

Whole Blood Processing systems: An Analysis On The Differences Between Automated Blood Processing System (ABPS) And The Bottom-To-Top (BAT) Semiautomated Processing System

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Introduction

In recent years, a global trend to automatize medical procedures to increase efficiency and deliver the highest quality standards has been implemented. In Blood component preparation laboratories, automation might ease the multiple and repetitive steps performed manually or semi-automatically and can increase the blood bank operational and production efficiency and consistency of the components.^{[1][2]}

Whole Blood (WB) products can be processed and separated into components by semiautomatic processing systems, which can be either a top-to-top (TAT) method or a bottom-to-top (BAT) method (also known as buffy coat method), or by a fully automated blood processing system (ABPS).^{[3][4]}

In Europe, for semiautomatic processing systems, the BAT method is the prevalent one due to its technical features as well as the fact that it produces from a WB product a Red Cell Concentrate (RCC), a unit of plasma and a buffy coat platelet concentrate, in contrast with the TAT method that only produces a RCC, and a unit of plasma called Platelet-Rich Plasma.^[4]

Related to fully automated processing systems, the only one currently in the market is the Reveos® Automated Blood Processing System, manufactured by Terumo Blood and Cell Technologies.^[5]

Objectives

The aim of this study is to review and summarize the existing literature related to the ABPS and BAT to understand and compare the technical and operational features from both WB processing systems and position the most appropriate one for the specific requirements of Blood Bank Centers.

Methods

We performed a Literature Review through the PubMed Database, the ISPOR Publication Database, the International Society of Blood Transfusion Database, the Transfusion Database and using the Embase® search engine. We have also assessed the Reveos® Automated Blood Processing System Operator's Manual, version 1.1, and the Terumo Blood and Cell Technologies data on files, as well as performing a process timing measurement of the ABPS in a Spanish blood bank regional center.

Results

From a productivity perspective, ABPS can process up to 4 WB units in one cycle that lasts 25 minutes and requires only one operator.^{[2][6]} For an operator that works 7.5 hours per day and 250 days a year, he/she could process up to 18.000 WB units per year with only one ABPS. Moreover, if the blood center has higher WB processing requirements, one single operator can handle 4 ABPS and, thus, process up to 288 WB units per day, and 72.000 WB units per year.^[7]

Due to the automation of the process, from the 25 minutes that ABPS requires to process 4 WB units, only 4 minutes are used by the operator to load and unload the device with the 4 WB units. The remaining 21 minutes are used by the ABPS for balancing, centrifuging, expressing, and sealing the 4 WB units automatically.^{[7][8]} In **Figure 1**, the different parameters are being portrayed and compared between both systems.

The BAT system can also process up to 4 WB units in one cycle with one operator. It requires 10 minutes for balancing, 14 minutes for centrifuging, and 5 minutes for sealing. For each step, an operator must take the 4 WB units and move/transfer them, amounting around 6 minutes. The average total time is 34 minutes, 10 more minutes compared with ABPS. Furthermore, these operator-dependent steps are opened for potential human mistakes such as handling errors. In a year, the blood center could only process up to 13.235 WB units with a single BAT production line.^[2]

Looking at the WB processing line, ABPS requires the operator to perform only 9 interventions to produce 4 units. On the other side, the BAT system requires the operator to perform at least 26 interventions. This is due to the automation that ABPS provides to the blood bank center. The numbers circled in red from **Figure 2** portray the different interventions performed automatically using the ABPS.

ABPS' technical features, such as the user-friendly LCD screen that shows in real-time the current step being performed and states the next steps to be taken, as well as lower operator interventions, have an impact on the required operator training time, being only up to 16 hours. Moreover, ABPS requires only one device that takes 1,13m² room space and 1 standard operation procedure (SOP).^[7]

On the other side, the BAT system requires a longer operator training time that can last from some days to several weeks. Each one of the different devices from the BAT system (balancing device, centrifuge device, sealing device, component extractor/separator device) require appropriate training. Furthermore, considering that there are several brands and models for each one of these devices, one blood center might use different ones. Compared with ABPS, the BAT system requires a higher quantity of SOPs, more room space and at least 4 different devices to produce WB products.^[9]

Parameters	ABPS	BAT
Operators required to process 4 WB units	1	1
Time to process 4 WB units (min)	25	34
Operator time to handle the production of 4 units (min)	4	6
Time used for balancing 4 WB units (min)		10
Time used for centrifuging 4 WB units (min)	21	14
Time used for sealing 4 WB units (min)		5
Quantity of WB units processed by 1 operator annually using 1 production line*	18.000	13.235
Manual operator interventions to produce 4 units	9	26
Number of devices required to produce WB products	1	4
SOPs required**	+	+++
Room space required**	+	++++
Operator training time**	+	+++++

*Operator working hours/day: 7.5h; Operator working days/year: 250 days
**The higher the quantity of +, the higher the number

Figure 1. Parameters assessed for ABPS and BAT system.

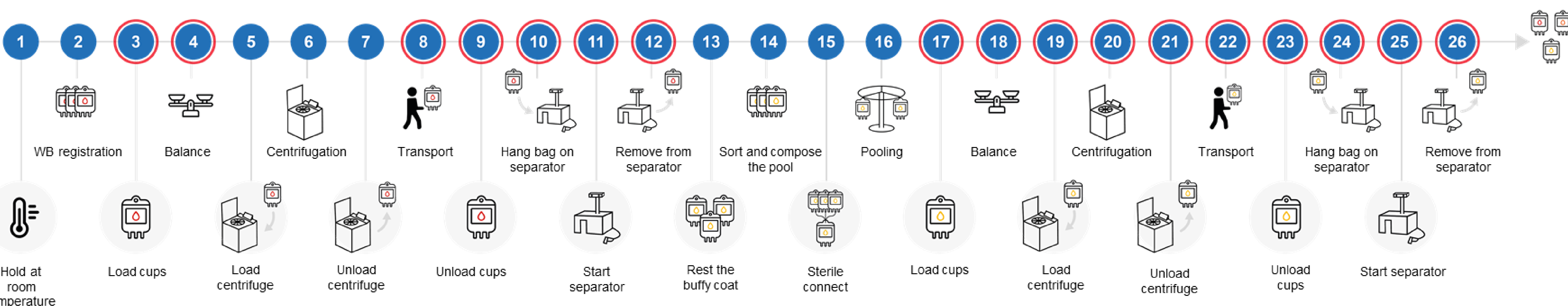


Figure 2. Whole Blood Processing for ABPS (only the numbers without red circles) and for BAT system (all the numbers: 1 to 26).

References

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Conclusions

ABPS provides a less human-dependent, less time consuming, more efficient and standardized option for WB processing versus the BAT system.

The BAT system is more operator dependent. Each step that requires human interaction is prone to human errors. These could impact the end product, decreasing its quality or forcing the operator to discard it.

Operational efficiencies are inclined to be found using ABPS for blood bank centers, both from an operator management side and from an infrastructure and installation utilization.