Patterns in Saline Flush Intervals Observed in Hemodialysis (HD): The Scheduling of Saline Flushes and its Correlation with HD Treatment Variables.

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.Outset

Abstract

Extracorporeal circuit clotting (ECC) is a well-established complication of hemodialysis (HD), and is associated with an increased need for the administration of anticoagulants (e.g., heparin). The use of anticoagulants often leads to treatment interruptions, post-bolus adverse events, decreasing overall efficacy of treatment. Coagulation is most often associated with clotting of the prescribed filter, a problematic vascular access, fluctuations in blood pressure, and/or inefficient pre-dialysis anticoagulation efforts. Intermittent Predilution Convective Hemodialysis (IPCH) via Saline Flush, addresses the burden of ECC by providing a less hemotoxic anticoagulant, allows for less treatment interruptions due to ECC, and increases hourly clearance by adding convective clearance (middle molecule clearance) to standard hemodialysis treatment.

An analysis of non-home hemodialysis treatments performed by the Tablo® Hemodialysis System was performed to quantify the use of IPCH via Saline Flush in patients receiving HD. A multivariate analysis with high-pressure alarm occurrence as the dependent variable and key treatment parameters as covariates was done. The objective is to look at the associations of occurrence of high-pressure alarms with key treatment and patient parameters.

A total of 3,864 HD treatments were analyzed across multiple acute center/clinics. The mean cycle time was 203.1 ± 50.5 min, mean blood and dialysate flow rates of 331.3 ± 54.2 and 292.4 ± 30.3 ml/min, respectively. A positive association (OR: 1.21, CI: [1.06,1.39, p=<0.001) was noted between High-pressure Alarming (detection of a measurable increase in circuit pressure (venous, arterial) and a detection of low-systolic blood pressure. Conversely, the continuous monitoring of intradialytic pressure, and the automated saline delivery mechanism proves to be precise, with the observation of low saline flush intervals (administration of saline in short bursts) reporting a negative association (OR: 0.72, CI: [0.54, 0.97, p=<0.001) with high-pressure alarming.

Hemodialysis patients reporting low-systolic blood pressure are at a higher risk for ECC, yet precise machine alarming can mitigate this patient risk from going undetected. The standard of prescribing anticoagulants (e.g., heparin) in HD is no longer the state-of-the-art, therefore the ability to prescribe low-flush interval saline flushing (short-bursts) is of great advantage.

Introduction

Thoughtful patient assessment, precisions in machine alarming, and the pre-treatment prescription of Intermittent Predilution Convective Hemodialysis (IPCH), via a scheduled saline flush, addresses the risk of ECC by reducing dependence on anticoagulants and decreasing treatment interruptions.

Methods and Materials

A multivariate analysis with high-pressure alarm occurrence as the dependent variable and key treatment parameters as covariates was done. The objective is to look at the associations of occurrence of high-pressure alarms with key treatment and patient parameters.

Results

Table 1: Mean outcomes associated with treatment parameters of acute/sub-acute hemodialysis treatments.

	n	Mean	Std Dev
Patient Weight	3,864	23.67	40.76
Cycle Time	3,838	203.10	50.56
BFR Max	3,864	331.30	54.24
DFR Max	3,864	292.40	30.31
UFR Max	3,864	1,641.38	401.96

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The hemodialysis system is designed with the ability/option to prescribe a saline flush, at chosen intervals throughout the HD cycle. This prescription is at the discretion of the treating physician and is patient specific. The saline dilution volume is not given in bolus (single, large volume anticoagulation), yet is dispersed throughout the treatment in low-volume (multiple, short-burst volume of saline), with the HD system adjusting for this volume over the life of the treatment. The treating physician's pre-treatment prescription of IPCH, using low-interval dilutions of saline, should aid in keeping the patient's systolic blood pressure normalized, thus significantly decreasing the odds of a high-pressure alarm, which are directly related to ECC.

Table 2: Covariate associations via Odds Ratio (OR) with High-Pressure Alarming during acute/sub-acute hemodialysis treatments.

	OR	Lower CI	Upper CI	p-value*
manual_flush_observed	1.001	1.002	1.004	1.237 e-11
sbp_low	1.219	1.066	1.395	3.798 e-03
ufr_max	0.999	0.9994	0.9998	1.747 e-03
Is_low_FI	0.7289	0.5471	0.9711	3.076 e-02
cycle-time	1.003	1.001	1.004	8.938 e-06

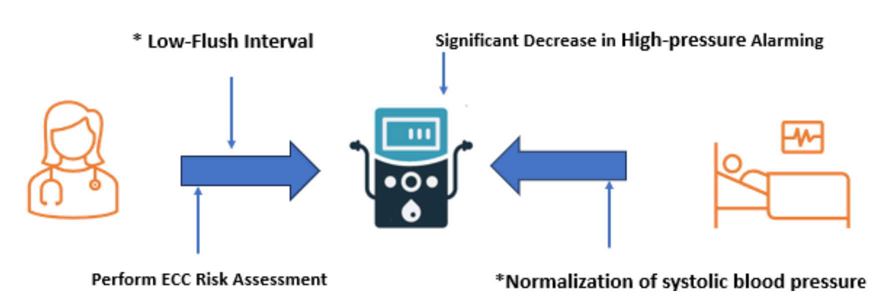
Positive associations with High Pressure Alarm: ['sbp_low']

Negative associations with High Pressure Alarm: ['Is_Low_FI']

Discussion

Novel approaches to HD prescriptions call for a novel dialysis machines, machines that allows for the mitigation of known HD complications, and intelligent machine alarming, all managed with the tip of the finger prior to beginning the dialysis treatment.

Figure 1: Proposed methodology for decreasing incidence of high-pressure (venous/arterial) machine alarming in HHD.



Conclusions

Hemodialysis patients reporting low-systolic blood pressure are at a higher risk for ECC, yet precise machine alarming can mitigate this patient risk from going undetected. The standard of prescribing anticoagulants (e.g., heparin) in HD is no longer the state-of-the-art, therefore the ability to prescribe low-flush interval saline flushing (short-bursts) is of great advantage.

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