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Hazard functioning modeling for dextrose fluids associated hemodilution; Cox-regressional analysis for patients' Hematocrit Hemoglobin Ratio

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Abstract

Aims: This study looks at the cox-regressional relationships between hematocrit to hemoglobin ratio (HHR) and a group of outcomes of interest (cOI). These outcomes include death from any cause, acute myocardial infarction, stroke, and severe dilutional hyponatraemia incidence. Additionally other outcome of interest in this study will be prolongation of admission days, infection rate, acute kidney injury, and mandating the transition to the critical unit and mechanical ventilation intubation. The study also will investigate the performances of the tested ratio and will explore their sensitivity, specificity, and accuracy indexes.

Methods: Between 2018 and 2022, a retrospective study was conducted at the King Hussein Medical Centre in Amman, Jordan, involving 926 patients. The study aimed to determine the potential risk of dilution of red blood cells in circulation caused by dextrose-containing fluids in patients with chronic kidney disease. The study aimed to determine the ideal threshold levels of the investigated ratio (HHR) to enhance clinical outcomes and safety margins, particularly in patients with severe renal impairment or chronic kidney disease in a hospital setting. The study included patients with fluctuating kidney function, renal replacement therapy, uncontrolled diabetes, and conditions necessitating specific fluid regimens. The study used binary logistic regression and cox-regression proportional hazard modelling to examine the correlation between the hematocrit to haemoglobin ratio and the composite outcomes of interest (cOI) in patients from Jordan. The findings suggest that higher cOI likelihood indicates a more advantageous condition, while lower values suggest a less advantageous condition.

Results: A retrospective study at the KHMC in Amman, Jordan, involved 1306 patients from 2018 to 2022. The study focused on the hematocrit to haemoglobin ratio (HHR) and achieved correct classification rates of 70.8%. The best HHR was 2.555:1, with a 42.8% chance of occurring at this level. Cox-Regression Proportional Hazard Modelling revealed a censored percentage of 83.4% in HHR>2.555 stratum and 51.5% in HHR≤2.555 stratum. The study found a high percentage of HD patients processed in the analysis.

Conclusion: Intravenous dextrose fluids associated hemodilutional state is linked to all-cause mortality in admitted medically and surgically patients and cardiovascular death. Low ratio increases the risk. Factors such as malnutrition and kidney function loss contribute to prognosis. Future studies should focus on mechanistic pathways, optimal targets, age, and sociodemographic factors.

Keywords: Hematocrit to hemoglobin ratio; Maintenance fluid associated hemodilutional Optimal operating thresholds; Overall health status; Cox-Regression Modeling; Jordanian cohort.

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1. Introduction

Anaemia is a commonly encountered complication among hospitalised patients; therefore, it is critical to have a thorough understanding of the incidence rate of anaemia throughout their hospitalisation. In order to normalise low concentrations of hematocrit and haemoglobin, blood transfusions are utilised; nevertheless, the accessibility and expense of blood supply continue to be constraints. Hemodilution, a frequently employed method, entails the addition of fluids to decrease the viscosity of blood. The presence of fluid-associated dilutional anaemia in conjunction with abrupt hyponatremia is particularly hazardous.

Hahn and his colleagues introduced the terms "red-cell mass" and "blood volume" in 1949 to denote the heightened mass and volume of red blood cells in comparison to the overall volume of blood. All blood cells may be diluted by intravenous fluids administered during surgery, leading to changes in red cell mass, haemoglobin concentration, and hematocrit. Hemodilution, in which plasma volume is increased through the use of crystalloid, colloid, or excess fluids, is an essential component of this process.

However, due to sodium movements, 80% of the administered dextrose is converted into intercellular fluid. The volume of plasma and the initial rate of extracellular fluids are both diminished as a result of the passive diffusion of water.As a secondary water intake source, fluids containing dextrose are frequently employed, which results in prolonged plasma constituted cells and electrolytes, including albumin and sodium levels, which are frequently hemodilutional.

Secondly, risk ratios for a variety of hemodilution scenarios can be calculated using relative risk statistics and distinct evaluations of acute and chronic phase RBC dilution. This is significant because, in the modern context of transfusion avoidance, there is currently no way to establish hematocrit or, more scientifically, hematocrit to haemoglobin ratio (HHR) cutoff levels and quantify the risk of hemodilutional consequences in admitted patients undergoing surgery or admitted to more advanced critical units.It is challenging to ascertain the impact of prolonged dextrose infusion spanning several days to weeks on haematocrit due to the paucity of research examining this approach.

To simulate the processes of the body, the isovolumic hemodilution method is utilised. This entails drawing blood and diluting it to multiple haematocrit levels using a plasma substitute solution. Nevertheless, this methodology has been deemed flawed on account of anaemia that develops during blood collection, drying, and the analysis of the haemodilution phase of rats; consequently, inaccurate haematocrit results may also ensue.Water intoxication in recuperating patients can be induced by the stimulation of antidiuretic hormone (ADH) by dextrose fluids and hemodilution. In contrast to dextrose water, which is hypotonic and dextrose metabolism yields only sodium bicarbonate, NaCl fluid solution is more suitable for this objective.

Stimulation of ADH results in increased water reabsorption in the renal system, which causes haemoglobin reduction in hemodilution simulations to be unpredictable. In solution, dextrose, a glucose and sugar carbohydrate, provides energy. It is capable of being metabolised into bicarbonate, which can cause artificial anaemia by reducing the level of Hb in the blood by up to 1 g/dL.It has been demonstrated that the hematocrit/hemoglobin ratio, which indicates the oxygen-carrying capacity of the blood, is associated with clinical outcomes. A low ratio was associated with a poor prognosis in patients with spontaneous intracerebral haemorrhages, and it was the best indicator of anaemia in patients with heart disease, according to Nilsson and Stegmayr.

Although the hematocrit/hemoglobin ratio can be used to monitor transfusion-associated hemodilutional in patients who are admitted to the hospital for medical or surgical reasons, it is not a reliable method without considering additional assessing measures, such as albumin and sodium hemodilutions. By integrating two or more of the previously mentioned variables into triage process evaluations or utilising the hematocrit to haemoglobin ratio (the variable of interest) in conjunction with the composite hemo-related ratio, models and assessments of reactivity to changes in the ratio, minimum and maximum patient ratios, and transfusion prediction at specific times can be generated.

Typically, the risk of infusion-associated hemodilution over time during treatment is described using a Cox-regressional Hazard Functioning model; if a clinician can estimate the probability of an adverse outcome, they may alter treatment. There are numerous reasons why the proposed hazard modelling is significant from both a clinical and research standpoint. This research examines the effects of hemodilution induced by dextrose fluids on patients who have been admitted to the hospital for medical or surgical procedures. The hypothesis posits that patients undergoing this intervention will exhibit reduced hematocrit and haemoglobin levels, or more precisely, a decreased hematocrit to haemoglobin ratio in subsequent assessments. This may be attributed to diminished or absent quantities of accompanying electrolytes, specifically sodium.

Undoubtedly, a correlation exists between patient mortality and haemoglobin and hematocrit levels; persistently low levels signify unfavourable clinical outcomes, while persistently high levels also contribute to increased morbidity and mortality. The objective of this retrospective study is to estimate the survival and hazard functions of patients who were admitted for medical and surgical procedures and were given fluids containing dextrose. We will specifically employ time-to-event analysis to examine the impact of dextrose-containing fluids, with a focus on those that are not containing saline sources.

2. Methodology

Between 2018 and 2022, a total of 926 patients were included in this observational study conducted at the King Hussein Medical Centre (KHMC) in Amman, Jordan. The study was retrospective and conducted at a single centre under the Royal Medical Services (RMS). The Institutional Review Board (IRB) has requested ethical approval to examine medical records from the Hakeem system. Individuals who were 18 years of age or older were regarded as adults. This study excluded individuals who had been diagnosed with chronic kidney disease (CKD) and exhibited symptoms such as proteinuria, haematuria, structural renal disease (with or without an estimated glomerular filtration rate of 60 mL/min/1.73 m2), individuals who had received a kidney transplant, or individuals with Stage 5 CKD who were undergoing dialysis. The study encompassed all medically and surgically admitted patients whose medical records contained a minimum of 80% of the necessary information. A retrospective study was conducted on patients who were admitted to the hospital for medical or surgical reasons.

The purpose of the study was to administer dextrose-containing fluid to these patients in order to observe the decline in the ratio of hematocrit to haemoglobin (Hct: Hb). The specific aim of the study was to determine the potential risk of dilution of red blood cells in circulation caused by these fluids. This data source was used in the present study to analyse the risk of a decrease in the Hct: Hb ratio due to the dilution of red blood cells in circulation. The study aimed to analyse the impact of these fluids on the ratio of hematocrit (Hct) to haemoglobin (Hb) by diluting red blood cells (RBCs) at different time intervals during admission. These admission intervals represent the combined outcome of the decline patterns of the Hct: Hb ratio at specific times following admission. The purpose of this study was to determine the ideal threshold levels of the investigated ratio, HHR, in order to enhance clinical outcomes and simultaneously enhance safety margins, specifically in patients with severe renal impairment or chronic kidney disease in a hospital setting.

Fluid therapy in hospital settings is frequently insufficiently monitored in patients with chronic renal failure and kidney disease, despite the well-meaning efforts. This can greatly enhance the likelihood of complications and mortality. Given the widespread and frequent use of fluids containing dextrose, a significant portion of the population is at a high risk of experiencing complications from hemodilution. Patients with fluctuating kidney function, undergoing renal replacement therapy, uncontrolled diabetes, and conditions necessitating specific fluid regimens were not included in the trial. If there was a 25% decrease in creatinine clearance from the initial measurement, the Data Safety Monitoring Board (DSMB) recommended stopping the administration of study fluids and making a +/- 30% adjustment at that time. This measure was implemented to prevent alterations in the patients' well-being that could have a prolonged impact on the outcome of the study intervention. If there is a change in serum sodium levels greater than 5mEq/L, along with symptoms of low or high sodium levels, the DSMB recommended stopping the administration of study fluids and making adjustments to serum sodium levels within a range of +/- 30%. This action was taken in response to the patients' concerns regarding the use of dextrose solutions, which led to the discovery of dilutional hyponatremia.

The demographic information of patients includes their age, gender, presence of any current ongoing investigation (cOI), duration of admission, and burden of comorbidities. Moreover, during this investigation, multiple biochemical parameters The hematocrit percentage (HCT%) and its hemoglobin-based quotient (HHR) were determined through manual calculations. Blood samples obtained from the peripheral or central ports access were used to collect and analyse statistical and clinical data. The blood samples were examined to obtain biochemical data, including sodium levels, as well as measurements of haemoglobin and hematocrit.

Initially, a binary logistic regression was conducted to examine the correlation between the hematocrit to haemoglobin ratio (HHR) and the composite outcomes of interest (cOI) in patients from Jordan. This analysis aimed to determine the magnitude of the correlations, the proportion of the dependent variable's variability explained by the independent variables, and the accuracy of predicting the dependent variable. We performed distinct Receiver Operating Characteristic (ROC) and sensitivity analyses for the two independent variables mentioned previously in order to evaluate their influence on the probability of cOI (complication of interest) events. These events may either have no instances of any OI (represented as negative or 0) or a greater likelihood of positive results, or they may involve at least one OI occurrence (represented as positive or 1) and a greater likelihood of negative results.

We illustrated the binary logistic correlation between the examined prognosticator of interest and the probability of cOI (critical organ injury) occurring. The BLgR (binary logistic regression) models presented in Table 1 were utilised for this analysis. Figure 1 displayed the ROC (receiver operating characteristic) results, while Table 2 presented the sensitivity tests. The findings were also utilised in Figure 2. A higher proportion of the cOI likelihood indicates a more advantageous condition, whereas a lower proportion indicates a less advantageous condition. In essence, when the values of the dependent variable are higher, it indicates a stronger support for the positive cOI condition, which in turn suggests a higher probability of unfavourable clinical outcomes. On the other hand, when the dependent variable values are lower, it suggests stronger evidence for the negative cOI condition, which means there is a higher likelihood of positive clinical outcomes.

In the context of cox-regression proportional hazard modelling analysis, we investigated two prognostic factors: the higher hematocrit to haemoglobin ratio (HHR) and the lower HHR [Stratum I vs. Stratum II]. We employed the Cox proportional hazards regression test to examine the hazard function (HR) while considering the mean sodium level (Na) as a covariate, which was measured at 130.14 mEq/l. The secondary conduction analysis investigated the disparities in sodium concentration (>129.51 mEq/l) between Stratum I and Stratum II. The Cox proportional hazards model was used to estimate the hazard function at the average value of the covariate HHR, which was 2.665:1. The study compared the composite outcome of interest (cOI) with the hazard function throughout the entire duration of patients' hemodialysis treatment (LOD) measured in years.

3. Results

An observational study with a retrospective approach was carried out at the KHMC at RMS in Amman, Jordan, with a total of 1306 patients participating in the various departments. The course of the study lasted from 2018 until 2022. For reasons such as missing data (more than 20%) or incorrect national or military identification numbers (especially for those who began or continued hemodialysis near 2018 and subsequently passed away, a total of 380 patients were not included in this study. This was due to the fact that the information that was provided was either incomplete or inaccurate.

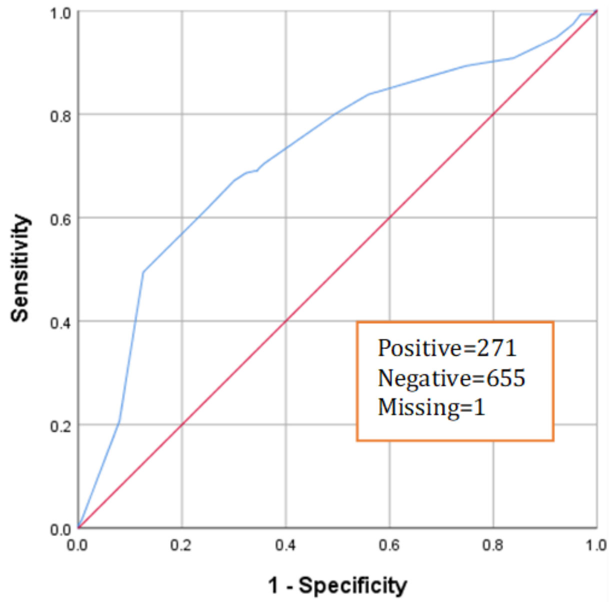
Table 1 The binary logistic regression analysis for hematocrit to haemoglobin ratio.

Tested predictors	**B±SEM**	**Wald**	**Sig.**	**Exp (B)**	**95% C.I. for EXP(B)**		**χ^2 (df) Sig**	**VR**	**%Cases**
					Lower	Upper			
%Prob of cOI	=e (16.033-6.388×HHR)/ [1+ e (16.033-6.388×HHR)]								
HHR	-6.388±0.655	95.143	0.000	0.002	0.000	0.006	(8) 63.329 0.000*	10.7%-15.3%	70.8%
Constant	16.033±1.723	86.549	0.000	9.18×10^4					

BLgR: The binary logistic regression.
Na: Sodium levels in mEq per l.
HHR: Hematocrit to hemoglobin ratio.
KHMC: King Hussein Medical Center.
HDU: The hemodialysis unit.
RMS: Royal Medical Services.
cOI: The composite Outcomes of Interest.

Based on the investigated hematocrit to haemoglobin ratio (HHR), the constructed BLgR-based models for proposing the percent probability of having positive cOI over negative cOI were [[e (16.033-6.388×HHR)/[1+ e (16.033-6.388×HHR)]. Furthermore, the study achieved correct classification rates of 70.8% (j2(8) = 63.329; p-value = 0.000) for the cases.

In contrast, the extent to which the dependent variable's variability is accounted for by our models varies between 10.7% and 15.3%, contingent upon whether the Cox & Snell R2 or Nagelkerke R2 methods are consulted (Table 1). In comparison to the probability of cOI positivity, the AUROCs± for the hematocrit to haemoglobin ratio (HHR) under investigation were 0.720±0.019 (95% CI: 0.682-0.758). Figure 1. In addition to the ROC illustrations, the positivity, negativity, and missing analysed values for each of the aforementioned prognosticator were [271, 655, and 1].



HHR vs %probability of cOI

AUC±SEM	p-Value
0.720±0.019 (95% CI; 0.682-0.758)	0.000*

Figure 1 The Receiver Operating Characteristic (ROC) test examined the area under the ROC curves (AUROCs) for hematocrit to haemoglobin ratio (HHR)

Table 2 The optimal cut-off points and other sensitivity indices for the investigated HHR

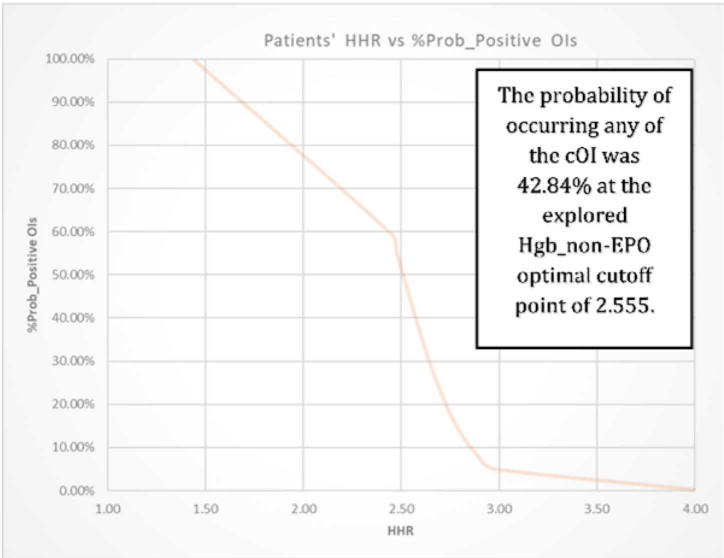
Prognostic Indicator	Cutoff	TPR	FPR	YI	TNR	PPV	NPV	NLR	PLR	AI
HHR	2.555	67.2%	30.1%	37.08%	69.92%	48.02%	83.73%	46.97%	223.29%	69.11%

TPR: True positive rate or sensitivity. FPR: False positive rate. YI: Youden's index. TNR: True negative rate or specificity. cOI: The composite Outcomes of Interest. Na: Sodium levels in mEq per l. HHR: Hematocrit to hemoglobin ratio.	KHMC: King Hussein Medical Center. HDU: The hemodialysis unit. RMS: Royal Medical Services. PPV: Positive predictive value. NPV: Negative predictive value. NLR: Negative likelihood ratio. PLR: Positive likelihood ratio. AI: Accuracy index.

The best levels for each of the HHR was 2.555:1, in terms of the chance of finding inferior cOI instead of superior cOI. Other sensitivity indices, like specificity, positive/negative predictive values, and accuracy index, showed different results than the ones listed above were [66.1%, 87.18%, 68.06%, 86.12%, and 80.99%]. The binary logistic regression analysis showed that any of the cOI had a 42.8% chance of happening at the best HHR of 2.555:1, as shown in Figure 2.

The findings from the analysis of Cox-Regression Proportional Hazard Modelling, which was linked to Hazard Functioning, revealed that the percentage of individuals who were censored was 83.4% in the HHR>2.555 stratum (Stratum I) and 51.5% in the HHR≤2.555 stratum (Stratum II), resulting in a total of 70.2%. For the HD patients who were the subject of the study, the percentage of cases that were processed in the cox-regressional proportional hazard analysis was approximately 98.2% (16 HD patients). The percentage of cases that were included in the analysis was

1.7%, while the percentage of cases that were excluded from the analysis was roughly 1.7%. In the secondary investigated prognosticator, the censored percentage was found to be 85.9% in the Na>129.51 stratum (Stratum I) and 31.9% in the Na≤129.51 stratum (Stratum II), resulting in a total of 70.4%.

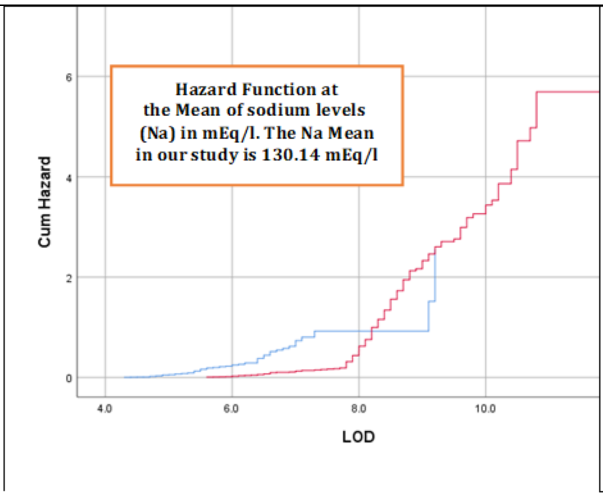


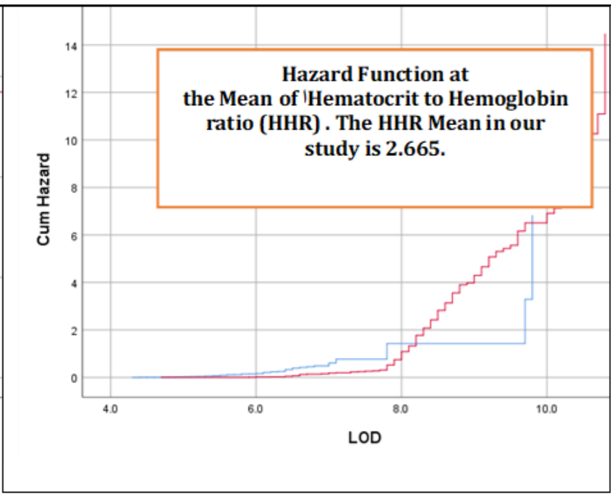
%cOI=e (16.033-6.388×HHR)/ [1+ e (16.033-6.388×HHR)]

Figure 2 The BLgR analyses contrasted

BLgR: The binary logistic regression
Na: Sodium levels in mEq per l.
HHR: Hematocrit to hemoglobin ratio.
KHMC: King Hussein Medical Center.
HDU: The hemodialysis unit.
RMS: Royal Medical Services.
cOI: The composite Outcomes of Interest

The cox-regressional proportional hazard analysis case processing summary for the HD patients who were studied was approximately 98.6% (914 HD patients) for cases that were included in the analysis and 1.3% (12 HD patients) for cases that were excluded from the analysis, respectively. Last but not least, it is of the utmost importance to mention that the cox-regressional models for the two prognosticators that were taken into consideration, namely HHR and Na, were as follows: [7.732±0.879 (95% CI; 406.7-12771), p-value=0.000, j2(1) =89.20, p-value<0.005] and [0.187±0.040 (95% CI; 1.114-1.304), p-value=0.000, j2(1) =21.244, p-value<0.005] respectively (Figure 4).





Stratum Status			
Stratum	Event	Censored	%Censored
Stratum I HHR>2.555	89	446	83.4%
Stratum II HHR≤2.555	182	193	51.5%
Total	271	639	70.2%

Case Processing Summary		
Cases available in analysis	Event	271 (29.2%)
	Censored	639 (68.9%)
	Total	910 (98.2%)
Cases dropped	Cases with missing values	1 (0.1%)
	Cases with negative time	0 (0.0%)
	Censored cases before	16 (1.7%)
	Total	17 (1.8%)
Total		927 (100.0%)

Cox-Regressional Model		
B±SEM	EXP (B) Sig	χ^2 Sig
0.187±0.040 (95% CI; 1.114-1.304)	1.205 0.000*	21.244 0.000*

Stratum Status			
Stratum	Event	Censored	%Censored
Stratum I Na>129.51 mEq/l	92	559	85.9%
Stratum II Na≤129.51 mEq/l	179	84	31.9%
Total	271	643	70.4%

Case Processing Summary		
Cases available in analysis	Event	271 (29.2%)
	Censored	643 (69.4%)
	Total	914 (98.6%)
Cases dropped	Cases with missing values	1(0.1%)
	Cases with negative time	0(0.0%)
	Censored cases before	12 (1.3%)
	Total	13(1.4%)
Total		927 (100.0%)

Cox-Regressional Model		
B±SEM	EXP (B) Sig	χ^2 Sig
7.732±0.879 (95% CI; 406.7-12771)	2279.13 0.000*	89.20 0.000*

Figure 3 The Cox-Regression Proportional Hazard Modeling analysis related Hazard Functioning

4. Discussion

An examination of dextrose fluids indicates that the likelihood of hemodilution is twice as high in comparison to patients receiving saline. The rising hazard ratios observed in older patients with elevated hematocrit and reduced haemoglobin levels indicate that older patients with efficient erythropoiesis are less vulnerable to the impact of fluids on hemodilution. Erythropoiesis is generally reduced in elderly individuals, resulting in a decreased susceptibility to alterations in fluid balance.

The study is subject to limitations, including potential bias and a decrease in data quality caused by a significant number of dropouts in hematocrit measurements. Hemodilution is potentially detrimental because it decreases blood viscosity, which in turn reduces microcirculatory blood flow. Additionally, the decreased oxygen carrying capacity of the blood impairs the delivery of oxygen to tissues, leading to tissue ischemia. The harmful effects of hemodilution vary depending on the underlying pathology. Acute haemorrhage is particularly harmful in cases of acute bleeding, while chronic diseases with elevated blood viscosity, such as coronary artery disease and cerebrovascular disease, can also be detrimental.

This study investigates the effect of dextrose infusion on red cell mass, a subject that has not been explored in prior research. The results indicate a gradual decrease in the proportion of red blood cells to the volume of plasma, with hematocrit and haemoglobin levels consistently decreasing following infusions. The study further confirms previous research that the sudden decrease in the number of red blood cells is mainly caused by dilution of the blood. The discrepancy in timing between the intervals of RBCP or Hb level compared to the stable pre-infusion values and the duration of dextrose infusion indicates a modification in the production and lifespan of red blood cells. The hazard rate curve measures the impact of these conditions on the patient over time, establishing specific clinical goals for medical intervention. The study concludes that a lower hematocrit ratio is associated with an elevated risk of patient mortality when receiving dextrose fluids. Hemodilution is linked to longer length of stay (LOS) and increased morbidity. To minimise harm to patients, it is advised to avoid using dextrose fluids during high-risk periods of surgery. The study proposes that a cost-efficient strategy involving the use of dextrose fluid and careful timing of administration can optimise patient outcomes.

This study demonstrates that there is a correlation between a specific ratio of the patient's hematocrit to the predicted Hb value and an elevated risk of postoperative complications, especially when using dextrose tonicity fluids. When the ratio is 1:1, there is a critical threshold where the increase in postoperative complications becomes significant. This information can be used as a risk-benefit analysis to evaluate the use of dextrose tonicity fluids for inducing hemodilution in situations where there are no specific fluid guidelines.

During a 7-year observational study involving 631 stable hemodialysis patients, it was found that low levels of sodium in the blood were independently associated with increased risk of death from any cause and cardiovascular-related causes, regardless of age. The study identified that the patients' hyponatremia was caused by fluid overload, inflammation, diet, and predialysis blood glucose. Stable hemodialysis patients with low serum sodium levels may suggest inadequate glucose control. Predialysis blood glucose levels are indicative of serum sodium levels. This indicates the need for further investigation into the prognostic factors of stable and healthy hemodialysis patients. Survival in decompensated heart failure patients was enhanced by late hemoconcentration, even in cases where the causes were unknown. Uninterrupted alleviation of congestion is crucial throughout the course of treatment. A comprehensive study was conducted on a cohort of 422 heart failure patients with hemoconcentration. The occurrence of hemoconcentration at a later stage was found to be associated with reduced duration of hospitalisation, decreased body weight, transition to oral diuretics, and increased dosage of loop diuretics. The survival rate for decompensated heart failure only improved when hemoconcentration was implemented after a late hospitalisation. This highlights the significance of maintaining decongestion in the treatment of heart failure.The range is from 27 to 29.

Preoperative serum sodium concentrations that exceed 142 mEq/L or fall below 138 mEq/L have been found to be associated with higher rates of morbidity and mortality. This suggests that the linear relationship between serum sodium concentrations and adverse outcomes should be reconsidered. This study found that both hypernatremia (with sodium levels between 143-145 mEq/L) and borderline hyponatremia (with sodium levels between 135-137 mEq/L) had an impact on perioperative morbidity and mortality. Preoperative serum sodium concentrations below 138 mEq/L and above 142 mEq/L were correlated with increased morbidity and mortality, even when falling within the "normal" range. Hematocrit monitoring conducted continuously resulted in a decrease in intradialytic symptoms among 280 renal patients, without any impact on treatment volumes or durations. Hemodialysis is essential for treating kidney disease, particularly in low-income nations. A study conducted from March 2019 to February 2023, involving 280 patients with renal impairment, revealed that individuals with renal disease, particularly those in low-income countries, require hemodialysis. Hematocrit monitoring conducted continuously resulted in a two-fold reduction in intradialytic symptoms among patients prone to hypotension, without any modifications to treatment schedules or volume.30-31

Hydrolysis significantly reduced the concentration of solute particles in the serum, and prompt identification and intervention are crucial due to the potential fatality. Reduced sodium levels led to an increase in weight gain between dialysis sessions, regardless of age. This weight gain was specifically caused by lower sodium levels during dialysis. The study examined the causes of hyponatremia in stable hemodialysis patients across all age groups. There was no observed correlation between blood sodium levels and the features listed in Table 1. The prevalence of diabetic nephropathy was higher in the low-sodium groups. There was an inverse relationship observed between blood salt levels and weight gain in older patients during the time between dialysis sessions. Low blood salt levels can serve as a prognostic indicator for stable hemodialysis patients across all age groups. The aetiology of hyponatremia remains unclear; however, it is advisable to screen stable hemodialysis patients with hypotonic blood sodium levels for diabetes mellitus. Statistically significant disparities were observed among sodium quartiles in various factors including body weight, diabetes, systolic blood pressure, interdialytic weight gain, total ultrafiltration, serum glucose, albumin, creatinine, vascular access, and hemolysis type. Individuals in the lowest quartile, Q1, of serum sodium levels exhibited a significantly reduced lean tissue index (LTI). Patients with sNa levels below 136 mEq/l had a higher independent risk of mortality, with an odds ratio (OR) of 1.62.The range of numbers is 32-33.

We utilised binary logistic regression analysis in our study to predict the likelihood of encountering inferior cOI instead of superior cOI. The optimal thresholds for sodium levels (Na) and hematocrit to haemoglobin ratio (HHR) were found to be 129.51 milliequivalents per litre (mEq/l) and 2.555 to 1, respectively. The optimal thresholds for these indices were 66.1%, 87.18%, 68.06%, 86.12%, and 80.99%. Moreover, our research revealed that a higher percentage of cOI indicates a positive state, while a lower percentage of cOI indicates a negative state. Decreased levels of sodium (Na) and high heart rate (HHR), combined with an increased limit of detection (LOD), provide stronger evidence in favour of the positive condition (lower coefficient of interest, cOI).

Our analysis using Cox-Regression Proportional Hazard Modelling revealed that in the HHR>2.555 stratum (Stratum I), 83.4% of individuals were censored. In the HHR≤2.555 stratum (Stratum II), 51.5% of individuals were censored. This gives a combined total of 70.2% of individuals who were censored. The case processing summary for patients with HD undergoing cox-regressional proportional hazard analysis reveals that 98.6% of cases were included in the analysis, while 1.3% of cases were excluded.

This study is limited because retrospective descriptive studies are unable to establish a direct cause-and-effect relationship between sodium and hemo-Quotient values and the likelihood of cOI. Including patients with end-stage renal disease (ESRD) in the study could introduce selection bias and restrict the ability to apply the findings to a broader population. In contrast to previous observational retrospective studies that did not examine these factors, this particular study did. The study examined the intricate correlation between sodium levels and hematocrit to haemoglobin ratios, and the detrimental impact on patients. Potential areas for future research encompass the application of multiple imputation in survival analysis, conducting simulation studies to expand upon the findings regarding Cox-Schoenfeld residuals, examining methods to test for homoscedasticity, exploring techniques to identify instances where specific functional forms of hazard ratio misspecification result in erroneous inferences on the proportional hazards assumption, and utilising transformations on the time variable. These areas are strongly connected to the examination of proportional hazards and have the potential to enhance our comprehension of how to make accurate inferences while utilising the Cox proportional hazards model.

5. Conclusions

Intravenous dextrose fluids associated hemodilutional state is linked to all-cause mortality in admitted medically and surgically patients and cardiovascular death. Low ratio increases the risk. Factors such as malnutrition and kidney function loss contribute to prognosis. Future studies should focus on mechanistic pathways, optimal targets, age, and sociodemographic factors.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in this manuscript

Statement of ethical approval

There is no animal/human subject involvement in this manuscript

Statement of informed consent

Owing to the retrospective design of this study, the informed consent form was waived.

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