

Supplementary material to Correa et. al. “Electrolyte Changes in Contemporary Hemodialysis: A Secondary Analysis of the Monitoring in Dialysis (MiD) Study”

Index of contents

Supplementary Table 1. Characteristics of the participants at baseline according to country of origin.

Supplementary Table 2. Characteristics of the dialysis prescription at baseline, according to country of origin.

Supplementary Table 3. Changes in pre-HD to post-HD serum electrolytes according to country of origin.

Supplementary Table 4. Fixed effect estimates from models predicting pre- to immediately post-HD electrolyte change from dialysate concentration and pre-dialysis electrolyte concentration in the MiD Study.

Supplementary Table 5. Predicted change in serum sodium concentration from pre-HD to post-HD measurement.

Supplementary Table 6. Predicted change in serum potassium concentration from pre-HD to post-HD measurement.

Supplementary Table 7. Predicted change in serum bicarbonate concentration from pre-HD to post-HD measurement.

Supplementary Table 8. Predicted change in serum calcium concentration from pre-HD to post-HD measurement.

Supplementary Figure 1. Predicted change in serum sodium (A, India; B, US), serum potassium (C, India; D, US), serum bicarbonate (E, India; F, US), and serum calcium (G, India; H, US), according to baseline serum electrolyte and dialysate prescription. Each graph is based on a model that adjusted for the pre-HD concentration of the corresponding electrolyte of interest.

Supplementary Table 1. Characteristics of the participants at baseline according to country of origin

Baseline Characteristics	All subjects (n=66)	United States (n=43)	India (n=23)	P-value
Age, years	56 ± 12	56 ± 12	57 ± 13	0.66
Male, n (%)	46 (70)	27 (63)	19 (83)	0.16
Race, n (%)				<0.001
Asian	23 (35)	0 (0)	23 (100)	
Black	35 (53)	35 (82)	0 (0)	
White	7 (11)	7 (16)	0 (0)	
Other	1 (1)	1 (2)	0 (0)	
ESRD vintage, years	2.4 [1.2, 5.3]	3.5 [1.2, 5.7]	2.2 [1.1, 3.0]	<0.001
Vascular access, n (%)				0.001
AV fistula	46 (71)	25 (59)	21 (91)	
AV graft	16 (25)	15 (36)	1 (4)	
Catheter	3 (5)	2 (5)	1 (4)	
Comorbid conditions, n (%)				
Diabetes mellitus	28 (43)	15 (35)	13 (56)	0.01
Hyperlipidemia	40 (61)	32 (74)	8 (35)	0.003
Hypertension	56 (85)	42 (98)	14 (61)	<0.001
Ischemic heart disease	32 (48)	22 (51)	10 (44)	0.61
Congestive heart failure	17 (26)	17 (40)	0 (0)	<0.001
Arrhythmia	21 (32)	21 (49)	0 (0)	<0.001
Atrial fibrillation	7 (11)	7 (16)	0 (0)	0.09
Systolic blood pressure, mmHg	141 ± 23	140 ± 26	143 ± 18	0.57
Diastolic blood pressure, mmHg	77 ± 13	76 ± 15	79 ± 7	0.18
Medication use, n(%)				
Aspirin	30 (45)	21 (49)	9 (39)	0.60
Statin	32 (48)	20 (47)	12 (52)	0.80
ACEI or ARB	22 (33)	20 (47)	2 (9)	<0.01
Beta-blockers	36 (55)	25 (58)	11 (48)	0.45
Pre-dialysis Laboratory values				
Blood urea nitrogen, mg/dL	60 ± 18	59 ± 16	62 ± 22	0.47
Creatinine, mg/dL	10.0 ± 3.4	10.9 ± 3.5	8.3 ± 2.4	0.01
Sodium, mEq/L	137 ± 4	138 ± 4	134 ± 4	<0.001
Potassium, mEq/L	5.0 ± 1.0	4.8 ± 0.7	5.4 ± 1.3	0.07
Calcium, mg/dL	8.7 ± 0.8	8.8 ± 0.8	8.4 ± 0.8	0.08
Bicarbonate, mEq/L	22 ± 4	23.8 ± 2.9	18.8 ± 2.9	<0.001
Magnesium, mg/dL	2.4 ± 0.5	2.2 ± 0.3	2.8 ± 0.6	0.001
Phosphorus, mg/dL	5.5 ± 2.0	5.7 ± 2.1	5.0 ± 1.9	0.19
Hemoglobin, g/dL	11 ± 1	10.8 ± 1.0	10 ± 2	0.12
Serum albumin, g/dL	3.9 ± 0.3	4.0 ± 0.3	3.8 ± 0.4	0.01

Continuous variables are presented as means ± standard deviation or median [25th, 75th percentiles]. Abbreviations: ESRD, end-stage renal disease; AV, arteriovenous; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker.

Percentages may not add to 100 due to rounding.

Supplementary Table 2. Characteristics of the dialysis prescription at baseline, according to country of origin

Baseline Characteristics	All subjects (n=66)	United States (n=43)	India (n=23)	P-value
Duration of hemodialysis, hours	4.0 [3.0, 6.0]	3.8 [3.0, 5.0]	4.0 [3.0, 6.0]	0.20
spKt/V	1.5 ± 0.4	1.5 ± 0.3	1.4 ± 0.6	0.44
Pre-dialysis weight, kg	86.7 ± 28.8	97.6 ± 28.7	66.5 ± 14.9	<0.001
Kg over dry weight target before dialysis	4.2 [-0.4, 12.0]	4.5 [0.7, 12.0]	4.1 [-0.4, 6.3]	0.07
UFR, ml/kg/h	10 ± 4	10 ± 4	10 ± 4	0.74
Dialysate Flow, mL/min	600 [500, 800]	664 [600, 800]	500 [485, 500]	<0.001
Blood Flow, mL/min	390 [324, 461]	437 [391, 491]	302 [262, 332]	<0.001
High-flux dialyzer, n (%)	42 (64)	40 (93)	2 (8.7)	<0.001
Membrane reuse, n (%)	18 (27)	10 (23)	8 (35)	0.39
Cellulose membrane, n (%)	5 (8)	0 (0)	5 (22)	<0.01
Dialysate temperature, n (%)				<0.01
35.5 Celsius	1 (2)	1 (2)	0 (0)	
36.0 Celsius	3 (5)	3 (7)	0 (0)	
36.5 Celsius	5 (8)	0 (0)	5 (22)	
37.0 Celsius	57 (86)	39 (91)	18 (78)	
Dialysate potassium, n (%)				<0.01
1.0 mEq/L	1 (2)	1 (2)	0 (0)	
2.0 mEq/L	53 (80)	30 (70)	13 (100)	
3.0 mEq/L	11 (17)	11 (26)	0 (0)	
4.0 mEq/L	1 (2)	1 (2)	0 (0)	
Dialysate calcium, n (%)				<0.001
1.5 and 1.6 mEq/L	13 (20)	0 (0)	13 (56)	
2.0 and 2.5 mEq/L	39 (59)	39 (91)	0 (0)	
3.0 and 3.5 mEq/L	14 (21)	4 (9)	10 (44)	
Dialysate sodium, n (%)				0.45
135 mEq/L	6 (10)	3 (7)	3 (17)	
138 mEq/L	6 (10)	4 (9)	2 (11)	
140 mEq/L	49 (80)	36 (84)	13 (72)	
Dialysate Bicarbonate, n (%)				<0.001
24 - 32 mEq/L	16 (24)	6 (14)	10 (43)	
33 - 36 mEq/L	34 (52)	21 (49)	13 (57)	
37 - 40 mEq/L	16 (24)	16 (37)	0 (0)	

Continuous variables are presented as means ± standard deviation or median [25th, 75th percentiles]. Abbreviations: spKt/V, single-pool Kt/V; UFR, ultrafiltration rate. Percentages may not add to 100 due to rounding.

Supplementary Table 3. Changes in pre-HD to post-HD serum electrolytes according to country of origin.

	<i>Change in serum electrolyte (post-HD minus pre-HD) in mEq/L or mg/dL* Mean (SE)</i>					
	Unadjusted		Model 1		Model 2	
Dialysate Sodium n/N (%)	US	India	US	India	US	India
135 (mEq/L) 191/1511 (13%)	-1.4 (0.6)	3.7 (1.6)	-2.2 (0.4)	3.6 (1.5)	-2.2 (0.4)	3.7 (1.5)
138 (mEq/L) 146/1511 (10%)	-0.2 (1.3)	-1.5 (1.9)	-0.5 (0.6)	0.2 (1.8)	-0.5 (0.6)	0.2 (1.8)
140 (mEq/L) 1174/1511 (78%)	0.1 (0.4)	0.7 (0.8)	0.3 (0.2)	0.3 (0.7)	0.3 (0.2)	0.1 (0.7)
P-value	0.01	0.09	<0.001	0.12	<0.001	0.10
Dialysate Potassium n/N (%)						
1 and 2 (mEq/L) 1336/1630 (82%)	-1.3 (0.1)	-1.3 (0.1)	-1.3 (0.04)	-1.3 (0.1)	-1.3 (0.04)	-1.3 (0.1)
3 and 4 (mEq/L) 294/1630 (18%)	-0.8 (0.1)	-	-0.9 (0.1)	-	-0.9 (0.1)	-
P-value	<0.001	NA	<0.001	NA	<0.001	NA
Dialysate Bicarbonate n/N (%)						
24 to 32 (mEq/L) 351/1610 (22%)	2.7 (0.7)	6 (0.4)	2.1 (0.6)	5.9 (0.5)	2.0 (0.6)	5.8 (0.6)
33 to 36 (mEq/L) 803/1610 (50%)	4.2 (0.4)	5.5 (0.4)	3.6 (0.4)	5.4 (0.5)	3.6 (0.4)	5.5 (0.5)
37 to 40 (mEq/L) 456/1610 (28%)	5.0 (0.4)	-	5.9 (0.4)	-	5.9 (0.4)	-
P-value	0.01	0.31	<0.001	0.49	<0.001	0.67
Dialysate Calcium n/N (%)						
1.5 and 1.6 (mEq/L) 359/1647 (22%)	-	1.2 (0.3)	-	1.1 (0.3)	-	1.1 (0.3)
2 and 2.5 (mEq/L) 926/1647 (22%)	0.3 (0.1)	-	0.3 (0.1)	-	0.3 (0.1)	-
3 and 3.5 (mEq/L) 362/1647 (22%)	1.1 (0.1)	1.3 (0.3)	1.4 (0.1)	1.4 (0.3)	1.4 (0.1)	1.4 (0.3)
P-value	<0.001	0.86	<0.001	0.56	<0.001	0.56

Model 1 adjusted for the pre-dialysis serum concentration; Model 2 adjusted for the pre-dialysis serum concentration and dialysis session length.

P-values for global difference in change of serum electrolyte concentration across categories of dialysate prescription.

* Changes in serum sodium, potassium and bicarbonate are presented in mEq/L; changes in serum calcium are presented in mg/dL.

The total number of sessions with laboratory data may vary due to missing collections or data recording. Percentages may not add to 100 due to rounding

Supplementary Table 4. Fixed effect estimates from models predicting pre- to immediately post-HD electrolyte change from dialysate concentration and pre-dialysis electrolyte concentration in the MiD Study

General formula to estimate electrolyte change							
Electrolyte Change = Intercept + Dialysate Concentration*Value + Pre-HD Electrolyte Concentration*Value + Random Coefficient*Value							
Estimates for fixed effect models							
Sodium change		Potassium change		Bicarbonate change		Calcium change	
	Estimate		Estimate		Estimate		Estimate
Intercept	98.4934	Intercept	-2.1318	Intercept	18.1823	Intercept	-0.9714
Dialysate Na 135	-2.0521	Dialysate K 1	-0.9748	Dialysate Bicarbonate 24-32	-2.9452	Dialysate Calcium 1.5 and 1.6	-0.461
Dialysate Na 138	-1.0502	Dialysate K 2	-0.6068	Dialysate Bicarbonate 33-36	-2.1587	Dialysate Calcium 2 and 2.5	-0.9256
Dialysate Na 140	Reference	Dialysate K 3	-0.2718	Dialysate Bicarbonate 37-40	Reference	Dialysate Calcium 3.0 and 3.5	Reference
Pre-HD Na	-0.7139	Dialysate K 4	Reference	Pre-HD Bicarbonate	-0.522	Pre-HD Ca 7.0-7.5	3.1478
		Pre-HD K 3.0-3.5	2.5824			Pre-HD Ca 7.6-8.0	2.781
		Pre-HD K 3.6-4.0	2.158			Pre-HD Ca 8.1-8.5	2.5544
		Pre-HD K 4.1-4.5	1.8006			Pre-HD Ca 8.6-9.0	2.232
		Pre-HD K 4.6-5.0	1.4941			Pre-HD Ca 9.1-9.5	1.9723
		Pre-HD K 5.1-5.5	1.1744			Pre-HD Ca 9.6-10.0	1.6949
		Pre-HD K 5.6-6.0	0.8316			Pre-HD Ca 10.1-10.5	1.3898
		Pre-HD K 6.1-6.5	0.4361			Pre-HD Ca 10.6-11.0	1.3668
		Pre-HD K 6.6-7.0	Reference			Pre-HD Ca 11.1-11.5	0.6853
						Pre-HD Ca 11.6-12.0	Reference

Supplementary Table 5. Predicted change in serum sodium concentration from pre-HD to post-HD measurement.

Pre-HD sodium concentration (mEq/L)	Dialysate sodium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate sodium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate sodium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)
130	135	3.6	138	4.6	140	5.7
131	135	2.9	138	3.9	140	5
132	135	2.2	138	3.2	140	4.3
133	135	1.5	138	2.5	140	3.5
134	135	0.8	138	1.8	140	2.8
135	135	0.1	138	1.1	140	2.1
136	135	-0.6	138	0.4	140	1.4
137	135	-1.4	138	-0.4	140	0.7
138	135	-2.1	138	-1.1	140	0
139	135	-2.8	138	-1.8	140	-0.7
140	135	-3.5	138	-2.5	140	-1.4
141	135	-4.2	138	-3.2	140	-2.2
142	135	-4.9	138	-3.9	140	-2.9
143	135	-5.6	138	-4.6	140	-3.6
144	135	-6.4	138	-5.4	140	-4.3
145	135	-7.1	138	-6.1	140	-5

Abbreviations: HD, hemodialysis.

Predictive model for post-dialysis serum sodium concentration accounts for pre-dialysis serum sodium concentration and dialysate sodium prescription.

Supplementary Table 6. Predicted change in serum potassium concentration from pre-HD to post-HD measurement.

Pre-HD potassium concentration (mEq/L)	Dialysate potassium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate potassium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate potassium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate potassium concentration (mEq/L)	Expected Change Pre-Post (mEq/L)
3.0-3.5	1	-0.5	2	-0.2	3	0.2	4	0.5
3.6-4.0	1	-0.9	2	-0.6	3	-0.2	4	0
4.1-4.5	1	-1.3	2	-0.9	3	-0.6	4	-0.3
4.6-5.0	1	-1.6	2	-1.2	3	-0.9	4	-0.6
5.1-5.5	1	-1.9	2	-1.6	3	-1.2	4	-1
5.6-6.0	1	-2.3	2	-1.9	3	-1.6	4	-1.3
6.1-6.5	1	-2.7	2	-2.3	3	-2	4	-1.7
6.6-7.0	1	-3.1	2	-2.7	3	-2.4	4	-2.1

Abbreviations: HD, hemodialysis.

Predictive model for post-dialysis serum potassium concentration accounts for pre-dialysis serum potassium concentration and dialysate potassium prescription.

Supplementary Table 7. Predicted change in serum bicarbonate concentration from pre-HD to post-HD measurement.

Pre-HD bicarbonate concentration (mEq/L)	Dialysate bicarbonate concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate bicarbonate concentration (mEq/L)	Expected Change Pre-Post (mEq/L)	Dialysate bicarbonate concentration (mEq/L)	Expected Change Pre-Post (mEq/L)
15	24 to 32	7.4	33 to 36	8.2	37 to 40	10.4
16	24 to 32	6.9	33 to 36	7.7	37 to 40	9.8
17	24 to 32	6.4	33 to 36	7.1	37 to 40	9.3
18	24 to 32	5.8	33 to 36	6.6	37 to 40	8.8
19	24 to 32	5.3	33 to 36	6.1	37 to 40	8.3
20	24 to 32	4.8	33 to 36	5.6	37 to 40	7.7
21	24 to 32	4.3	33 to 36	5.1	37 to 40	7.2
22	24 to 32	3.8	33 to 36	4.5	37 to 40	6.7
23	24 to 32	3.2	33 to 36	4	37 to 40	6.2
24	24 to 32	2.7	33 to 36	3.5	37 to 40	5.7
25	24 to 32	2.2	33 to 36	3	37 to 40	5.1
26	24 to 32	1.7	33 to 36	2.5	37 to 40	4.6
27	24 to 32	1.1	33 to 36	1.9	37 to 40	4.1
28	24 to 32	0.6	33 to 36	1.4	37 to 40	3.6
29	24 to 32	0.1	33 to 36	0.9	37 to 40	3
30	24 to 32	-0.4	33 to 36	0.4	37 to 40	2.5
31	24 to 32	-0.9	33 to 36	-0.2	37 to 40	2
32	24 to 32	-1.5	33 to 36	-0.7	37 to 40	1.5
33	24 to 32	-2	33 to 36	-1.2	37 to 40	1
34	24 to 32	-2.5	33 to 36	-1.7	37 to 40	0.4
35	24 to 32	-3	33 to 36	-2.2	37 to 40	-0.1
36	24 to 32	-3.6	33 to 36	-2.8	37 to 40	-0.6
37	24 to 32	-4.1	33 to 36	-3.3	37 to 40	-1.1
38	24 to 32	-4.6	33 to 36	-3.8	37 to 40	-1.7
39	24 to 32	-5.1	33 to 36	-4.3	37 to 40	-2.2
40	24 to 32	-5.6	33 to 36	-4.9	37 to 40	-2.7

Abbreviations: HD, hemodialysis.

Predictive model for post-dialysis serum bicarbonate concentration accounts for pre-dialysis serum bicarbonate concentration and dialysate bicarbonate prescription.

Supplementary Table 8. Predicted post-HD serum calcium concentration.

Pre-HD calcium concentration (mg/dL)	Dialysate calcium concentration (mEq/L)	Expected Change Pre-Post (mg/dL)	Dialysate calcium concentration (mEq/L)	Expected Change Pre-Post (mg/dL)	Dialysate calcium concentration (mEq/L)	Expected Change Pre-Post (mg/dL)
7.0-7.5	1.5 and 1.6	1.7	2 and 2.5	1.3	3.0 and 3.5	2.2
7.6-8.0	1.5 and 1.6	1.3	2 and 2.5	0.9	3.0 and 3.5	1.8
8.1-8.5	1.5 and 1.6	1.1	2 and 2.5	0.7	3.0 and 3.5	1.6
8.6-9.0	1.5 and 1.6	0.8	2 and 2.5	0.3	3.0 and 3.5	1.3
9.1-9.5	1.5 and 1.6	0.5	2 and 2.5	0.1	3.0 and 3.5	1
9.6-10.0	1.5 and 1.6	0.3	2 and 2.5	-0.2	3.0 and 3.5	0.7
10.1-10.5	1.5 and 1.6	0	2 and 2.5	-0.5	3.0 and 3.5	0.4
10.6-11.0	1.5 and 1.6	-0.1	2 and 2.5	-0.5	3.0 and 3.5	0.4
11.1-11.5	1.5 and 1.6	-0.7	2 and 2.5	-1.2	3.0 and 3.5	-0.3
11.5-12.0	1.5 and 1.6	-1.4	2 and 2.5	-1.9	3.0 and 3.5	-1

Abbreviations: HD, hemodialysis.

Predictive model for post-dialysis serum calcium concentration accounts for pre-dialysis serum calcium concentration and dialysate calcium prescription.

Supplementary Figure 1. Predicted change in serum sodium (A, India; B, US), serum potassium (C, India; D, US), serum bicarbonate (E, India; F, US), and serum calcium (G, India; H, US), according to baseline serum electrolyte and dialysate prescription. Each graph is based on a model that adjusted for the pre-HD concentration of the corresponding electrolyte of interest.

