

Value stream mapping and analysis of the quality parameters from the control units processed using a semi-automated, buffy coat method, in a Colombian blood bank center

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Introduction

The assessment of product quality parameters and operational procedures among healthcare and blood bank centers has increased in recent years. Understanding the insights and differences among medical devices and procedures to optimize the outcomes is needed.^{[1][2][3][4]}

Objectives

The aim of this study is to perform in Colsanitas Blood Bank Center (BBC), located in Bogotá, Colombia, a value stream mapping on the semi-automated (buffy coat method), blood processing system to better understand the multiple manual steps that operators are required to perform as well as the timings from each one of them.

In addition, this study aims to analyze and review multiple product quality parameters from the control units processed using the semi-automated system.

Methods

We performed in Colsanitas BBC a value stream mapping of its semi-automated, blood processing system for 3 days. The same healthcare professional operated the system throughout the selected timeframe. The mapping included the listing and timing of all operator manual steps, as well as the assessment of productivity and management bottlenecks, and the feasibility of Colsanitas BBC to increase the quantity of processing cycles using the current semi-automated, blood processing system.

The technologies used were the separator CompoMat® 5G (Fresenius Kabi) and the centrifuge Roto Silenta 630 RS (Hettich Lab Technology), as well as other minor equipment such as the sealer Hematron (Baxter).

In addition, we performed a retrospective analysis of 12 product quality parameters from the control units processed in BBC between 1st January 2018 and 31st December 2021. The same semi-automated, blood processing system and medical technologies were used throughout the timeframe.

Visual charts were developed to portray the outcomes.

Results

Between 2018 to 2021, quality parameters from 717 control units from Colsanitas BBC, processed with the semi-automated, buffy coat method, were analyzed.

As shown in Table 1, the averages from whole blood units' parameters were: volume (464±6,7ml); hematocrit (45,5±5%); leukocytes (3,4±1,5×10⁹/L); platelets (128,7±27,4×10⁹/L).

The averages from red cell concentrates' parameters were: volume (278,2±25,1ml); hematocrit (56,3±6,7%); leukocytes (0,33±0,25×10⁹/L); platelets (1,34±2,13×10⁹/L).

The average volume from plasma units was 197,2±20,9ml.

The averages from platelet units' parameters were: volume (61±4,9ml); leukocytes (0,023±0,05×10⁹/L); platelets (76,5±21,7×10⁹/L).

From the value stream mapping, 57 operator manual interventions were registered and timed. Table 2 shows all the interventions as well as the time required for each one of them.

Productivity bottlenecks were found related to room space, daily delivery schedule of whole blood units, quantity of manual interventions and required operators, operator training and experience, and type of whole blood processing system.

Conclusions

Quality parameters from control units processed in Colsanitas BBC have maintained similar levels from 2018 to 2021 and comply with Colombian national guidelines on whole blood products. However, other whole blood processing systems could optimize the standardization process decreasing the standard deviation and increasing the quantity for selected parameters such as Hematocrit, volume, platelets, etc.

On another hand, the current semi-automated, blood processing system requires the operator to perform multiple manual interventions that can lead to errors, limits productivity and scalability, and has several bottlenecks, from processing time to operator's training and experience. Therefore, it would be appropriate to consider the implementation of a more automatized processing method that can decrease operator manual steps, optimize productivity workflow, and decrease time bottlenecks and operator variability.

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Product	Parameters	Semi-automated processing system	
		Average	Standard Deviation
Whole Blood unit			
	Volume (mL)	463,98	6,74
	Hematocrit (%)	45,48	5,03
	Leukocytes (count/U)	3,40E+09	1,49E+09
	Platelet (count/U)	1,29E+11	2,74E+10
Red Cell Concentrate			
	Volume (mL)	278,15	25,06
	Hematocrit (%)	56,33	6,66
	Leukocytes (count/U)	3,31E+08	2,50E+08
	Platelet (count/U)	1,34E+09	2,13E+09
Plasma concentrate			
	Volume (mL)	197,23	20,89
Platelet unit			
	Volume (mL)	60,96	4,94
	Leukocytes (count/U)	2,32E+07	4,98E+07
	Platelet (count/U)	7,65E+10	2,17E+10
	pH	7,90	0,30

Table 1. Parameters' average and standard deviation from each product control unit processed using a semi-automated, buffy coat method during 1st January 2018 to 31st December 2021.

Manual operator steps	Colsanitas BBC		
	Blood units	Minutes	Seconds
Measure the temperature from the bags and/or box	1	0	3
Write down the temperature measurement	1	0	2
Check that donor questionnaires match the whole blood bags delivered and that they are correctly filled	1	0	5
Place and prepare the whole blood bags on the processing table	1	0	18
Open the excel file to fill it with the data from the blood bags	NA	0	10
Scan the whole blood bags	1	0	2
Weigh the whole blood bags	1	0	5
Write down the weigh on the same blood bags	1	0	3
Balance the weigh among the whole blood bags	2	0	30
Agitate the whole blood bags	1	0	45
Switch on the centrifuge (Roto Silenta 630 RS from Hettich Lab Tech)	NA	0	15
Click start to preheat the centrifuge	NA	0	1
Centrifuge preheating process*	NA	15	0
Place the whole blood bags in the centrifuge baskets	1	0	10
Close the centrifuge cover	NA	0	1
Select the centrifuge protocol	NA	0	5
Click start for the centrifugation process	NA	0	1
Centrifugation process* (up to 4000RPM)	NA	11	0
Centrifuge deceleration process*	NA	12	0
Switch on the separator (Compomat 5G from Fresenius)	NA	0	20
Calibrate the separator (once a day)	NA	2	0
Open the centrifuge cover after the centrifugation is over	NA	0	1
Place the blood bags into the separator	1	0	40
Scan the blood bag, the separator, and the operator tag	1	0	3
Select the separator protocol	1	0	6
Click start for the separator process	1	0	1
Separation process*	1	4	0
Extract the fractionated bags from the separator	1	0	10
Place the plasma on the processing table	1	0	5
Place the red cell concentrates (RCC) on the processing table	1	0	5
Hang the buffy coat	1	0	10
The buffy coat remains hanged during 3 hours*	1	180	0
Perform a stripper to the plasma unit (stripper once)	1	0	20
Perform a stripper to the RCC (standard: 5 times; for control units: 10 times)	1	1	15
Seal the RCC tubes with Hematron from Baxter to have control pilots	1	0	35
Place the two tubes from the RCC at each side of the bag for a proper storage	1	0	20
Remove the buffy coat from the hanger	1	0	5
Agitate the buffy coat	1	0	30
Place the buffy coat into the centrifuge baskets	1	0	10
Weigh the centrifuge baskets	2	0	5
Balance the weigh among centrifuge baskets	2	0	25
Place the centrifuge baskets into the centrifuge	2	0	20
Close the centrifuge cover	NA	0	1
Select the centrifuge protocol	NA	0	5
Click start for the centrifugation process	NA	0	1
Centrifugation process* (up to 900RPM)	NA	9	0
Centrifuge deceleration process*	NA	7	35
Open the centrifuge cover after the centrifugation is over	NA	0	1
Place the buffy coat into the separator	1	0	40
Scan the blood bag, the separator, and the operator tag	1	0	3
Select the separator protocol	1	0	6
Click start for the separator process	1	0	1
Separation process to get platelets (part 1: buffy coat separation)*	1	0	55
The separator stops and the operator needs to manually extract the air bubbles from the platelet bag	1	1	0
Click continue for the separator process	1	0	1
Separation process to get platelets (part 2: weigh the platelet bag and seal it)*	1	0	55
Extract the buffy coat and discard it	1	0	10
Extract the fractionated platelet bags from the separator and place them on the balance	1	0	12
Weigh the platelet bags at the balance	1	0	5
Write down the weigh	1	0	3
Seal the tubes to have control pilots	1	0	20
Inspectionate the platelet bag for air bubbles	1	0	10
If air bubbles are found, manually push the air bubbles into the end of the tube	1	0	40
Seal the end of the tube where the bubbles were pushed	1	0	10
Place the platelet bag on a shelf	1	0	10
The platelet bag remains on a shelf during 2 hours*	1	120	0
Place the platelet bag into the platelet shaker	1	1	0
The platelet bag remains on the platelet shaker during 24 hours*	1	1440	0
Total manual steps		57	

Table 2. Value stream mapping of all operator manual interventions for the semi-automated, blood processing system. *Step where the operator needs to wait until the process is completed.