

Association of Automated Saline Flush Delivery and Removal with Access Pressure Alarms in Acute Hemodialysis

Michael Aragon, MD, Sheshadri Thiruvankadam
 Outset Medical. San Jose, California



BACKGROUND

- Extracorporeal circuit clotting (ECC) is an established complication of hemodialysis (HD).
- ECC can lead to blood loss, treatment interruption, reduced efficiency and thrombosis.
- High arterial or venous pressure alarms are an early surrogate marker of ECC.
- Anticoagulation (e.g., heparin) can be used for circuit patency but increases bleeding risk.
- Evidence supports the use of saline flushes to reduce ECC without anticoagulation.
- There is no current guidance or recommendation on optimal intermittent saline flush volume or frequency to reduce ECC.
- The Tablo Hemodialysis System enables prescribing of intermittent saline flushes at a wide range of volumes and intervals and with automated fluid removal.
- Embedded sensors in Tablo detect arterial and venous pressure.
- Sensor alarm data in Tablo treatments with and without prescribed saline flush allow correlation between saline flush delivery and pressure-related alarms, as a surrogate marker for ECC.

OBJECTIVE

- To evaluate and report on the association between saline flush volume and frequency with the occurrence of high-pressure alarms during acute hemodialysis.

METHODS

- Study Design: Retrospective analysis of Tablo sensor data (IRB exempted)
- Population: Acute HD treatments
- Outcome Variable: High-pressure alarms (arterial or venous)
- Analysis: Multivariate logistic regression
- Covariates:
 - Saline flush volume and interval
 - Treatment duration
 - Blood and dialysate flow rates
 - Manual flush delivery
 - Systolic blood pressure (SBP) <100 mmHg

RESULTS

- Total treatments analyzed: 3,864
- Mean treatment time: 203.1 ± 50.6 mins
- Mean prescribed autoflush volume: 72.0 ± 24.9
- Mean prescribed interval: 32.6 ± 20.0 mins
- Maximum blood flow rate: 331.3 ± 54.3 mL/min
- Maximum dialysate flow rate: 292.4 ± 30.3 mL/min

Mean outcomes associated with treatment parameters of Acute Hemodialysis				
Parameter (unit of measure)	Mean	Standard deviation		
Prescribed auto flush volume (ml)	72.0	24.9		
Prescribed manual flush volume (ml)	64.5	22.7		
Prescribed saline flush interval (mins)	32.6	20.0		
Treatment Duration(mins)	203.1	50.6		
Blood flowrate Maximum (ml/min)	331.3	54.3		
Dialysate flowrate Maximum (ml/min)	292.4	30.3		
Total Autoflush Delivered per Tx (mL)	349.8	173.9		
Total Manual Flush Delivered per Tx (mL)	125.5	121.3		
Prescribed Low Saline Flush Interval(mins) *	0.71	0.45		
Low Systolic Blood Pressure (mmHg)*	0.41	0.49		
Tablo's Default Auto-Flush Parameters*	0.34	0.48		
Covariate associations via Odds Ratio (OR) with High-Pressure Alarming during Acute Hemodialysis				
Covariate	OR	Lower 95% CI	Upper 95% CI	p-value**
Total Manual Flush Delivered per Tx (mLs)	1.003413	1.002424	1.004402	<0.001
Low Systolic Blood Pressure (<100 mmHg)	1.219791	1.066245	1.395449	0.003
Prescribed Low Saline Flush Interval (<2000secs)	0.72897	0.547187	0.971143	0.031
Treatment Duration (mins)	1.003248	1.001813	1.004685	<0.001
*Boolean fields: Prescribed low saline flush interval was "TRUE" if 2000 seconds (~33.3 min) and "FALSE" if greater. Low Systolic Blood Pressure was "TRUE" if <100mm Hg and "FALSE" if greater. Auto Flush Parameters were "TRUE" if prescribed and "FALSE" if not prescribed				
** p <0.05 indicates statistical significance				

MULTIVARIATE ANALYSIS

- Systolic blood pressure (<100mmHG) was associated with higher odds ratio (OR: 1.22, CI: [1.07,1.40], p=0.003) of high-pressure alarms.
- Saline flush interval of <2000secs (<33.3 minutes) was associated with lower OR (OR: 0.73, CI: [0.55, 0.97, p =0.031) of occurrence.
- Manual flush volume and treatment duration reached statistical significance in reducing likelihood of high venous and arterial pressure alarms; however, effect sizes were small.

DISCUSSION

- Systolic blood pressure <100mmHg during hemodialysis may increase the incidence of pressure related alarms
- Saline flushes during hemodialysis at intervals <33.3mins may reduce the likelihood of high venous or arterial pressure alarms.
- Treatment duration and saline flush volume may have a small impact on the incidence of high venous and arterial pressure alarms

CONCLUSION

- These findings suggest that maintaining SBP >100mmHg while on dialysis and saline flush delivery frequency of <33.3 mins may help reduce high-pressure alarms that are early surrogate markers of ECC.
- Tablo's automated saline delivery can reduce user burden associated with the frequent saline flush delivery associated with fewer access related alarms during treatment.