INFUSION PUMPS FOR BLOOD AND BLOOD PRODUCTS TRANSFUSIONS AND ADMINISTRATION

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INTRODUCTION

Over the years, individual health authorities have been performing different clinical practices regarding blood and blood products transfusions and administration, which can be confusing for both patients and clinicians who receive and provide the treatment, respectively, at different healthcare sites. Some clinicians use gravity sets, while others have adopted to using volumetric infusion pumps. For those clinical areas using gravity sets, this question was raised: "Why can we not administer blood or blood products with infusion pumps?" The main concern was whether there were any contraindications to using infusion pumps for blood and blood products transfusions. This paper tries to address this concern by reviewing the technical limitations and identifying whether there are in fact any contraindications.

LITERATURE REVIEW

In some hospitals, the delivery of blood and blood products (i.e., immunoglobulin, red blood cells, platelets, or plasma) via infusion pumps is common practice[1-2]. Specialized administration sets are supplied by infusion pump manufacturers to enable clinicians to administer blood and blood products using infusion pumps, which facilitate accurate and timely transfusions. However, a common concern is whether the infusion pump mechanism contributes to red blood cell (RBC) hemolysis.

A review of the existing articles related to blood and blood products transfusions and administration showed that particular infusion pump models are acceptable for blood and platelets administration[2-5], that a volumetric pump is the most suitable mechanism for blood administration[6], and that there is a clinical preference to using infusion pumps for blood transfusions over gravity sets[1].

RBC hemolysis occurs when RBCs are damaged and its occurrence can be observed through increased levels of hemoglobin or potassium[2]. Several studies showed that little RBC hemolysis occurred when infusion pumps were used for blood administration[2-5]. Furthermore, infusion pumps were also found to be acceptable for platelet transfusions[7]. Factors that can affect RBC hemolysis and that should be considered during blood transfusions using infusion pumps include type and age of the blood, blood storage conditions and handling, infusion pump type, and infusion rate. Frey et al. found that compared to the syringe and peristaltic pumps, the volumetric pump is the least destructive to RBCs[6].

Although gravity sets were once the standard for blood and blood products administration, infusion pumps are now widely used in healthcare[1-2], are a worthy alternative to gravity sets, and are preferred by nurses administering the treatment, according to Houck and Whiteford[1].

STANDARDS & GUIDELINES

Advisory and regulatory bodies, such as the Canadian Standards Association (CSA), Canadian Society of Transfusion Medicine (CSTM), Canadian Blood Services, Provincial Blood Coordinating Office, and ECRI Institute, were consulted for standards, guidelines and recommendations regarding the use of infusion pumps for blood and blood products administration..

Both the CSA and CSTM, which regulate blood transfusion practice in Canada, recommend that the facility have operating policies and procedures regarding installation, performance testing, calibration, maintenance

and documentation for the use of infusion pumps for administering blood and blood products[8,9]. Maintenance schedules were said to be based on manufacturer recommendations.

The Canadian Blood Services[10], Provincial Blood Coordinating Office, and ECRI Institute also reccomended following manufacturer reccomendations as to whether a particular infusion pump is intended to be used in administering blood and blood products.

MANUFACTURER RECOMMENDATIONS

According to the CSA and CSTM, all infusion pumps used for blood and blood products transfusions should be intended for that purpose as indicated by the manufacturer[8,9]. The pumps should also be properly used and maintained in accordance with the manufacturer instructions. For that reason, the manufacturers of the most numerous infusion pump models at Vancouver Coastal Health (VCH) and Providence Health Care (PHC) were contacted and asked which particular models were intended for use with blood and blood products. The manufacturers contacted were B. Braun, Baxter Healthcare, Cardinal Health, Hospira, and Smiths Medical.

The manufacturers were asked whether any research was done on using the infusion pump model with blood and blood products, what testing procedures were used, and whether there were any contraindications. Other information gathered include whether special administration sets were required, the recommended preventive maintenance (PM) schedules for each model, and whether there was additional testing or calibration that was done for the pumps that would be used with blood and blood products.

APPROVED INFUSION PUMPS

All infusion pumps that were currently being used at VCH and PHC were considered for blood and blood products administration. After consulting with the manufacturers of the respective pumps, the infusion pump models approved for blood and blood products transfusions are summarized in Table 1.

Table 1: Infusion pump models approved for blood and blood products transfusions and administration at VCH and PHC.

Manufacturer	Approved Infusion Pump Models
B. Braun	PERFUSOR SPACE
Baxter Healthcare	2M8151 2M9161 2M9163 FLOGARD 6201 FLOGARD 6301
Cardinal Health	Alaris 7100 Alaris 7130 Alaris 7130B Alaris 7131 Alaris 7200 Alaris 7230 Alaris 7230E
Hospira	Omniflow 4000 Omniflow 4000Plus
Smiths Medical	Medfusion 3500

PREVENTIVE MAINTENANCE

The Canadian Standards Association (CSA) and Canadian Society for Transfusion Medicine (CSTM) standards indicate that the preventive maintenance (PM) schedule should be followed according to manufacturer recommendations, and the recommended PM schedule was 12 months.

The biomedical engineering departments of VCH and PHC had established PM schedules for infusion pumps based on the staff's years of experience with the pumps. Although the PM schedules were being met, the established PM frequencies did not consider the infusion pump's application with blood or blood products. To meet the annual PM frequency indicated by manufacturers, it would be necessary for the biomedical engineering departments to consider this added application when considering a possible revision of the existing PM schedules.

COST ANALYSIS

There would be an increase in costs associated with the implementation of using

infusion pumps for blood and blood products transfusions and administration. The main reason is the different administration sets used. The following cost analysis considers the switch from using gravity sets to infusion pumps for blood administration, which would be the most common case if an institution were to start using infusing pumps for this purpose.

Cardinal Health was contacted and indicated that the most common tubings used with infusion pumps intended for blood administration were the AL72980E, AL10015415 and AL79980, which have unit prices of approximately $22.90, $22.83 and $24.62, respectively. *Note: The blood administration set prices were provided by Cardinal Health and are list prices only. They do not take into consideration possible discounts that could be applicable.*

The cost of the current gravity sets used for blood transfusions at VCH is $3.86 for the Baxter JC7790, and $7.94 for the Y-set JC7751, which is used in critical care areas. The Codan C98C443 set used for intravenous immunoglobulin (IVIG) and albumin infusions is approximately $2.50 each.

The average increase in cost was approximately estimated at $18.68 for each transfusion performed. The overall increase expenditure would ultimately depend on the number of blood transfusions performed.

Although not discussed in this report, it is important to mention other real costs that should also be considered:

- Indirect costs associated with increasing PM frequencies for the infusion pumps selected for blood-related transfusions so that CSA and CSTM standards are met.
- Time costs associated with added labour time needed in setting up, monitoring and maintaining the infusion pumps.
- Capital costs associated with purchasing additional infusion pumps should the current quantity of infusion pumps be insufficient to accommodate the use of infusion pumps for blood administration while continuing to meet its existing demands.

These costs, and possibly others, would need to be considered and researched in greater detail should a healthcare facility decide to implement the use of infusion pumps for blood and blood products transfusions. For example, looking at the current PM schedules and labour costs at VCH and PHC, the added biomedical engineering labour cost for the PM of infusion pumps ranges from $63 to $102 per pump, per PM service.

OTHER CONSIDERATIONS & CONCLUDING REMARKS

A few studies regarding the use of infusion pumps for blood and blood products transfusions and administration have been published. The general recommendation was that each infusion pump intended for the transfusion and administration of blood and blood products be individually assessed when evaluating its safety. The pump was proven to cause minimal damage to red blood cells (RBCs), and the convenience, improvement of flow rate, and added control afforded by infusion pumps make them an attractive alternative to gravity sets[1].

If infusion pumps are to be used for blood transfusions, the CSA and CSTM standards should be considered. According to the CSA and CSTM, the following items should be established[9-10]:

- Operating procedures, policies and processes shall be established for the proper use and control of the infusion pumps.
- The infusion pump shall be approved for its intended use.
- The preventive maintenance (PM) schedule shall be followed according to manufacturer recommendations.

After consulting with the major infusion pump manufacturers, a list of approved pumps included the Alaris SE pumps (models 7100, 7200, 7130, and 7230), which are the most common pump models at VCH and PHC

Infusion pump manufacturers were also consulted for the recommended PM schedule, which was 12 months for all approved infusion pumps. The biomedical engineering departments had set PM schedules for the existing infusion pumps based on experience with the pumps and did not consider the use of

the pumps with blood and blood products. In order to comply with the CSA and CSTM standards, the PM schedules for the infusion pumps would have to be revised.

An increase in costs is associated with implementing infusion pumps for blood and blood products use due to the different administration sets required for this purpose. The average increase in cost per transfusion would be approximately $18.68. The overall expenditure increase would ultimately depend on the number of blood and blood products transfusions performed, along with other indirect, time, labour, and capital cost considerations, which were not discussed here.

If additional tests for RBC hemolysis are to be performed, they should be done on a small series of outdated blood components under conditions anticipated in a clinical setting.

Overall, the biomedical engineering departments at VCH and PHC found no contraindications to the use of the approved infusion pumps for blood and blood products transfusions and administration. Should clinical areas decide to pursue the use of infusion pumps for blood related administration, the biomedical engineering department of the respective health authority should be able to assist the switch from gravity sets to infusion pumps for this purpose.

It is important to mention that infusion pumps do not completely automate transfusion and are not intended to replace the nurse or other clinical practicing professionals in monitoring the process and the patient.

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