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Reducing delivery times of emergency blood products through pneumatic tube systems

Jian Hao Jaryl Kok, Choong Weng Leslie Lam, Mee Yin Joanne Lee

Abstract:

OBJECTIVES: Recent advances in damage control resuscitation have advocated a push for early transfusion to maintain circulating volume and minimization of crystalloid use. While measures such as using rapid-matched group specific blood or uncrossmatched blood have been implemented to shorten this wait, delivery times can still be improved. We explored reducing delivery times by use of a pneumatic tube delivery system already built in our hospital. Few studies have evaluated this using fresh blood samples for one-way transport. We modified and evaluated our pneumatic tube delivery system for delivery timings and quality parameters; designing a robust protocol that also tested aged blood for simulated returns unlike other previous studies.

METHODS: Delivery timings of emergency blood products by our present portering system were collected and compared against that of products sent through the pneumatic tube system (PTS). The samples sent through the PTS were also tested and analyzed for temperature, quality, and hemolysis in accordance with established blood banking quality guidelines.

RESULTS: Blood products delivered by our PTS showed satisfactory conformance with all parameters of temperature, timing, and hemolysis. We showed a significant reduction in transport delivery times from mean of 8 min 43 s to 2 min 23 s.

CONCLUSIONS: Delivery of blood products by our modified PTS is safe and significantly reduces delivery time. This time savings could be clinically significant in resuscitation. Usage of the PTS could also cut down on workforce utilization of porters, freeing them up for other tasks in the hospital.

Keywords:

Blood transfusion, damage control resuscitation, delivery times, hemolysis, massive transfusion protocol, pneumatic tube systems

Introduction

Infusions of blood products are a crucial component of resuscitation for patients with hemorrhagic shock. Recent advances in damage control resuscitation advocate early transfusion and minimization of crystalloid use^[1] in maintaining circulating volume. Early transfusion reduces acidosis, coagulopathy, and inflammatory cycles associated with crystalloid resuscitation.^[2] Measures aimed at reducing time to blood transfusion, such

as the use of uncrossmatched blood or rapid-matched group specific blood, have been implemented. However, significant delays are still encountered. A recent prospective observational study of 22 hospitals in the United Kingdom showed an average time to transfusion of packed red blood cells (pRBCs) of 41 min.^[3]

Blood products in our hospital are currently transported from the blood transfusion services (BTS) in insulated cooler boxes to the requesting locations manually by porters. Valuable workforce is taken away from the resuscitation team when staff have to arrange porters for transport. The

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Department of Laboratory
Medicine, Ng Teng
Fong General Hospital,
Singapore

Address for correspondence:

Dr. Jian Hao Jaryl Kok,
Department of
Laboratory Medicine,
1 Jurong East Street 21,
Singapore 609606.
E-mail: jarykok@gmail.
com

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BTS also often found that porters had yet to arrive for collection when the urgent products were ready for dispatch, leading to unnecessary delays. Delivery by porters is affected by availability of portering services workforce, walking speeds of the assigned porters, elevator waiting time, and congestion of walkways.

As our hospital already had a pneumatic tube system (PTS) in place connecting the BTS with the critical care areas (namely, the emergency department [ED], intensive care units [ICUs], and operating theaters [OT]), we explored utilization of the PTS for delivery of blood products. If proven safe for implementation, such utilization could translate to reduced delivery times and workforce savings.

Several studies have evaluated PTS transport of pRBCs. Except for one study by Hellkamp *et al.*,^[4] all other published studies used fresh pRBC units of short duration from the time of collection.^[5,6] Returns of blood products through the PTS were also not evaluated in these one-way delivery evaluation studies. While most blood products activated for emergencies are transfused, there are occasional instances, such as patient demise or recognition of clinical futility where withdrawal of resuscitation efforts result in cancellation of planned transfusions and return of blood products.

We performed a feasibility study (Phase I) to evaluate our PTS for delivery of blood products to critical care locations within our hospital. Thawed Frozen Plasma (FFP) units and pRBC units that were near to expiry were used for our study. Our study design also included simulated return of products through the PTS, a 24 h quarantine and physical inspection after, followed by a second repeat issue the next day. We aimed to establish the safety and possible time savings of our PTS for transport of blood products. We also assessed repeat dispatch of units previously sent and returned. We believe this to be a more comprehensive assessment of PTS delivery of blood products than previous evaluations.

Methods

Establishing standards

No guidelines/standards on validation of PTS for transport of blood products were available locally in Singapore. The AABB (formerly known as American Association of Blood Banks) has a set of published guidelines,^[7] which offers guidance, recommending an evaluation framework broken into three phases. Phase I testing is focused on technical feasibility of the actual PTS in accurately and precisely delivering blood products to the desired location within transport temperature and time requirements. Phase II testing evaluates

the actual clinical workflow, activation and dispatch protocols, and performance in actual clinical use. Phase III evaluation is then conducted as a longitudinal audit post-implementation. We decided to adopt these Phase I guidelines as our validation standards. While these guidelines address physical integrity and temperature quality parameters, there were no recommendations on FFP coagulation factors or pRBC hemolysis. Transport through PTS has been shown to not have a significant impact on FFP.^[5,8] This is not surprising as FFP is acellular and mechanical forces within a PTS transport system should not have significant impact on a protein-plasma suspension. However, the same is not true for cellular pRBC units, and some trials have demonstrated significant change from red cell hemolysis after PTS transport.^[9] The United States Food and Drug Administration (FDA)^[10] and the European Committee on Blood Transfusion^[11] have guidelines on acceptable levels of hemolysis of pRBC units at the end of storage. We adopted these guidelines as surrogate cutoffs for acceptable levels of hemolysis post-PTS transport since that reflects the end-point before transfusion to patients. Several published articles evaluating hemolysis after the PTS transport of pRBCs have also adopted these as limits for allowable hemolysis in their studies.^[5,6]

The following points list the assessment criteria we set:

- Time: Transit time shall not exceed 10 min^[7] from launch to receipt
- Temperature: Shall not exceed 10°C^[7] upon receipt at the receiving location
- Temperature indicators: Shall remain within the range of >1°C but ≤10°C^[7] during transport to the desired location and back to BTS through the PTS
- Integrity of components: Products shall arrive in satisfactory condition, pass physical inspection, and be acceptable for transfusion in accordance with AABB^[12] and hospital nursing protocol requirements. Acceptable percentage hemolysis for pRBCs shall be <1% as per the FDA guidelines^[10]
- Correct destination: Products shall arrive at the desired location.^[7]

Blood product selection

We decided to limit the transport of blood products to only FFP and regular pRBCs for our study. Platelets were excluded due to the different temperature requirements for platelet transport. Transport of other non-routine and less common blood products requiring special request and processing (e.g., irradiated/washed/leukocyte, depleted/cytomegalovirus negative/autologous blood) were also excluded, as these products generally are not used in emergencies, may have different physical properties/red cell fragility, and are precious resources difficult to obtain and replace should there be any system error and failure of transport.

We did not evaluate prothrombin time/International Normalized Ratio and activated partial thromboplastin time in our study, as FFP quality has been found by earlier studies to be unaffected by PTS transport.^[5,8] Seven different units of expired thawed FFP (from routine clinical wastage so as not to waste precious donor resources unnecessarily) were used in our study. We evaluated delivery through our PTS for criteria of time, temperature maintenance, physical integrity by inspection, and correct destination of delivery. These units were reused for different locations.

Fourteen units of pRBCs near expiry (supplied for the purposes of validation by the National Blood Bank) were sent through our PTS to the different critical care locations. In contrast to other studies such as that by Raturi *et al.*^[5] where the mean age of their 10 pRBC units were 12.2 (5 units) and 15.4 days (5 units), the mean age of our 14 units was 35.4 days (range, 34–36 days). In our opinion, this better reflects the maximum expected degree of hemolysis post-PTS transport. This would then allow the reasonable conclusion that PTS transport does not cause clinically significant levels of hemolysis even for units at the end of their allowable shelf life if percentage hemolysis is found to remain below the cutoff of 1%.

Pneumatic tube system preparations and configurations

The PTS installed in our hospital was supplied by Sumetzberger GMBH through our local distributor Bes Technology Pte Ltd (Bestech). Air blowers at a central relay station generate negative/positive pressures to suck/push canisters along various pneumatic tubes. Our speed of transport was set at 6 m/s. The central relay station then switches canisters to various lines for final delivery to the destination station. The canisters are decelerated by an air cushion before arrival at the destination station then dropped into padded receptacle bins. Audible and visible alarms are triggered to alert staff of delivery. The entire PTS process is controlled by a computer system, which tracks each canister by location logging and radio frequency identification devices. It also records the timings at each phase. Any system malfunction can be identified on the computer system and technicians sent to the location immediately to retrieve the canister/repair the fault. Suitable PTS stations at ED, OT, and each of our five ICU pods were identified for transport, giving a total of seven destination locations for testing. Our PTS lines were programmed, giving all canisters sent from the department of laboratory medicine priority. Similar priority settings were also made for all canisters sent to/from ED, OT, and ICU. This ensured that emergency blood products sent between BTS and ED/OT/ICU received priority

over all other less urgent samples, giving the shortest delivery time possible.

Canister modifications

Initial pilot tests showed that sending blood products directly within the canisters were unacceptable, contrary to Sumetzberger's recommendations from their experience in other hospitals. Temperature limits were exceeded within 6 min which did not allow sufficient buffer in transport. This may be related to the different ambient temperatures in equatorial Singapore or other local tube factors. Due to our desire for a system that would allow potential returns of blood products, strict temperature maintenance between 1°C and 10°C was required for transport of blood products^[13] to ensure suitability for reissue. Several prototypes of insulating foam inserts were produced and evaluated to enhance temperature maintenance.

A Styrofoam model, manufactured by a local factory commissioned by Bestech, was eventually selected. The comparison results are detailed in Table 1.

Pneumatic tube system testing/study methodology

Testing was divided into two subphases with Phase IA being done with expired/wasted FFP units and Phase IB being done with pRBC units supplied by the National Blood Bank as detailed above. Testing was conducted over a variety of timings throughout the day.

“Activation,” “end of processing/preparation,” “porter collection,” and “final delivery” timings of all clinical emergency blood activations in our hospital are routinely recorded for clinical governance and audit purposes. These data were collated for September 2016–February 2017 for analysis.

FFP units were tested first in Phase IA with an investigator stationed in each critical care location placing a telephone call to BTS and activating a dispatch of FFP. All routine procedures such as checking of blood product unit number, blood group, expiry date, unit volume, and physical inspection were followed. Each unit's temperature was checked with a calibrated Infrared Thermometer before being packed into the Styrofoam insert, placed within the PTS canisters and dispatched. BTS staff then telephoned the activating critical care location to inform the investigator awaiting delivery. Upon arrival, the investigator would retrieve the canister and walk to the furthest emergency bay/OT/ICU room before opening the canister and retrieving the unit. Temperature was measured with a calibrated Infrared Thermometer and routine checks of the FFP unit (as above) were conducted and recorded, simulating the clinical workflow performed before transfusion. A simulated cancellation of order and return to BTS

was then performed with the temperature of the unit checked and recorded before being packed back into the Styrofoam insert and placed into the PTS canister. BTS was then telephoned to inform them of the blood product for return before the unit was dispatched back through PTS. BTS staff then collected the unit from the BTS PTS station and repeated the process of temperature measurement and other routine checks. The FFP unit was then replaced in the refrigerator and the same process repeated the next day. One unit of FFP each was sent to/from our seven critical care locations and reissued the next day for a total of 14 evaluations of two-way transport through the PTS.

Phase IB testing with pRBC units followed a similar workflow. Samples were taken from each bag at every point before PTS transport. A B Braun Non-Vented Dispensing Pin with double sealing function was used to spike each pRBC bag, so repeated sampling could be performed. The units were placed into the blood refrigerator after simulated return and inspected for

visible signs of hemolysis after a 24 h quarantine in accordance with the routine clinical workflow/AABB guidelines. They were dispatched again the next day, simulating reissue of a previously returned unit. Repeat testing with a second unit for each location was also performed. Two units of pRBCs were sent to/from our seven critical care locations and reissued the next day for a total of 28 evaluations of two-way transport through the PTS [Figure 1].

Total hemoglobin (Hb), hematocrit, free plasma Hb, serum potassium, phosphate, lactate dehydrogenase, and aspartate aminotransferase were measured for all pRBC samples.

Results

Manual portering timings (current workflow)

A review of all emergency pRBC activations over 6 months was carried out from September 2016 to February 2017. The mean time transport time of the pRBC units by

Table 1: Canister prototype testing

	Ease of use	Capacity	Mean time temperature maintained <10°C (min)	Remarks
Canister prototype				
No insulation	N/A	2 units	5.75	Unacceptably short duration of temperature maintenance
In-house design	Fair	2 units	37.5	Concerns with manufacturing reproducibility
Styrofoam prototypes				
Regular size, deep, thin wall	Fair	2 units	72.5	Difficulty in retrieving unit at bottom of canister
Regular size, deep, thick wall	Poor	Nil	N/A	Unable to safely squeeze blood products in without risk of breakage. Prototype rejected outright
Regular size, thin wall with bottom spacer	Good	1 unit	75	Best compromise Eventual design selected
Big size, thin wall	Good	2 units	77.5	Requires expensive modifications of our existing PTS stations
Big size, thick wall	Fair	2 units	92.5	

PTS=Pneumatic tube system, N/A=Not available

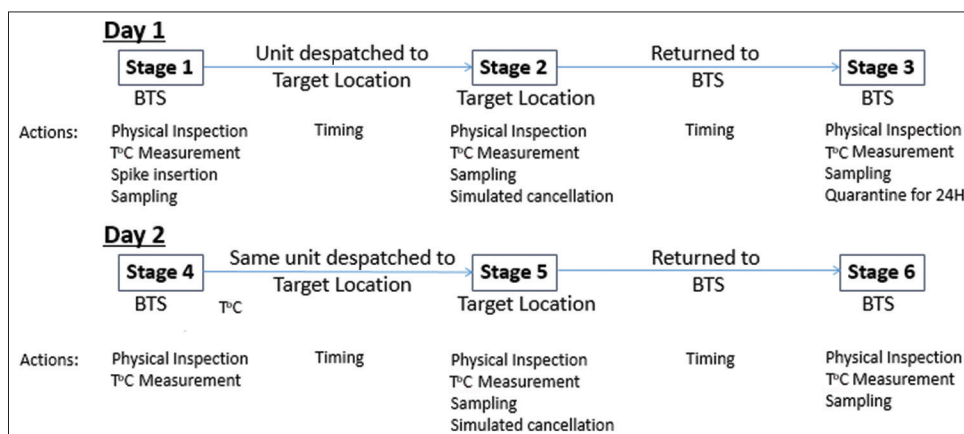


Figure 1: Summary of stages

manual porters (from “end of processing/preparation” to “final delivery”) was 8 min 43 s, and the median time was 5 min 0 s (*n* = 37, range: 1–48 min).

Pneumatic tube system studies

Pneumatic tube system transport time

Investigators at BTS and the critical care locations had synchronized clocks and recorded all timings for blood product activation, dispatch, and receipt.

The delivery time attributable to PTS transport alone is shown below. The mean timing across all locations was 2 min 23 s (standard deviation: 50.0 s), with a range of 1 min 5 s to 6 min 19 s. This timing is inclusive of delays from lines being busy sending/receiving other clinical specimens [Figure 2].

Comparison of pneumatic tube system versus manual portering timings

A significant difference in timings was found comparing the two transport means with a mean of 2 min 23 s (PTS) versus 8 min 43 s (manual). This result is statistically significant with *P* = 0.0000146 on statistical analysis with a one-tailed *t*-test [Table 2].

Temperature

All FFP units dispatched through PTS were successfully maintained between 1°C and 10°C. For pRBC units, temperature was successfully maintained ≥1°C and ≤10°C except for 4 units which exceeded 10°C only at the last stage (return from target location to BTS). These four instances account for 9.5% (4 instances/[28 pRBC + 14 FFP dispatches sent]) with the majority having no temperature maintenance issues [Figure 3].

Hemolysis for packed red blood cells units

Our pRBC units were at the mean age of 35.4 days (range, 34–36 days) at the time of testing.

Measurement of whole blood total Hb and hematocrit was performed on EDTA anti-coagulated samples, drawn from pRBC units, on our Sysmex® XN-3000 analyzer.

Aliquots of pRBC samples were also centrifuged and tested for free plasma Hb using the Hemocue® plasma/low Hb.

Percentage hemolysis was then calculated using the formula below:

$$\text{Percent hemolysis (\%)} = \frac{(100 - \text{Hct}) \times \text{plasma hemoglobin (g/dl)}}{\text{Total hemoglobin (g/dl)}}$$

Maximum percentage hemolysis reached after two times of two-way PTS transport was only 0.548% and comfortably below both the FDA and European Committee on blood transfusion’s limits of 1% and 0.8% hemolysis, respectively. Mean percentage hemolysis of our 14 units tested was 0.271% (range, 0.150%–0.548%). This is despite using units close to expiry which previous studies have not done [Figure 4 and Table 3].

Physical integrity

None of the units sent through PTS had any occurrences of leakage/breakage nor were there any abnormalities detected on physical inspection of the units (cloudiness, foreign streak, or abnormal presence of clumping of cells/clots/air bubbles in the blood bag).

Table 2: Pneumatic tube system versus portering timing comparison

Group	Mean (s)	Variance	<i>n</i>
PTS transport	143.2619048	3123.564	42
Manual porters	523.7837838	304929.7	37

PTS=Pneumatic tube system

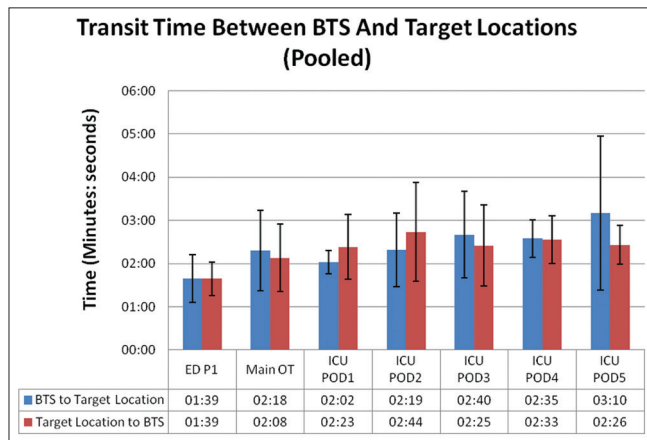


Figure 2: Transit times. Solid bars display the mean timings for each location with the error bars showing the 95% confidence interval

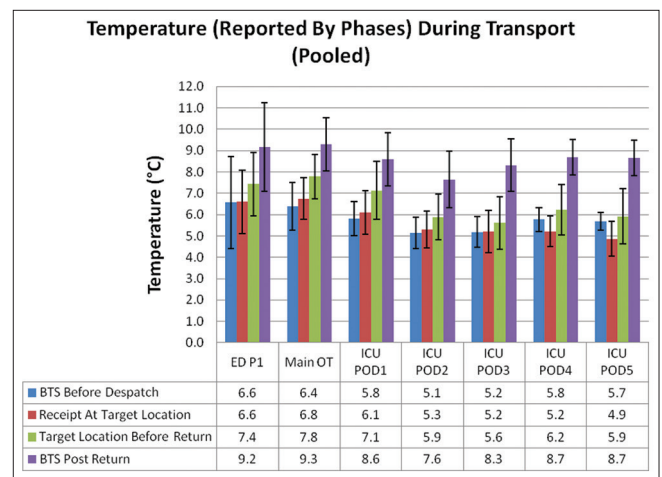


Figure 3: Transport temperature. Solid bars display the mean timings for each location with the error bars showing the 95% confidence interval

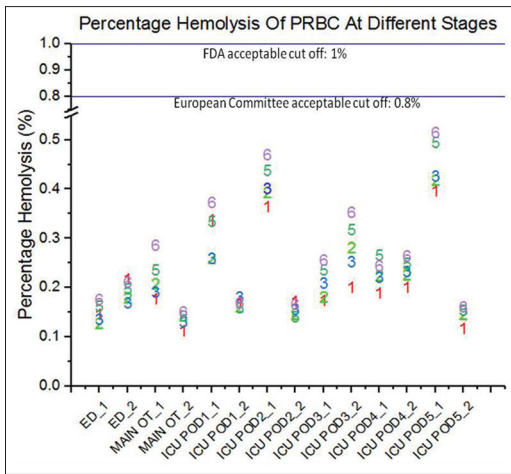


Figure 4: Percentage hemolysis by stages. Percentage hemolysis data are shown at the different stages, described below: 1: At BTS pre PTS transport; 2: At target location, post one-way PTS transport; 3: Back at BTS, post two-way PTS transport; 4: At BTS, pre 2nd round (2nd day) of PTS transport (not tested for percentage hemolysis); 5: At target location, post 2nd round (2nd day) of PTS transport; 6: Back at BTS post 2nd round (2nd day) of two-way PTS transport. PTS: Pneumatic tube system, BTS=Blood transfusion services

Failure of delivery/misdirected canisters

There were no misdirected canisters in all our studies. One instance of failure of delivery occurred during Phase IA tests with FFP. This was due to a jam in an adjacent ICU pod (sharing the same PTS line) from the pod tests were being conducted in. The PTS engineers shut down the line for repairs without consulting BTS. A unit already *en route* from BTS thus could not be delivered and the canister was sent back to BTS. Our hospital workflow currently does not require users to be informed of unscheduled downtime anticipated to last <30 min. However, if PTS transport of blood products is implemented, users will need to be informed at all times should the PTS not be in service to prevent delays in transport of urgent specimens and wastage of products.

This case highlighted the need for a robust system to be in place to deal with PTS downtime or errors before implementation of Phase II tests and sending of clinical blood products through PTS.

Discussion

Our study showed superior timings for PTS transportation with a mean timing of 2 min 23 s (range, 1 min 5 s–6 min 19 s) in comparison to manual portering which had a mean portering-associated transport time of 8 min 43 s (range, 1–48 min). This significant reduction in delivery time could potentially result in improvement in resuscitation outcomes for patients.

Evaluation of other parameters important for transportation of blood products showed satisfactory

Table 3: Summary table of hemolysis

Overall	Start	Post 1 st stage	Post 2 nd stage
ED 122788	0.145	0.135	0.176
ED 137723	0.217	0.169	0.211
Main OT 122899	0.177	0.190	0.286
Main OT 122844	0.111	0.130	0.150
ICU P1 122794	0.338	0.259	0.372
ICU P1 094588	0.169	0.180	0.169
ICU P2 094673	0.365	0.401	0.470
ICU P2 094686	0.172	0.155	0.166
ICU P3 094687	0.173	0.209	0.255
ICU P3 094715	0.200	0.251	0.352
ICU P4 118941	0.189	0.220	0.243
ICU P4 119712	0.201	0.233	0.264
ICU P5 122770	0.396	0.426	0.515
ICU P5 122787	0.117	0.153	0.161
Total mean	0.212	0.222	0.271
Percentage increase (%)	-	4.710	27.83 (from baseline) 22.07 (from end of 1st stage)
SD	0.086	0.087	0.113
Median	0.183	0.199	0.249

SD=Standard deviation, OT=Operating theaters, ICU=Intensive Care Units, ED=Emergency department

performance with:

1. Satisfactory physical condition and product integrity of all blood products after PTS transport on arrival at critical care locations
2. Satisfactory physical condition and product integrity of all blood products after simulated return and PTS transport from critical care locations back to BTS
3. Temperature maintained within range between 1°C and 10°C for all blood products transported through PTS from BTS to critical care locations
4. Temperature maintained within range between 1°C and 10°C for 90.5% of blood products after simulated return and transport through PTS from critical care locations back to BTS
5. Correct location of delivery of all units with no misdirected canisters
6. Acceptable levels of hemolysis for pRBC units with maximum hemolysis only 0.548%.

While 9.5% of simulated returns were received by BTS above 10.0°C, this is not anticipated to be a significant issue operationally as most blood products requested for in emergency resuscitations are expected to be used. Any potential wastage resulting from returns may be acceptable on the balance of improved delivery times and more responsive blood product support for patient resuscitation.

Limitations

While our study aimed to study more aged pRBC samples as compared to the previous studies, we were not able

to conduct our tests at the 42-day expiry mark for the pRBC units due to logistical issues and coordination with our National Blood Bank stocks. The units were tested between 34 and 36 days of age, an improvement from the previous studies. Hemolysis levels might potentially be higher for older pRBC units at the 42-day mark. However, with our maximum percentage hemolysis rate of 0.548% comfortably below the FDA cutoff of 1%, we do not expect this to be a significant issue.

Our study closely mimicked the actual workflow for actual emergency blood request activations. Eventual clinical application of the PTS for delivery may run into other unforeseen issues and require coordination of workflow and training of clinical staff with the new protocol. This will be further evaluated in Phase II of our implementation study.

Conclusions

We have demonstrated that usage of the PTS significantly cuts down transport time for emergency blood products and that such PTS transport is safe. All blood quality indices conformed to requirements from AABB and other international standards. Utilization of the PTS could decrease delivery times of blood products, making an impact in clinical resuscitation. It also decreases utilization of portering workforce, allowing for more efficient deployment of porters where they are clinically needed.

Our hospital is moving on to Phase II of evaluation based on these results. Actual time differences in delivery of blood products for clinical transfusion and clinical impact will be examined.

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Conflicts of interest

There are no conflicts of interest.

References

1. Ball CG. Damage control resuscitation: History, theory and technique. *Can J Surg* 2014;57:55-60.
2. Cotton BA, Guy JS, Morris JA Jr, Abumrad NN. The cellular, metabolic, and systemic consequences of aggressive fluid resuscitation strategies. *Shock* 2006;26:115-21.
3. Stanworth SJ, Davenport R, Curry N, Seeney F, Eaglestone S, Edwards A, *et al.* Mortality from trauma haemorrhage and opportunities for improvement in transfusion practice. *Br J Surg* 2016;103:357-65.
4. Hellkamp J, Carl A, Kohse KP. Stability of packed red blood cell units during mechanical transport using a modern pneumatic tube system. *Inf Ther Transfus Med* 2002;29:259-64.
5. Raturi M, Shastry S, Shivhare A. Bank to bedside: A reliable and efficient transportation of blood by pneumatic tube system. *Global J Transfus Med* 2016;1:7-11.
6. Dhar S, Basu S, Chakraborty S, Sinha S. Evaluation of the pneumatic tube system for transportation of packed red cell units. *Asian J Transfus Sci* 2015;9:195-8.
7. Monique M, Roger R, Lynne U, Connie MW. Validation Process (Criteria Development). In: Monique M, editor. *Guidelines for Pneumatic Tube Delivery Systems: Validation and Use to Transport Blood Components*. 1st ed. Bethesda: American Association of Blood Banks; 2004. p. 8-11.
8. Tanley PC, Wallas CH, Abram MC, Richardson LD. Use of a pneumatic tube system for delivery of blood bank products and specimens. *Transfusion* 1987;27:196-8.
9. Kara H, Bayir A, Ak A, Degirmenci S, Akinci M, Agacayak A, *et al.* Hemolysis associated with pneumatic tube system transport for blood samples. *Pak J Med Sci* 2014;30:50-8.
10. Summary Basis of Approval of Red Blood Cells Frozen and Red Blood Cells Deglycerolized (reference no. 86-0335). Applicant-Department of the Navy, Naval Hospital. Bethesda, MD; 1986. p. 635-10.
11. Guide to the Preparation, Use and Quality Assurance of Blood Components. 16th ed. European Committee on Blood Transfusion; 2010.
12. Kim M. Administration of blood components – Events and considerations before component administration. In: Mark KF, editor. *AABB Technical Manual*. 18th ed. Bethesda: American Association of Blood Banks; 2017. p. 545-8.
13. Nancy MD. Hospital storage, monitoring, pretransfusion processing, distribution and inventory management of blood components. In: Mark KF, editor. *AABB Technical Manual*. 18th ed. Bethesda: American Association of Blood Banks; 2017. p. 213-27.