

Hemostatic Benefits of an Absorbable Polysaccharide Powder in Redo Cardiac Surgery: A Comparative Study

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Background: Redo cardiac surgery outcomes, including increased transfusions and risk of reoperation, worsen with post-operative bleeding. This study aimed to directly compare the use of an absorbable polysaccharide powder to no hemostatic agent use during planned non-emergent redo cardiac surgery.

Methods: Fifty-one participants in two cohorts underwent planned non-emergent redo cardiac surgery. The retrospective cohort (n = 26) was chosen from redo cardiac surgeries completed between 2019 and 2020, while the prospective cohort (n = 25) included sequential redo cardiac surgeries with the use of an absorbable polysaccharide powder. Patient operative characteristics, along with first 24-hour transfusion use (packed red blood cells (pRBC), fresh frozen plasma (FFP) and platelets (Plts), chest tube outputs (CTO) at 12, 24 and 48 hours, and reoperation rates were compared.

Results: There was a higher non-statistical average of intraoperative pRBC and FFP rates in the retrospective cohort, compared to cases where absorbable polysaccharide powder was used (2 ± 2.9 vs 1.1 ± 1.4 units pRBC, $p = 0.414$; and 1.4 ± 1.8 vs 0.6 ± 1 units FFP, $p = 0.070$) while there were statistical differences in Plts use in the retrospective cohort compared to when absorbable polysaccharide powder was used (1 ± 1.3 vs 0.4 ± 0.7 units plts, $p = 0.028$). Statistically significant lower amounts of CTO in the first 12 hours and the 12–24-hour intervals were found when absorbable polysaccharide powder was used (817 ± 520 vs 558 ± 352 milliliters, $p = 0.028$; and 1144 ± 704 vs 830 ± 474 milliliters, $p = 0.044$, respectively). There were three reoperations in the retrospective cohort due to suspected bleeding, compared to no reoperations in the absorbable polysaccharide powder cohort.

Conclusion: This study highlights fewer transfusions, lower CTO, and decreased need for reoperation when using absorbable polysaccharide powder in redo cardiac surgeries. Further randomized trials are needed to more accurately define benefits of absorbable polysaccharide powder in redo cardiac surgeries. Word count: 302.

Keywords: absorbable polysaccharide powder, redo cardiac surgery, hemostasis

Introduction

Redo cardiac surgery is increasingly common due to increasing patient longevity and medical advances.^{1,2} These surgeries pose challenges including higher-than-average rates of blood transfusions, increased chest tube output (CTO), need for re-operation due to bleeding, longer length in the intensive care unit (ICU), and increased overall hospital length of stay (LOS), all of which can worsen patient outcomes, and increase healthcare costs.

Surgeries requiring redo-sternotomy are associated with increased morbidity and mortality in the post-operative (PO) period, most specifically when re-entry injuries occur.^{3–5} When having a preoperative computerized tomography of the chest, risk of re-entry injury is found to be lower, yet due to potential longer cardiopulmonary bypass times leading to increased inflammation, increased blood loss and impaired hemostasis,^{2,3,6} nearly half of redo cardiac surgeries still require increased packed red blood cells (pRBC) and fresh frozen plasma (FFP).⁶ Previous literature has shown longer

LOS at 18.8 days compared to 12.2 days in the primary sternotomy population.² Strategies utilizing aprotinin, tranexamic acid or other hemostatic agents to decrease bleeding have been effective in decreasing transfusion needs.⁷

Different types of hemostatic agents offer various modes of action, allowing to choose the best individual fit. Hemostatic agents can be separated into active and non-active agents. Non-active hemostatic agents with plant derivative (cellulose-based or starch-based), collagen and gelatin, are known to absorb fluid, activate platelets, form a matrix for clot formation, lower pH and/or cause a tamponade effect. These agents rely on an intact coagulation pathway. On the contrary, active hemostatic agents use biologically active elements of the coagulation cascade to enhance biological reactions for coagulation. This includes thrombin (human and recombinant) and fibrinogen which act by actively forming fibrin clots, found in fibrin sealant formulations.^{8,9} Absorbable microporous polysaccharide hemosphere (MPH) is a hemostatic agent with a broad coverage area and essentially no toxicity or antigenicity.^{9–11} The MPH powder is a starch-derived hemostatic agent and has strong dehydrating properties promoting natural hemostasis by facilitating platelet aggregation and clot formation. This powder, when used in accordance to instruction for use (IFU) guides, swells immediately upon contact with blood or fluid, creating a stable hemostatic plug, ultimately allowing the control of surgical bleeding that traditionally occurs with redo cardiac surgeries. The big advantage of an MPH powder over other mechanical hemostatic agents is fast absorption time (24–48 hours) as compared to two to six weeks for oxidized cellulose and gelatin sponges, or even up to 12 months in the case of fibrin sealants.^{8,9} Short absorption time minimizes inflammatory and foreign body responses.⁹ The use of an MPH powder in primary cardiac surgery showed much less incidence of transfusions and decreased CTO and no significant differences between groups in PO complications or mortality.¹²

An International Hemostatic Expert Panel was convened by the Society for the Advancement of Blood Management to develop evidence-based topical hemostatic agent recommendations for cardiothoracic surgery, through active and non-active hemostatic agents. Guided recommendations for which agent(s) to use in cardiothoracic surgery depend on an intact coagulation system. If the coagulation system is not intact, active hemostatic agents would be used in most cases, except for non-surgical bleeding of raw surfaces where agents with dual active and non-active properties would be used. In contrast, an intact coagulation system, mechanical hemostatic agents, such as MPH powder, and other synthetic sealants classified as non-active hemostatic agents would be used.¹³

This study hypothesizes that use of absorbable polysaccharide powders in redo cardiac surgeries will lead to reduced transfusion requirements, lower CTO, and fewer reoperations. Primary end points include transfusion usage, CTO and reoperation rates, which will be compared with and without the use of an absorbable polysaccharide hemostatic agent. Secondary endpoints include total and post-operative LOS, ICU days, and operating room (OR) time.

Methods

Following institutional review board approval through WCG Institutional Review Board (Study Number: 1312055, IRB tracking number 20212980) and complying with the principles of the Declaration of Helsinki, a list of retrospective redo cardiac surgeries was provided between 2019 and 2020. This prospective observational pilot study with retrospective control cohort was conducted at a Midwest regional hospital. The study included a prospective cohort testing the use of an absorbable polysaccharide powder in redo cardiac surgery, between 2021 and 2023, and a non-randomized retrospective control cohort without use of hemostatic agents, between 2019 and 2020.

The retrospective (control) cohort data consisted of 46 redo cardiac surgeries between 2019 and 2020. A consent was not required per WCG IRB for the control cohort. Criteria for inclusion was non-emergent redo cardiac surgery completed before 2021, no hemostatic agents used at the time of redo sternotomy cardiac surgery, age ≥ 19 years, English speaking and not pregnant. Following exclusion of subjects in the retrospective control cohort, 26 participants remained. This study was classified as a pilot study due to the small sample size.

Potential prospective participants were provided the consent prior to surgery to understand the purpose of the study. Each were individually consented prior to a planned non-emergent redo sternotomy cardiac surgery from June 2021 to January 2023 with the same inclusion criteria as the control cohort. From the 29 consented patients, 25 remained in the MPH intervention cohort. Those initially consented but not included in the MPH cohort ($n = 4$), included three withdrawals (reconsideration of participation, surgery cancellation/reschedule due to washout of a platelet inhibitor,

and surgery cancellation due to endocarditis), along with a protocol deviation where the MPH was not used in surgery. [Figure 1](#) displays the flow pattern of participant selection.

Due to the length of time between the control and MPH cohorts (2019–2023), surgical protocols, anesthesia management and post-operative care processes were evaluated to ensure consistency across all cases and to minimize selection bias. No significant changes were noted in surgical protocols or anesthesia management during this time frame. The only change for PO care would be the variance of sternal incision dressings. The surgical teams were relatively the same in both cohorts, and the same three surgeons were on staff during this entire time and followed the IFU for application of the hemostatic agents.

Data Collection

Data collection was completed for the control cohort through chart reviews. Following pre-surgical consenting, data collection was completed for the MPH cohort. The same data collection tool was used for both cohorts by the same research coordinator (and overseen by the research department manager). Preoperative clinical characteristics (age, gender, co-morbidities, anti-coagulation needs, Society of Thoracic Surgeons (STS) risk score if provided, and laboratory values), PO characteristics (LOS, ICU days, cardiopulmonary bypass time) and outcomes (transfusion requirements, CTO, and complications including reoperations, discharge status and 30-day mortality) were collected. [Table 1](#) describes all collected variables, broken down into separate cohorts.

Study Agent

The study agent is an absorbable polysaccharide powder (5 grams), 100% plant-based, and enhances natural hemostasis by concentrating red blood cells, platelets and other blood solids. This absorbable hemostatic particle medical device is approved by the Food and Drug Administration for surgical wound bleeding. This MPH powder is a fine, biocompatible, sterilized white powder which, when applied to surgical wound sites, provides a barrier to further blood loss, regardless of the individual's coagulation status.¹⁴

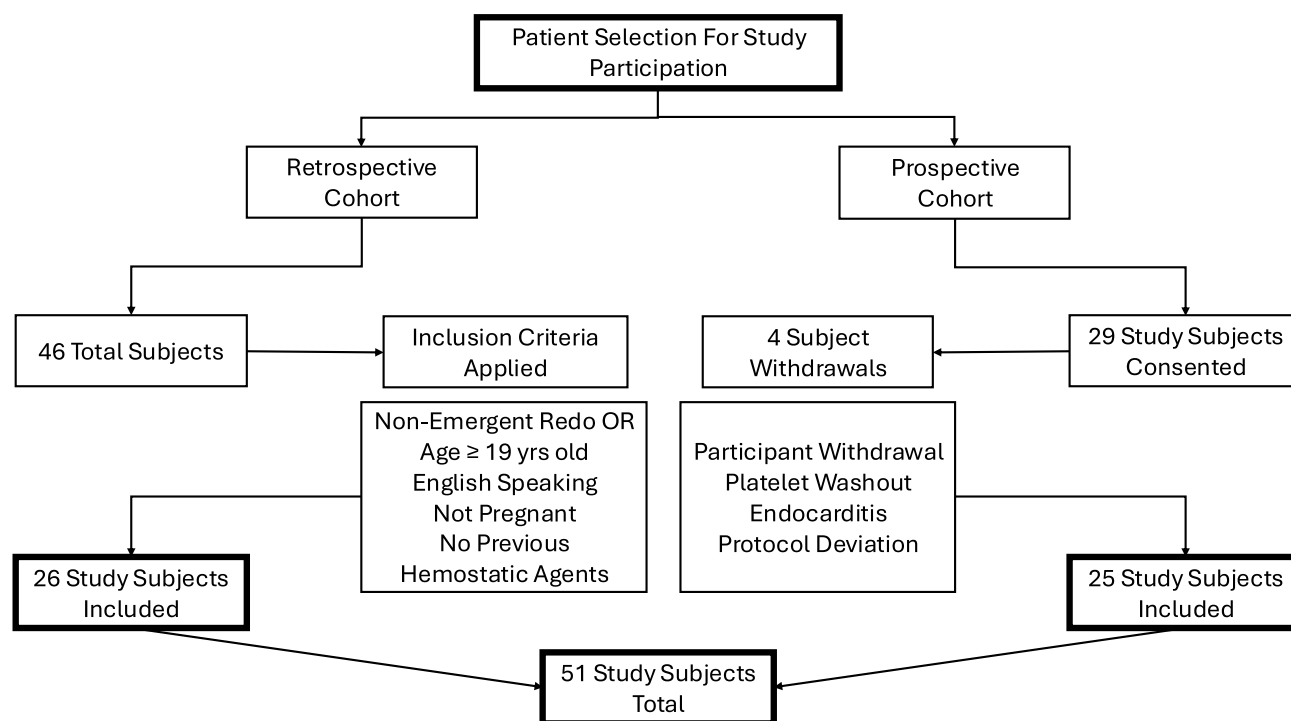


Figure 1 Flow of Patient Selection.

Table 1 Clinical Characteristics of Individual Cohorts and Total Sample

	Control Group		MPH Group		Complete Sample	
	f (%)	m ± SD	f (%)	m ± SD	f (%)	m ± SD
Number of Patients	26		25		51	
Age (yrs)		67.6 ± 9.6		68.2 ± 12.7		67.9 ± 11.2
Gender						
Male	20 (76.9)		17 (68)		37 (72.5)	
Female	6 (23.1)		8 (32)		14 (27.5)	
Preoperative Co-Morbidities						
AKI ± CKD	7 (26.9)		6 (24)		13 (25.5)	
Atrial Fibrillation	10 (38.5)		12 (48)		22 (43.1)	
CAD	22 (84.6)		18 (72)		40 (78.4)	
Cancer	3 (11.5)		6 (24)		9 (17.6)	
CHF	12 (46.2)		14 (56)		26 (51)	
COPD	4 (15.4)		3 (12)		7 (13.7)	
CVA	9 (34.6)		3 (12)		12 (23.5)	
Diabetes Mellitus	9 (34.6)		8 (32)		17 (33.3)	
PE	1 (3.8)		2 (8)		3 (5.9)	
STS Risk Score	(n = 20)		(n = 19)		(n = 39)	
<4%	6 (30)		9 (47.4)		15 (38.5)	
4–8%	6 (30)		7 (36.8)		13 (33.3)	
>8%	8 (40)		3 (15.8)		11 (28.2)	
Status at Discharge						
Home	16 (61.5)		18 (72)		34 (66.7)	
LTAC	2 (7.7)		1 (4)		3 (5.9)	
SNF	3 (11.5)		1 (4)		4 (7.8)	
Rehab	5 (19.2)		3 (12)		8 (15.7)	
Death	0 (0)		2 (8)		2 (3.9)	
CPB Time (mins)		162.7 ± 72.5		160.3 ± 84.3		161.5 ± 77.7
Packed Red Blood Cells (units)						
Intraoperatively		2 ± 2.9		1.1 ± 1.4		1.5 ± 2.3
0–2 hours PO		0.04 ± 0.2		0		0.01 ± 0.14
>2–4 hours PO		0.4 ± 0.9		0.1 ± 0.4		0.3 ± 0.7
>4–8 hours PO		0.6 ± 1.4		0.1 ± 0.3		0.4 ± 1
>8 hours PO		0.8 ± 1.4		0.6 ± 1.3		0.7 ± 1.3

(Continued)

Table 1 (Continued).

	Control Group		MPH Group		Complete Sample	
	f (%)	m ± SD	f (%)	m ± SD	f (%)	m ± SD
FFP Use (units)						
Intraoperatively		1.4 ± 1.8		0.6 ± 1		1 ± 1.5
0–2 hours PO		0.4 ± 1.4		0.1 ± 0.4		0.3 ± 1
>2–4 hours PO		0.3 ± 0.9		0		0.1 ± 0.6
>4–8 hours PO		0.2 ± 0.6		0.1 ± 0.4		0.2 ± 0.5
>8 hours PO		0.4 ± 1		0		0.2 ± 0.7
Platelets (units)						
Intraoperatively		1 ± 1.3		0.4 ± 0.7		0.7 ± 1.1
0–2 hours PO		0.3 ± 0.8		0.04 ± 0.2		0.2 ± 0.6
>2–4 hours PO		0.1 ± 0.3		0		0.04 ± 0.2
>4–8 hours PO		0.3 ± 0.7		0.04 ± 0.2		0.2 ± 0.5
>8 hours PO		0.2 ± 0.6		0.04 ± 0.2		0.1 ± 0.4
Chest Tube Output (mL)						
0–12 hours		817 ± 520		558 ± 352		690 ± 460
12–24 hours		1144 ± 704		830 ± 474		990 ± 617
24–48 hours		1511 ± 1013		1132 ± 565		1325 ± 838
Reoperation in 1st 30 days	3 (11.5)		0 (0)		3 (5.9)	
Length of Stay (days)						
Admit to DC		11.5 ± 5.7		9 ± 5.2		10.2 ± 5.6
POD #1 to DC		6.8 ± 3.7		7.3 ± 4.7		7.1 ± 4.2
Post-OR ICU Days		4.4 ± 2.7		4.5 ± 4.6		4.5 ± 3.7
OR Time (cut to close, mins)		333 ± 120		347 ± 145		340 ± 131
Mortality in 1st 30-days	0 (0)		2 (8)		2(4)	

Abbreviations: AKI, acute kidney injury; CAD, coronary artery disease; CHF, congestive heart failure; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CPB, cardiopulmonary bypass; CVA, cerebrovascular accident; DC, discharge; f, frequency; FFP, fresh frozen plasma; ICU, intensive care unit; LTAC, long term acute care; m, mean; mins, minutes; mL, milliliters; MPH, Microporous Polysaccharide Hemospheres; OR, operating room; PE, pulmonary embolism; PO, post-operative; POD, post-operative day; post-op, post-operative; SD, standard deviation; SNF, skilled nursing facility; STS, Society of Thoracic Surgeons; yrs, years; 1st, first.

All surgeons followed the IFU guide for the application of the MPH powder to maintain consistency in the study. After completion of the redo cardiac surgery, excess blood was removed, and the MPH powder was applied. After achieving homeostasis, excess MPH powder was removed, and the sternal closure was completed.

Statistical Analysis

Descriptive statistics were analyzed. Continuous variables were reported as either mean ± standard deviation or median and interquartile ranges (Table 2). Categorical variables were reported as frequency and percentage. Mann–Whitney U and Chi-Square analyses were used to compare the retrospective and prospective cohorts, with the Fisher’s Exact

Table 2 Statistical Results Across Groups

	Control Group		MPH Group		Mann-Whitney U	Chi-Square χ^2 (1)
	Md (IQR)/95% CI [L,U]	f, %	Md (IQR)/95% CI [L,U]	f, %	p-value	p-value
Number of Patients	26		25			
Packed Red Blood Cells Use (units)						
Intraoperatively	1 (2.25)/[0.78,3.14]		0 (2)/[0.49,1.67]		0.414	
0–2 hours PO	0 (0)/[–0.04,0.12]		0 (0)/[0.00,0.00]		0.327	
>2–4 hours PO	0 (0)/[0.00,0.76]		0 (0)/[–0.06,0.30]		0.237	
>4–8 hours PO	0 (1)/[0.07,1.16]		0 (0)/[–0.03,0.19]		0.063	
>8 hours PO	0 (1.25)/0.25,1.37]		0 (0)/[0.05,1.15]		0.271	
FFP Use (units)						
Intraoperatively	2 (2)/[0.70,2.15]		0 (1.5)/[0.20,1.00]		0.070	
0–2 hours PO	0 (0)/[–0.14,0.98]		0 (0)/[–0.09,0.25]		0.312	
>2–4 hours PO	0 (0)/[–0.08,0.62]		0 (0)/[0.00,0.00]		0.083	
>4–8 hours PO	0 (0)/[–0.01,0.47]		0 (0)/[–0.09,0.25]		0.188	
>8 hours PO	0 (0)/[–0.03,0.80]		0 (0)/[0.00,0.00]		0.043	
Platelet Use (units)						
Intraoperatively	1 (1)/[0.46,1.54]		0 (1)/[0.11,0.69]		0.028	
0–2 hours PO	0 (0)/[0.02,0.67]		0 (0)/[–0.04,0.12]		0.086	
>2–4 hours PO	0 (0)/[–0.03,0.19]		0 (0)/[0.00,0.00]		0.161	
>4–8 hours PO	0 (0)/[–0.00, 0.54]		0 (0)/[–0.04,0.12]		0.092	
>8 hours PO	0 (0)/[–0.01,0.15]		0 (0)/[–0.04,0.12]		0.165	
Chest Tube Output (mL)						
0–12 hours	675 (418.75)/[606.90, 1026.56]		520 (317.5)/[412.74, 703.26]		0.028	
12–24 hours	980 (641.25)/[859.64, 1428.06]		820 (417.5)/[634.49, 1025.91]		0.044	
24–48 hours	1320 (697.5)/[1102.29, 1920.40]		1100 (510)/[898.49, 1365.11]		0.113	
Reoperation in 1st 30 days		3 (11.5)		0 (0)		0.235*
Length of Stay (days)						
Admit to DC	10 (7.25)/[9.15,13.77]		7 (3)/[6.79,11.13]		0.049	
POD #1 to DC	6 (4)/[5.35, 8.34]		6 (2.5)/[5.33, 9.23]		0.819	
Post-OR ICU Days	5 (4)/[3.35, 5.50]		4 (3)/[2.58, 6.38]		0.413	
OR Time (cut to close, mins)	310.5 (115.5)/[284.31, 380.84]		321 (177.5)/[287.40, 406.76]		0.547	
Mortality in 1st 30-days		0 (0)		2 (8)		0.235*

Notes: *FET = Fisher's Exact Test used instead due to >20% of expected cell count <5; **Bolded** and *Italicized* values correlate to statistically significant p-values of <0.05. **Abbreviations:** CI [L,U], Confidence Interval [Low, Upper]; DC, Discharge; FFP, Fresh Frozen Plasma; ICU, Intensive Care Unit; Md (IQR), Median (Interquartile Ratio); Mins, Minutes; mL, Milliliters; OR, Operating Room; PO, Post-operative; POD, Post-Operative Day.

values were reported for cell frequency less than 5. All statistical analyses were performed using SPSS, version 28, with a statistical significance threshold p-value <0.05. Using the G*Power 3.1 analysis program, and selecting the Wilcoxon-Mann-Whitney test, powered at 95%, the minimal sample size needed to have appropriate power is 110 participants in each cohort, demonstrating an under-powered study.

Results

Preoperative Clinical Characteristics

A total of 51 patients met inclusion criteria ($n = 26$, 51% in the control cohort, and $n = 25$, 49% in the MPH cohort). The full sample consisted of 72.5% males, average age was 67.9 ± 11.2 years, with 51% history of congestive heart failure, and 78% history of coronary artery disease. A third (33.3%) of the sample was diabetic and nearly a quarter (23.5%) had a history of a cerebrovascular accident (CVA).

In the control cohort, there were 26 participants, 77% male and an average age of 67.6 ± 9.6 years. The STS risk scores were defined in 20 participants (77%) and classified in three categories: <4% risk, 4–8% risk and >8% risk. The STS risk score <4% and 4–8% categories each had six participants (30% each), while 40% had an STS risk score of >8% ($n = 8$). In the MPH cohort, there were 25 participants, 68% were male, and an average age of 68.2 ± 12.7 years. The STS risk score of <4% was most prominent in the prospective cohort with nine participants (47.4%), while seven participants (36.8%) had STS risk scores 4–8% and only three participants had an STS risk score >8% (15.8%). The remaining 12 STS scores (six in each cohort) were not documented by the surgeon, and therefore unable to be collected and reported. [Table 1](#) demonstrates additional pre-operative clinical characteristics.

Post-Operative Characteristic

Average LOS in the control group from admission to discharge, was 11.5 ± 5.7 days, and 9 ± 5.2 days in the MPH group. The average LOS starting the first postoperative day to discharge was 6.8 ± 3.7 days in the control group, and 7.3 ± 4.7 days in the MPH group. Total days in the ICU were comparable between the control and MPH cohorts (4.4 ± 1.7 days versus 4.5 ± 4.6 days respectively), and the average OR time from first incision to final closure was similar between groups (333 ± 120 minutes versus 347 ± 145 , respectively). The control group received on average of 2 ± 2.9 units of pRBC intraoperatively, with 1.4 ± 1.8 units of FFP and 1 ± 1.3 units of Plts intraoperatively, compared to 1.1 ± 1.4 units of pRBC intraoperatively, with 0.6 ± 1 units of FFP and 0.4 ± 0.7 units of Plts in the MPH group. The first 12 hours of CTO in the control group was 817 ± 520 milliliters (mL), with total CTO of 1144 ± 704 mL between 12 and 24 hours PO, and a total of 1511 ± 1013 mL of CTO at the 24–48-hour PO interval. In contrast, the first 12 hours and the next 12–24 hours PO CTO for the MPH group was less at 558 ± 352 and 830 ± 474 mL, respectively. The total CTO at 24–48 hours measured 1132 ± 565 mL.

Perioperative Outcomes

Length of stay was statistically less in the MPH group compared to the control group (7 (3) vs 10 (7.25), $p = 0.049$). There were no statistical differences in the PO day #1 to discharge LOS between groups, and there were no differences in the ICU LOS between groups. There were no statistical differences between the delivery of pRBCs across groups at all five time-intervals (intraoperatively, 0–2 hours post-operatively (PO), 2–4 hours PO, 4–8 hours PO and >8 hours PO) as well as between the delivery of FFP at the first four time-intervals (intraoperatively, 0–2 hours post-operatively (PO), 2–4 hours PO, and 4–8 hours PO). There were statistically significant differences between the two groups of FFP delivered at the “> 8 hours” interval ($p = 0.043$), likely due to less FFP needed after 8 hours following surgery. There were statistically significant differences noted between the control and MPH cohorts with the delivery of Plts intraoperatively (2 (2) vs 0 (1.5), $p = 0.028$). Accumulative CTO at the first two measured intervals (0–12 hours and 12–24 hours) demonstrated statistical differences between the control and MPH groups (675 (418.75) vs 520 (317.5), $p = 0.028$; 980 (641.25) vs 820 (417.5), $p = 0.044$). However, there were no statistical differences between the control and MPH cohorts for CTO measured between 24 and 48 hours (1320 (697.5) vs 1100 (510), $p = 0.113$). The three reoperations in the control group (11.5%) did not reach statistical significance when compared to the MPH group (0 (0), $p = 0.235$). [Table 2](#) further describes additional comparisons between groups. The two deaths in the MPH group did not reach statistical significance when compared to the retrospective cohort (2 (8%) vs 0 (0), $p = 0.235$), noted below.

In the control group, 61.5% returned directly home following surgery, while five participants (19.2%) utilized acute rehabilitation before returning home. In the MPH group, 72% returned directly home following surgery, while three participants (12%) utilized acute rehabilitation before returning home. There were no deaths within the first 30-days in

the retrospective cohort, and two deaths in the first 30-days in the MPH group, deemed unrelated to the use of the absorbable polysaccharide hemostatic agent. Despite being extubated on the first PO day, the first participant developed ventricular arrhythmias on day 2, required re-intubation, spiked a fever from an unknown source on day 5, required ongoing pressor support with failed attempts of extubation, and ultimately requiring tracheostomy and feeding tube placements. The family chose to withdrawal support on day 22 when hemodialysis was needed. The second participant suffered from PO respiratory failure due to pneumonia. Hypotension was found on day 6 during a ventilator weaning attempt, leading to a pulseless electrical activity arrest where resuscitation was not successful.

Discussion

Our study demonstrated when using an absorbable polysaccharide powder in 25 consecutive redo cardiac surgeries, overall intraoperative transfusion usage and reoperation rates were lower yet non-statistically significant. Overall CTO in the first 12–24 hours PO was significantly decreased in the prospective cohort. Two deaths in the MPH group were not related to the use of the MPH powder, but rather due to the patients' pre-existing conditions.

This study partially met all primary endpoints. Transfusion requirements with pRBCs were lower in the MPH group, but not statistically different. Frozen fresh plasma use was lower at all time points but was significantly lower only at >8 hours PO interval. Intraoperative Plts use was statistically lower, while lower PO Plts use was not statistically different across remaining intervals. Reduction in transfusion requirement was observed but not consistently significant, reinforcing the need for larger studies. Chest tube output was statistically lower at 0–12 hours and 12–24-hour PO. At 24–48 hours PO, CTO was still lower, but expected to not be significantly different from the control group based on the functionality of the absorbable polysaccharide powder. In the first 30-days PO, there were three reoperations in the control group and none in the MPH group. While this is clinically meaningful due to the state of less bleeding in the MPH group, this was not statistically significant and should be interpreted cautiously in smaller samples.

Only one of four secondary end points was met. Patients in the MPH group spent statistically less time in the hospital than patients in the control group. However, there were no statistical differences in the number of ICU days or post-surgery to discharge LOS. Many differences between groups for primary and secondary end points were found to not be statistically significant yet, may show a glimpse of what potentially could come with larger sample sizes, such as demonstrating cost reduction through lower PO LOS, decreased or low reoperation rates, and decreased transfusion usage. If the standard recommendation of utility of hemostatic agents in redo cardiac surgeries would be implemented following studies with larger samples, meaningful improvements would likely be seen in overall surgical outcomes, with shorter recoveries, however further investigation is needed.

While literature on hemostatic agents in redo cardiac surgeries is limited, with minimal recommendations pertaining to either active or non-active hemostatic agents by expert consensus,¹³ our findings align with previous studies for primary sternotomy cardiac surgeries showing decreased transfusions and CTO.^{11,13} Our study demonstrated the potential benefits of absorbable polysaccharide powder use in redo cardiac surgeries, including decreased transfusions, decreased CTO, no reoperations in the prospective cohort, and decreased total LOS from admission to discharge. As previously mentioned, larger sample sizes are needed to more firmly generalize this data. Based on the face value of study results, the use of hemostatic agents should be considered in redo cardiac surgeries to decrease occurrence of bleeding. Larger sample sizes would also benefit long-term complication evaluation, including mortality incidence, as this short overview of PO evaluation is not enough in a small sample to glean any correlations for long-term outcomes.

This retrospective, single center designed study spanned five years (2019–2023) between two separate cohorts, giving rise to the inability to predict long-term complications such as thrombotic events, late infections and/or late reoperations. This limitation inhibits the generalizability of results, thus requiring larger sample sizes for more meaningful understanding of results. In addition, another significant limitation to this underpowered study is the overall sample size being relatively small, more consistently fitting a pilot style study. The method of documenting pre-operative co-morbid conditions could have been more precise. There are numerous types of heart failure where the risk of mortality may be affected. The same could be said for the varying differences between types of kidney injury as well. Documentation of atrial fibrillation occurring PO does not account for preoperative atrial fibrillation, potentially overestimating occurrence. While co-morbidities for both the control cohort and the MPH cohort were similar, more CVAs and coronary artery

disease were found in the control cohort, and heart failure was slightly more prominent in the prospective cohort. We did not account for the confounding variables through multi-variable regression due to the small sample size. One major strength of this prospective study is consistent surgical application between three surgeons included in this study time frame, as well as minimal changes between surgical and anesthesia teams, as well as minimal changes to the post-operative recovery process, ultimately limiting bias of the sample.

Conclusion

Our study suggests the use of an absorbable polysaccharide powder in redo cardiac surgeries may be associated with reduced incidence of transfusions, lower CTO, and fewer reoperations due to suspected bleeding. While not always statistically significant, using a hemostatic agent in redo cardiac surgery demonstrated early clinical benefits with potential decreased hospital costs and improved outcomes. Caution should be exercised when interpreting results until validated with a fully powered, randomized trial. While no direct adverse events were found resulting from the use of a hemostatic agent, and no reoperations were noted in the intervention cohort, statistical significance was not consistently reached across all outcomes. Given preliminary findings, a hemostatic agent used in redo cardiac surgery may be beneficial to decrease the risk of bleeding and improve overall patient outcomes, however before implementing standard of practice, replication of results in a larger, randomized cohort is necessary.

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