

The high-volume pre-dilution on-line HDF (HV Pre O-HDF) is the ideal blood purification method from the point of amino acid nutritional view

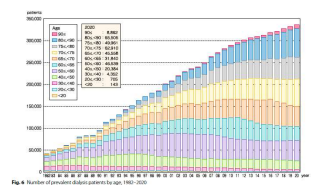
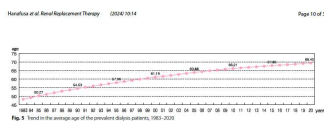
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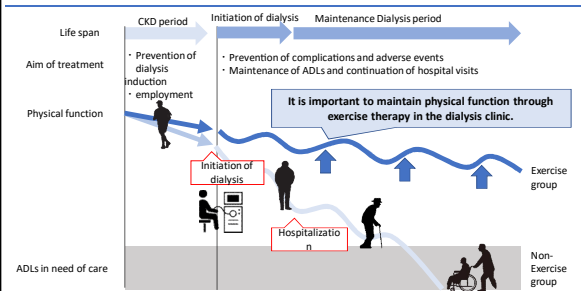
Background

Japanese dialysis patients: Mean Age and Distribution



Elderly ESRD patients with sarcopenia and frailty have been recently increased in Japan.

Lifespan and Rehabilitation of Dialysis Patients



Diagnosis of Frail

Item	Description
Shrinking	Unintentionally lost 2 kg or more in past 6 months
Weakness	Grip strength <28 kg in men or 18 kg in women
Exhaustion	In the past 2 weeks, have you felt tired without reason?
Slowness	Gait speed <1.0 m/s
Low activity	Engages in moderate levels of physical exercise or sport

CLINICAL FRAILTY SCALE

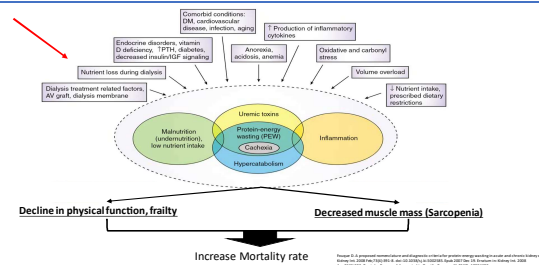
- 1 VERY ROBUST** People of an advanced age, energetic and independent. They will continue to enjoy an active life for many years.
- 2 ROBUST** People who have no chronic diseases, but are not as fit as those in category 1. Often, they exercise or are very active occasionally, as, normally.
- 3 MARGINAL FRAILTY** People whose medical problems are well controlled, but who are not regularly active beyond their walking.
- 4 MILD FRAILTY** People who have 1 or 2 chronic diseases but are not as fit as those in category 1. Often, they exercise or are very active occasionally, as, normally.
- 5 MODERATE FRAILTY** People who often have medical problems, and need help with high water intake and activities of daily living. They exercise occasionally, but not as often as those in category 1. They are dependent on others for help with some tasks, and they are not as fit as those in category 1.
- 6 SEVERE FRAILTY** People who need help with all activities of daily living and with walking. They are dependent on others for help with most tasks, and they are not as fit as those in category 1.
- 7 VERY SEVERE FRAILTY** Completely dependent for personal care. This category is for people who are dependent on others for help with most tasks, and they are not as fit as those in category 1.
- 8 EXTREMELY SEVERE FRAILTY** Completely dependent for personal care and appearing frail. This category is for people who are dependent on others for help with most tasks, and they are not as fit as those in category 1.
- 9 TERMINALLY ILL** Approaching the end of life. This category applies to people who are dependent on others for help with most tasks, and they are not as fit as those in category 1.

SCORING FRAILTY IN PEOPLE WITH DEMENTIA

The frailty scale is scored as follows: 1 = Very Robust, 2 = Robust, 3 = Marginal Frailty, 4 = Mild Frailty, 5 = Moderate Frailty, 6 = Severe Frailty, 7 = Very Severe Frailty, 8 = Extremely Severe Frailty, 9 = Terminally Ill.

DELIVERSE UNIVERSITY

Issues with HD patients



It's important to prevent frailty, sarcopenia, and declines in physical function and activity level.

Nutrient loss during dialysis ?

Amino Acids and Albumin

As for albumin, it is possible to suppress albumin loss under the current dialyzers.

Table 4. Amino acid losses in the dialysate with different dialyzers (μmol/liter; N = 9)

Amino acid	CU	PMMA	PS-1st use	PS-6th reuse
1-Methylhistidine	1.7 ± 1.2	1.0 ± 0.9	1.7 ± 1.9	NM
3-Methylhistidine	2.1 ± 1.4	1.3 ± 1.4	2.1 ± 1.1	NM
Alanine	49 ± 24*	32 ± 13	44 ± 24	84 ± 48
Arginine	16 ± 7*	12 ± 5	18 ± 8	22 ± 17
Asparagine	11 ± 7	7.7 ± 4.2	12 ± 6*	27 ± 11*
Aspartate	1.0 ± 0.3*	0.6 ± 0.2	0.8 ± 0.5	4.6 ± 2.7*
Citrulline	11 ± 5*	8.0 ± 5.0	11 ± 5	12 ± 9
Glutamate	25 ± 10*	18 ± 4	27 ± 11*	23 ± 23
Glycine	49 ± 30	39 ± 18	53 ± 33	84 ± 58
Glutamine	70 ± 10	82 ± 12	82 ± 12	92 ± 49
Histidine	7.2 ± 3.6	6.4 ± 2.7	9.6 ± 4.3*	13.2 ± 6.2
Hydroxyproline	4.1 ± 2.2	3.2 ± 1.6	4.6 ± 3.2	9.8 ± 7.5
Isoleucine	12 ± 6	11 ± 4	16 ± 7*	15 ± 9
Leucine	21 ± 8	19 ± 7	27 ± 9*	34 ± 12
Lysine	20 ± 10	19 ± 7	27 ± 13*	18 ± 12
Methionine	4.7 ± 3.9*	2.6 ± 2.4	4.3 ± 3.1*	22 ± 14*
Ornithine	7.8 ± 3.9	8.2 ± 3.1	10.4 ± 4.7*	7.6 ± 4.1
Phenylalanine	12 ± 6	10 ± 5	14 ± 5*	12 ± 6
Proline	52 ± 25*	38 ± 16	52 ± 27	156 ± 64*
Serine	19 ± 17	14 ± 9	19 ± 12*	44 ± 50
Taurine	9.0 ± 4.4	7.3 ± 3.3	8.9 ± 3.4	37 ± 20*
Threonine	13 ± 11	6.8 ± 5.9	15 ± 14*	18 ± 11
Tryptophan	3.2 ± 1.4	2.6 ± 0.9	3.2 ± 1.1	7.3 ± 2.7*
Tyrosine	6.8 ± 3.9	5.2 ± 3.0	7.9 ± 3.4*	9.6 ± 4.0
Valine	31 ± 15	27 ± 11	36 ± 16*	52 ± 12
Total	457 ± 178	382 ± 102	504 ± 190*	804 ± 302
BCAA	63 ± 28	57 ± 22	79 ± 32*	102 ± 29
Essential	139 ± 62	117 ± 42	169 ± 73*	214 ± 65
Non-essential	318 ± 118*	265 ± 63	335 ± 120*	590 ± 246*
Total dialysis	7.2 ± 2.6	6.1 ± 1.5	8.0 ± 2.8	12.2 ± 4.4

Amino acid and albumin losses during hemodialysis
Ikizler TA, et. al: KI Vol. 46 (1994), pp 830-837

Total amino acid loss
6.1 ± 1.5 - 12.2 ± 4.4 g/session

Kato et al. *Renal Replacement Therapy* (2022) 8:51
<https://doi.org/10.1186/s41100-022-00441-4>

Renal Replacement Therapy

RESEARCH Open Access

High-volume pre-dilution on-line hemodiafiltration is the adequate blood purification method from the viewpoint of amino acid nutrition

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【 Aim 】

It seems to be important to restrain these amino acid losses during dialysis session from the point of nutritional view. We analyzed the amino acid losses that occur on performing high volume pre-dilution on-line HDF (HV Pre O-HDF) , HD, and post-dilution on-line HDF(Post O-HDF).

【 Methods 】

We compared the amino acid and albumin amount into the total waste fluid, reduction rate of β_2 -microglobulin (β_2 -MG) and Kt/V (urea) in same 9 patients when they received HV Pre O-HDF, Post O-HDF and HD.

Number of Patients 9	
Gender ; N	Male:7 Female:2
Age ; years	71.4 ± 2.5
Dialysis vintage ; years	9.3 ± 7.1
Diabetes ; N	4

Patient characteristics

【HV Pre O-HDF and HD prescription】

	HV Pre O-HDF	HD
Hemodiafilter Dialyzer	MFX-21Meco	FX-220
Dialysate flow rate	600ml/min	500ml/min
Replacement flow rate	400ml/min	-
Replacement fluid volume	90L/session	-
Treatment time	4hr	
Blood flow rate	200ml/min	

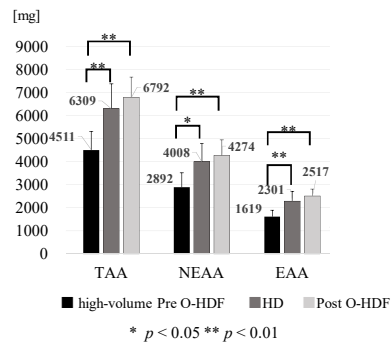
Hemodiafilter MFX21Meco(Nipro, Ltd) was used for HV Pre O-HDF and Dialyzer FX-220(Fresenius Ltd) was for HD. These hemodiafilter and dialyzer were designed to suppress albumin leakage as possible as during dialysis session.

【Post HDF prescription】

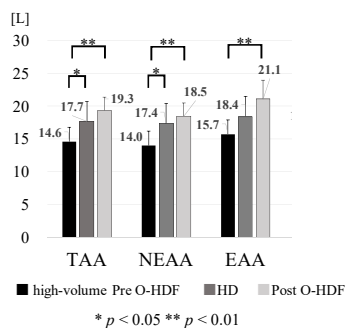
	Post O-HDF
Hemodiafilter Dialyzer	MFX-21Meco
Dialysate flow rate	600ml/min
Replacement flow rate	400ml/min
Replacement fluid volume	10L/session
Treatment time	4hr
Blood flow rate	200ml/min

Hemodiafilter MFX21Meco(Nipro, Ltd) was used for HV Pre O-HDF and Dialyzer FX-220(Fresenius Ltd) was for HD. These hemodiafilter and dialyzer were designed to suppress albumin leakage as possible as during dialysis session.

[Results]



[Results]



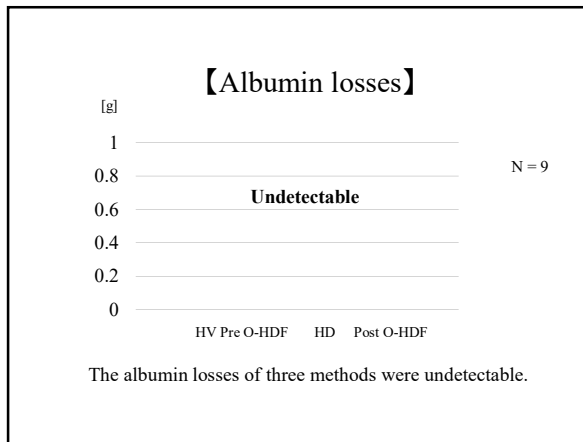
[Results]

Table 2 The subjects' general condition

	High-volume Pre O-HDF	Post O-HDF	HD	p value		
				High-volume Pre O-HDF vs. Post O-HDF	High-volume Pre O-HDF vs. HD	Post O-HDF vs. HD
Body weight (kg)	58.4 ± 9.6	57.2 ± 10.0	58.2 ± 9.9			0.964
Serum albumin (g/dL)	3.3 ± 0.3	3.7 ± 0.2	3.5 ± 0.3			0.055
nPCR (g/kg/day)	0.80 ± 0.07	0.83 ± 0.12	0.86 ± 0.11			0.494
QFR	89.7 ± 5.3	91.9 ± 4.8	92.2 ± 6.4			0.627
Total AA (nmol/ml)	2439 ± 333	2757 ± 341	2782 ± 331			0.095
NEAA (nmol/ml)	1677 ± 284	1871 ± 295	1851 ± 312			0.372
EAA (nmol/ml)	762 ± 96	885 ± 78	931 ± 92		0.002	0.567
BCAA (nmol/ml)	357 ± 56	387 ± 51	438 ± 65	0.574	0.029	0.212

Table 5 The β_2 -MG reduction rates and KtV for urea among the three procedures

	High-volume Pre O-HDF	Post O-HDF	HD	p value		
				High-volume Pre O-HDF vs Post O-HDF	High-volume Pre O-HDF vs HD	Post O-HDF vs HD
β_2 -MG reduction rate [%]	69.8±5.0	75.9±3.8	65.3±5.0	0.036	0.150	<0.01
KtV for urea	1.33±0.17	1.48±0.27	1.45±0.23	0.381		



【Discussion】

① : Because the amino acids concentration on the blood side decreased with dilution, it was thought that the diffusive effect of amino acids were less likely to occur with pre-HDF than with HD and post-HDF.

② : The HV Pre O-HDF can restrain the amino acid loss more effectively than the less volume Pre O-HDF.

【 Conclusion 】

The HV Pre O-HDF can restrain the amino acid loss more effectively than HD and Post O-HDF. Both of hemodiafilter and dialyzer which were used in this study showed extremely low albumin leakage. This method is most powerful method to restrain amino acid and albumin losses in order to keep nutritional condition to avoid sarcopenia and frailty in elderly ESRD patients.

Other papers about amino acids loss and HDF

ORIGINAL RESEARCH

Differences and Effects of Metabolic Fate of Individual Amino Acid Loss in High-Efficiency Hemodialysis and Hemodiafiltration

Stefano Moras, MD,* Roberto Aquilini, MD,† Paolo Ladarola, PhD,‡ M. L. Dianni, MD,* R. Sesti, RN,* M. Cadeddu, RN,* and Piergiorgio Bellomo, MD‡

Journal of Renal Nutrition, Vol 30, No 5 (September), 2020: pp 440-451

Substitution Volume of Pre-dilution On-Line HDF : 47 L
 Substitution Volume of Pre-dilution On-Line HDF : 21.7 L

Table 3. Loss of Amino Acids (AA) in mg per Hemodialysis Session in the Three Different Extracorporeal Methodologies

	HED	HDF post	HDF pre
Essential Amino Acids (EAA)			
Valine	319 ± 131 [†]	334 ± 188 [†]	339 ± 102 [†]
Histidine	292 ± 142 [‡]	330 ± 146 [‡]	242 ± 118
Leucine	221 ± 85 ^{‡,§}	246 ± 101 ^{‡,§}	237 ± 85 [†]
Phenylalanine	208 ± 87	217 ± 79 [‡]	186 ± 87 [‡]
Lysine	196 ± 81 ^{□□□□}	246 ± 87 ^{□□□□,§}	237 ± 51 [†]
Threonine	147 ± 74 ^{□□}	174 ± 72 ^{□□,§}	172 ± 88 [†]
Isoleucine	147 ± 61 [†]	159 ± 58 [†]	152 ± 34 [†]
Tryptophan	88 ± 36 [‡]	87 ± 72 ^{‡,§}	85 ± 31 [†]
Methionine	37 ± 15 ^{□□□□}	43 ± 13 ^{□□}	34 ± 10 ^{□□□}
Total AA loss, mg	1656 ± 67 ^{□□□□}	1656 ± 98 ^{□□□,§}	1784 ± 102 [†]
Nonessential amino acids (NEAA)			
Proline	802 ± 507 [†]	818 ± 434 [†]	876 ± 403 [†]
Cysteine	898 ± 338 ^{□□}	746 ± 266 ^{□□,§}	779 ± 270 [†]
Glutamic acid	550 ± 196 [†]	570 ± 174 ^{□□□}	680 ± 135 ^{□□□}
Glutamine	491 ± 245 [†]	434 ± 246 [†]	423 ± 220 [†]
Alanine	405 ± 147 [†]	392 ± 135 [†]	389 ± 102 [†]
Glycine	184 ± 98 [‡]	217 ± 87 ^{□□□}	152 ± 91 ^{□□□□}
Arginine	164 ± 56 ^{□□}	132 ± 75 ^{□□}	169 ± 88 [†]
Tyrosine	135 ± 49 [†]	130 ± 43 ^{□□,§}	102 ± 34 ^{□□}
Serine	61 ± 23 ^{†,§}	58 ± 29 [†]	51 ± 16 [†]
Asparagine	37 ± 19 [†]	43 ± 15 ^{□□}	34 ± 17 [†]
Aspartic acid	25 ± 12 [†]	29 ± 14 ^{□□□□□}	51 ± 17 ^{□□□□□}
Total AA loss, mg	3573 ± 284 [†]	3556 ± 288 ^{□□□□□}	3701 ± 314 ^{□□□□}
Branched-chain amino acid (BCAA)			
Valine	319 ± 131 [†]	334 ± 188 [†]	339 ± 102 [†]
Leucine	221 ± 85 ^{‡,§}	246 ± 101 ^{‡,§}	237 ± 85 [†]
Isoleucine	147 ± 61 [†]	159 ± 58 [†]	152 ± 34 [†]
Total loss, mg	687 ± 69 [†]	739 ± 74 ^{‡,§}	728 ± 73 [†]
Total AA loss	6098 ± 15 [†]	6131 ± 155 [†]	6213 ± 161 [†]

HDF, hemodiafiltration; HED, high-efficiency hemodialysis.
 □□□□□, P < .001; □□□□□, P < .003; □□□□□, P < .02; †, §, P < .05; ‡, P > .05.

Not significant change of total amino acids loss among HD, pre-dilution and post-dilution HDF

ORIGINAL ARTICLE

Artificial Kidney / Dialysis

Amino acid losses are lower during pre-dilution on-line HDF than HD of the same Kt/V for urea

Shunichiro Uraha¹, Toru Hyodo², Takashi Hosono³, Yasuhito Kanata⁴, Makoto Kitamura⁵, Miho Hida¹, Kenichi Kikuchi⁶

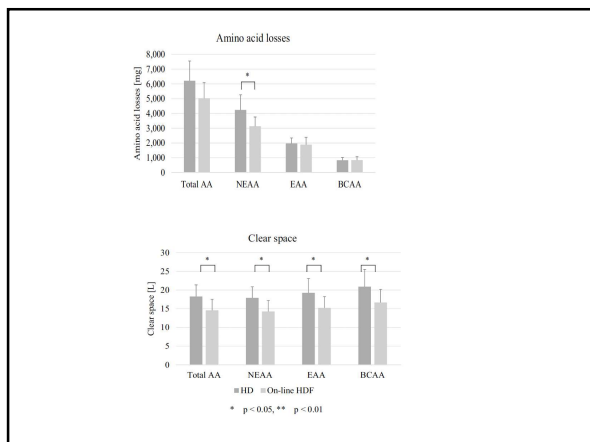
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Table 1 Patient characteristics

	HD	On-line HDF	P value
Number of patients (N)	10	10	
Age (years)	66.9 ± 3.4	64.1 ± 7.3	0.153
Sex			
Male, N (%)	7 (70)	8 (80)	
Female, N (%)	3 (30)	2 (20)	
Diabetes mellitus, N (%)	7 (70)	5 (50)	
Dialysis vintage (years)	3.4 ± 4.7	5.3 ± 6.5	0.124
Dry weight (kg)	57.1 ± 9.7	58.6 ± 11.1	0.754
Treatment duration (h)	4 ± 0	4 ± 0	
Blood flow rate (ml/min)	200 ± 0	200 ± 20	<0.001
Dialysate flow rate (ml/min)	463.0 ± 29.3	565.0 ± 42.5	<0.001
Substitution flow rate (mL/min)	0 ± 0	252.8 ± 26.4	
Substitution volume (L)	0 ± 0	37.0 ± 6.0	
Ultrafiltration volume (mL)	200 ± 37	230 ± 765	0.014
Kt/V for Urea	1.46 ± 0.25	1.46 ± 0.31	0.976
C-reactive protein (mg/dL)	0.17 ± 0.09	0.28 ± 0.39	0.379

Substitution Volume: 60 L

Data are expressed as means ± SD standard deviation unless stated otherwise



Papers in Japanese

① : Nakayama, et. al: The suppression of amino acid leakage by High flow on-line HDF. Nara Medical Association Dialysis Division Journal (1343-2877), Vol. 28, No. 1, Page 41-44 (2023.01)

[HFH has a greater effect on suppressing amino acid leakage than HD and is a useful dialysis dialysis to counteract dialysis-related sarcopenia.]

② : K Suzuki, et. al.: Food and nutrition according to blood purification methods. HDF(pre-dilution v.s. post-dilution) Clinical Dialysis (0910-5808) Vol. 39, No. 12, Page 1385-1389 (November 2023)

[The pre-dilution on-Line HDF has a low amino acid leakage rate and is excellent from a nutritional perspective.]

【Conclusion】

For elderly dialysis patients, pre-dilution On-Line HDF with high volume substitution (> 60 L per session) and low albumin leakage hemodiafilter should be recommended from the point of nutritional view.