible cases. In addition, PCs may be suspended in group AB plasma which do not have anti-AB isoagglutinins. This prevents immunoglobulin A (IgA) in donor plasma from causing anaphylactic reactions in the IgA-deficient recipients.[3]

PCs produced from the overnight holding period (24 hrs) have certain additional advantages which includes, (i) significant reduction in the level of platelet activation during collection preparation and storage of PCs and (ii) in addition, WBC present in WB can ingest the bacteria during the overnight storage period and consequently the risk of bacterial contamination of PCs will be reduced leading to better and safer clinical transfusion practices.[3] In addition, reduction in WBC in the PCs in overnight-held WB may decrease Cytomegalovirus risk transmission, HLA immunization and febrile reaction.[1]

Table 1: Comparison of platelet count, RBC count, WBC count, PDW, MPV of overnight PC versus fresh PC[2]

	Freshly prepared (*n* =50)		Overnight storage (n =50)		t test value	*P*
	Mean	SD	Mean	SD		
Platelet count						
Day 1	671.314	47.990	651.800	78.892	-15.92	0.386
Day 3	647.140	47.517	640.531	79.652	-15.61	0.542
Day 5	625.824	59.759	601.653	90.656	-12.40	0.685
RBC Count						
Day 1	0.016	0.006	0.011	0.004	3.916	0.001
Day 3	0.012	0.005	0.056	0.160	-0.922	0.366
Day 5	0.010	0.002	0.013	0.004	-0.368	0.717
WBC Count						
Day 1	0.018	0.010	0.030	0.009	3.925	<0.001
Day 3	0.020	0.011	0.028	0.040	1.385	0.169
Day 5	0.021	0.010	0.020	0.009	-1.539	0.127
PDW						
Day 1	9.840	2.010	10.012	1.754	-8.04	0.346
Day 3	8.001	2.201	09.439	13.186	-2.629	0.012
Day 5	7.858	2.239	06.678	1.833	-8.01	0.426
MPV						
Day 1	9.002	1.360	10.432	1.109	-8.399	0.152
Day 3	8.810	1.341	09.004	1.108	-8.704	0.523
Day 5	8.245	1.320	09.329	1.070	-8.22	0.356

MPV: MPV reflects onset of PSL; no significant variation was noted in the PCs prepared from overnight blood (24 hrs)

Table 2 shows Comparison of pH, pCO2, pO2, CHCO3- (p) of overnight PC versus fresh PC. The results of the comparison show that the above-mentioned parameters of the overnight PC are well within the acceptable limits.

All the PC's in our study had a pH of ≤6, thereby fulfilling the DGHS requirements.[2] pH estimation has been identified as being responsible for the highest co-relation with recovery and survival of PCs.[3] During anaerobic conditions, the stored PC's undergo glycolytic metabolism leading to production of lactic acid and consequent fall of pH.[3] Hence, the final pH of PC along with the *in vivo* recovery and survival of PC's will be defined based on the type of storage container and volume of plasma.[11] In our study, we have used 2nd-generation bags which allow free gaseous exchange and permit storage of PCs without comprising the DGHS standards.[2]

PCs should be stored in sufficient plasma having adequate bicarbonate content to act as a buffer to maintain greater than 6.2 as depletion on bicarbonate by lactic acid lowers the pH and adversely affects the PC viability.[3] In our study, the bicarbonate levels in all the PCs across both the categories were within the acceptable limits.

PCs are stored at room temperature 20-24^{0}C and are highly vulnerable to undergo bacterial contamination.

Table 2: Comparison of pH, pCO2, pO2, CHCO3- (p) of overnight PC versus fresh PC.[2]

	Freshly prepared		Overnight storage		*t* test	*P*
	Mean	SD	Mean	SD		
pH						
Day 1	7.38±0.05	0.248	7.29±0.04	0.280	0.131	0.896
Day 3	7.28±0.05	0.296	7.20±0.06	0.284	1.15	0.250
Day 5	7.22±0.02	0.286	7.12±0.04	0.904	0.153	0.881
*PCO2						
Day 1	96.520	27.703	81.230	14.728	2.55	0.012
Day 3	89.564	25.802	72.158	14.978	3.17	0.002
Day 5	80.967	24.302	65.870	16.010	2.70	0.008
*PO2						
Day 1	175.784	45.392	308.905	71.308	11.72	<0.001
Day 3	158.440	47.314	305.635	105.023	8.77	<0.001
Day 5	152.176	46.346	258.389	70.505	9.44	<0.001
***CHCO3 (P)**	**Freshly prepared**		**Overnight storage**		***t* test**	***P***
	Mean	**SD**	**Mean**	**SD**		
Day 1	13.638	1.799	15.425	1.770	2.19	0.03
Day 3	16.128	1.836	16.090	1.816	2.61	0.010
Day 5	15.376	2.016	14.538	1.934	2.93	0.004

The risk of bacterial contamination starts from asymptomatic bacteremia in donors to contamination during component preparation procedures. Molecular-based bacterial detection methods have high sensitivity and specificity which makes them appropriate for detection of bacteria in PCs.[3] We have used the FDA approved Bac/ALERT 3D (BioMerieux, USA) which is an automated colorimetric blood culture method. All the PC units studied were sterile.

The appearance of CD62P on the platelet membrane surface is a parameter that indicates a decrease in the quality of platelets during storage.

As for CD62P expression on day 1, the mean values in fresh PCs measured at days 1, 3, and 5 were 47.29 ± 4.74, 41.18 ± 5.58, and 40.87 ± 5.92%, respectively. The corresponding values for overnight PCs were 35.90 ± 11.84, 29.65 ± 10.15, and 30.53 ± 11.03%, respectively. The values of overnight PCs were significantly lower at all days ($P < 0.05$).

Comparison of CD62P expression during the storage period in fresh PCs showed a significant increase during storage ($P < 0.001$). Although in overnight PCs, the increase in CD62P expression from days 1 to 3 was not statistically significant ($P > 0.05$), it gained significance from days 3 to 5 and consequently from days 1 to 5 ($P < 0.05$).

The findings of our study which indicate lower levels of platelet activation in the PCs obtained from overnight stored blood show reduced levels of platelet activation during the entire storage period including the extended period of 7 days; similar findings were also reported by El-Danasoury *et al.*,[12] Thomas *et al.*[13] and Dijkstra Tiekstra *et al.*[14]

Comparison of CD62P expression during storage in fresh PCs showed a significant increase during storage ($P < 0.001$). Although in overnight PCs the increase in CD62P expression from days 1 to 3 was not statistically significant ($P > 0.05$), it gained significance from days 3 to 5 ($P < 0.05$) [Tables 3 and 4].

To identify the day on which changes become significant for PCs in each group, we compared values at consecutive time points. In the PCs obtained from fresh WB, the difference was significant between days 1 and 3 and between days 3 and 5, whereas the values of overnight PCs were significantly raised only on comparing day 5 with day 3.

These results indicate that in fresh PCs, CD62P expression increases significantly throughout the entire storage period, whereas in overnight PCs, the increase in CD62P expression becomes significant only after day 3,

meaning more stable and less activated platelets in the first 3 days of storage, during which they will mostly be used. The late increase in CD62P expression on day 5 is of relatively less significance. [Tables 3 and 4].

As highlighted in Table 1, platelet count from the freshly prepared WB was comparable to the platelet count in the overnight stored blood sample across days 1 to 5 and this difference was not statistically significant. Similar findings were also noted by Singh *et al.*[3] and Shrivastava. M[15]

The presence of RBCs is not statistically significant across days 1 to 5 among the freshly prepared PC from WB versus the overnight stored PC. Similar findings were also noted by Devine *et al.*[16]

Similar to the findings of Hughes *et al.,*[17] no statistically significant difference was noted between overnight stored platelet preparation and with regard to morphological parameters such as PDW and MPV across days 1 to 5.

Metabolic quality parameters such as pH, pCO2, pO2 and HCO3- from freshly prepared WB PC preparation versus overnight stored blood PC preparation were evaluated and displayed in Table 2. However, no significant differences were noted in both the categories. This finding is comparable to those done by Hess JR *et al.*[18]

The mean pH values in fresh PCs measured at days 1, 3, and 5 were 7.38 ± 0.05, 7.28 ± 0.05 and 7.22 ± 0.02, respectively. The corresponding values in overnight PCs were 7.29 ± 0.04, 7.20 ± 0.06 and 7.12 ± 0.04, respectively. Comparison of these values showed that they were significantly lower for overnight PCs on all days ($P < 0.001$). However, the pH in overnight PCs remained between the required range of 6.4 and 7.4. Our pH results are in agreement with studies done by Sandgren *et al.*[9,19]

Table 3: Comparison of CD62P and pH in fresh PC

Parameter	*P*
CD62P	
Day 1 vs. day 3	0.451
Day 3 vs. day 5	<0.001
Day 1 vs. day 5	<0.001
pH	
Day 1 vs. day 3	<0.001
Day 3 vs. day 5	<0.001
Day 1 vs. day 5	<0.001

Significant ($P < 0.05$); Highly significant (<0.01)

Table 4: Comparison of CD62P and pH in Overnight PC

Parameter	*P*
CD62P	
Day 1 vs. day 3	0.026
Day 3 vs. day 5	<0.001
Day 1 vs. day 5	<0.001
pH	
Day 1 vs. day 3	<0.001
Day 3 vs. day 5	<0.001
Day 1 vs. day 5	<0.001

Significant ($P < 0.05$); Highly significant (<0.01

The pH measurement is of great importance because pH has been correlated with in-vivo platelet recovery.[2] During the entire storage period, PCs prepared in both the categories fulfilled the quality requirements of the (American Association of Blood Banks) AABB[20] Council of Europe[21] and DGHS guidelines.[2]

None of the PC samples prepared from both fresh WB (8 hrs) and overnight blood (24 hrs) showed any evidence of bacterial contamination. This could be due to a) proper aseptic techniques followed during donor phlebotomy and b) white blood cells (WBCs) in the WB can ingest bacteria during the overnight storage period (24 hrs), and subsequently, the risk of bacterial contamination is markedly reduced under ambient temperature. The same conclusion has been substantiated by Sanz C *et al.*[22] in their study as well.

Discussion

The various biological morphological and functional changes associated with blood storage have been well documented and are collectively termed as 'storage lesion'. The storage lesion has implications for the RBCs and it is called as RBCs storage lesion, and similarly for the human PCs, the development is called as PSL.[13]

PSL represents the total structural, functional and biochemical alteration that occurs in PCs during storage period and often associated with reduced *in vivo* platelet recovery, survival and functional activities.[23]

However, recent review of literature showed limited information regarding this serial biochemical and morphological change associated with the 'Holding period' before the WB is taken up for further processing. Holding period is defined as the time period during the various processing steps that precede storage. Unfortunately, no consensus exists regarding exactly what constitutes an optimum holding period. The holding period is extremely variable across different countries and regions and is also variable within the countries. As of now no standardized holding period for blood and blood components exist which can be uniformly applicable.[24]

Hence, we undertook the study to evaluate the various morphological and biochemical changes associated with overnight storage for an extended period of 5 days and the associated quality implications particularly with regard to the onset of PSL.

The exact PC preparation methodology is dependent on multiple factors and is primarily based on availability of financial resources, technical capabilities, quality parameters and clinical demands. Hence, currently different preparation methods with variable holding periods exist.[25]

Voluntary Blood Donation (VBD) camps conducted by various organizations form the main source of blood collection for the blood banks with proper emphasis on eligible donor selection, recruitment and retention, so that all the eligible donors are encouraged to donate with an altruistic view.[1]

In the recent days, as the emphasis on VBD camps has increased, more and more blood donation drives are being held at multiple locations which are situated at a relatively longer distance from the main blood bank, and as a consequence, proper storage and transportation of blood under ambient temperature have become more crucial. Hence, the concept of 'Holding period' of several hours before the WB was processed into various components became very relevant and important in modern day blood bank management.[2]

Identical to the studies conducted by El-Danasoury *et al.*[12] and Dijkstra -Tiekstra *et al.*,[14] our study also concluded that overnight storage of WB at room temperature before preparing PCs did not adversely affect the quality of the PCs produced.

Overnight hold of WB has numerous advantages particularly with regard to routine operational flexibilities and logistics.[26]

Overnight hold of WB allows sufficient time to transfer blood units under ambient temperature from the VBD camps to the blood center. Fewer transportation arrangements needs to be undertaken between the VBD camps and blood banks, thereby helping in making substantial savings in logistics with regard to manpower and transportation cost. In addition, working during office hours is not only more beneficial but less prone to error as compared to the night shifts, as night shifts are often associated with an increase in error rates when performing tasks and reduced efficiency.[27]

Conclusion

This study highlights the fact that all the necessary quality parameters of PC are broadly maintained in the samples prepared from the overnight held blood (24 hours). The preserved quality of overnight PCs along with associated logistic benefits should encourage blood bank management to seriously explore the feasibility of undertaking the 24-hours whole blood hold (overnight) before preparing PCs. However, more such studies on a much larger scale need to be undertaken to further validate the results and attain a final conclusion.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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