

Far-Infrared Therapy and Vascular Access Flow in Hemodialysis Patients With Arteriovenous Fistula or Graft: A Prospective Minimal Detectable Change Analysis

Supplementary Materials

Supplementary Table S1. Full paired and non-parametric analyses of vascular access flow (Qa), Kt/V, and URR.

Paired t-tests and Wilcoxon signed-rank tests were used to compare each follow-up value with baseline.

Outcome	n	Pre-treatment	Post-treatment	Mean change	Median change [IQR]	95% CI for mean change	Paired t-test P	Wilcoxon P
Qa: 1 month vs baseline	42	1,004.3 ± 451.1	1,044.0 ± 631.0	39.8 ± 589.4	-34.7 [-206.8, 97.8]	-143.9 to 223.4	0.664	0.285
Qa: 2 months vs baseline	42	1,004.3 ± 451.1	1,062.7 ± 445.7	58.4 ± 433.0	48.5 [-164.8, 204.2]	-76.5 to 193.3	0.387	0.476
Qa: 3 months vs baseline	42	1,004.3 ± 451.1	1,159.9 ± 668.9	155.7 ± 485.5	30.7 [-64.0, 273.4]	4.3 to 307.0	0.044	0.094
Qa: post-treatment avg vs baseline	42	1,004.3 ± 451.1	1,088.9 ± 539.1	84.6 ± 446.6	7.5 [-115.4, 155.8]	-54.5 to 223.8	0.226	0.453
Kt/V: 1 month vs baseline	42	1.73 ± 0.24	1.80 ± 0.32	0.07 ± 0.18	0.04 [-0.05, 0.13]	0.01 to 0.12	0.019	0.076
Kt/V: 2 months vs baseline	37	1.72 ± 0.24	1.71 ± 0.27	-0.01 ± 0.17	-0.02 [-0.11, 0.09]	-0.07 to 0.05	0.688	0.667
Kt/V: 3 months vs baseline	42	1.73 ± 0.24	1.80 ± 0.29	0.07 ± 0.24	0.05 [-0.07, 0.20]	-0.00 to 0.15	0.063	0.087
Kt/V: post-	42	1.73 ± 0.24	1.77 ± 0.25	0.05 ± 0.17	0.04 [-0.06, 0.13]	-0.00 to 0.10	0.071	0.076

treatment avg vs baseline					0.13]			
URR: 1 month vs baseline	42	76.0 ± 6.0	77.4 ± 6.4	1.4 ± 5.9	0.3 [-1.1, 1.7]	-0.5 to 3.2	0.140	0.294
URR: 2 months vs baseline	37	75.8 ± 6.1	75.8 ± 5.3	-0.0 ± 6.4	-0.8 [-2.0, 1.9]	-2.2 to 2.1	0.980	0.512
URR: 3 months vs baseline	42	76.0 ± 6.0	77.5 ± 5.5	1.4 ± 6.0	1.3 [-2.0, 3.0]	-0.4 to 3.3	0.128	0.167
URR: post- treatment avg vs baseline	42	76.0 ± 6.0	77.1 ± 5.0	1.1 ± 5.2	0.5 [-1.6, 2.0]	-0.6 to 2.7	0.197	0.368

Values are presented as mean ± SD or median [interquartile range]. Qa, vascular access flow; URR, urea reduction ratio.

Supplementary Table S2. Sensitivity analyses for the primary 3-month vascular access flow (Qa) change.

The primary Qa result was assessed using paired t-test, Wilcoxon signed-rank test, linear mixed-effects model, average post-treatment Qa, and outlier-excluded paired analysis. Outliers were defined using the $1.5 \times$ interquartile range rule applied to 3-month Qa change.

Analysis	Estimated mean change, mL/min	Lower 95% CI	Upper 95% CI	P value
Paired t-test, 3-month Qa	155.65	4.35	306.96	0.044
Wilcoxon signed-rank test, 3-month Qa	—	—	—	0.094
Linear mixed model, 3 months vs baseline	155.65	−15.06	326.36	0.083
Post-treatment average Qa vs baseline	84.61	−54.55	223.77	0.226
Outlier-excluded paired t-test, 3-month Qa	49.89	−29.27	129.04	0.210

The Wilcoxon signed-rank test does not yield a mean change or 95% CI (shown as —). CI, confidence interval; Qa, vascular access flow.

Supplementary Table S3. Robust, median quantile, and winsorized regression models for 3-month vascular access flow (Qa) change.

Robust linear regression, median quantile regression, and winsorized linear regression were performed as sensitivity analyses. Winsorization was applied to the 3-month Qa change using the 5th and 95th percentiles. P values are not shown as these analyses were intended to assess the direction and magnitude of effects under alternative distributional assumptions, rather than to define the primary treatment effect.

Model	Variable	Estimate (95% CI)
Robust linear regression	Intercept	192.14 (−60.71 to 444.98)
Robust linear regression	Baseline Qa, per 100 mL/min	−3.93 (−23.73 to 15.88)
Robust linear regression	Access vintage, per 12 months	−18.34 (−52.46 to 15.78)
Robust linear regression	AVG vs AVF	−73.26 (−260.81 to 114.28)
Median quantile regression	Intercept	121.43 (−150.81 to 558.30)
Median quantile regression	Baseline Qa, per 100 mL/min	−3.88 (−39.80 to 41.18)
Median quantile regression	Access vintage, per 12 months	−9.74 (−62.67 to 17.72)
Median quantile regression	AVG vs AVF	3.00 (−325.57 to 176.34)
Winsorized linear regression	Intercept	170.40 (−109.93 to 450.73)
Winsorized linear regression	Baseline Qa, per 100 mL/min	6.76 (−15.20 to 28.72)
Winsorized linear regression	Access vintage, per 12 months	−28.30 (−66.13 to 9.53)
Winsorized linear regression	AVG vs AVF	−143.78 (−351.71 to 64.16)

AVF, arteriovenous fistula; AVG, arteriovenous graft; CI, confidence interval; Qa, vascular access flow.

Supplementary Table S4. Exploratory subgroup summary by vascular access vintage and baseline vascular access flow (Qa).

Average-post responder was defined as any increase in average post-treatment Qa compared with baseline. Clinically meaningful response was defined as a 3-month Qa increase of ≥ 100 mL/min. These subgroup analyses were exploratory and should be interpreted with caution given small subgroup sizes.

Subgroup	n	Average-post responder, n (%)	3-month Qa increase ≥ 100 mL/min, n (%)
<36 months, <1000 mL/min	17	13 (76.5%)	9 (52.9%)
<36 months, ≥ 1000 mL/min	11	6 (54.5%)	7 (63.6%)
≥ 36 months, <1000 mL/min	7	1 (14.3%)	1 (14.3%)
≥ 36 months, ≥ 1000 mL/min	7	1 (14.3%)	1 (14.3%)

Qa, vascular access flow.

Supplementary Table S5. Repeated-measures models for vascular access flow (Qa) trajectory after far-infrared therapy (full output).

See Table 5 in main text for model description.

Model	Variable	Estimate (95% CI)	SE	df	P value
Post-treatment phase × access vintage	Post-treatment phase	37.20 (−159.23 to 233.64)	99.65	210.0	0.709
Post-treatment phase × access vintage	Access vintage, per 12 months	−1.97 (−31.22 to 27.27)	14.71	84.5	0.894
Post-treatment phase × access vintage	Baseline Qa, mL/min	0.85 (0.71 to 0.99)	0.07	42.0	<0.001
Post-treatment phase × access vintage	AVG vs AVF	−124.24 (−259.90 to 11.42)	67.22	42.0	0.072
Post-treatment phase × access vintage	Post-treatment phase × access vintage	−32.90 (−65.11 to −0.70)	16.34	210.0	0.045
Repeated time point × access vintage group	Post 1 × access vintage ≥36 months	−359.79 (−663.19 to −56.39)	153.91	210.0	0.020
Repeated time point × access vintage group	Post 2 × access vintage ≥36 months	−317.25 (−620.65 to −13.85)	153.91	210.0	0.041
Repeated time point × access vintage group	Post 3 × access vintage ≥36 months	−345.36 (−648.76 to −41.96)	153.91	210.0	0.026

AVF, arteriovenous fistula; AVG, arteriovenous graft; CI, confidence interval; FIR, far-infrared; Qa, vascular access flow; SE, standard error.

Supplementary Table S6. Correlations between vascular access flow (Qa) changes and dialysis adequacy changes.

Spearman correlation coefficients were calculated to evaluate associations between Qa changes and changes in Kt/V or URR.

Variable 1	Variable 2	Method	n	rho	P value
3-month Qa change	3-month Kt/V change	Spearman	42	−0.17	0.295
3-month Qa change	3-month URR change	Spearman	42	−0.19	0.226
Average post-treatment Qa change	Average post-treatment Kt/V change	Spearman	42	−0.00	0.982
Average post-treatment Qa change	Average post-treatment URR change	Spearman	42	0.03	0.828
3-month percent Qa change	3-month Kt/V change	Spearman	42	−0.18	0.249
3-month percent Qa change	3-month URR change	Spearman	42	−0.20	0.195

Qa, vascular access flow; URR, urea reduction ratio.

Supplementary Table S7. Changes in dialysis adequacy according to average post-treatment vascular access flow (Qa) response.

Qa response was defined as any increase in average post-treatment Qa compared with baseline (responder, n=21; non-responder, n=21). Changes in Kt/V and URR were compared between responders and non-responders using the Wilcoxon rank-sum test.

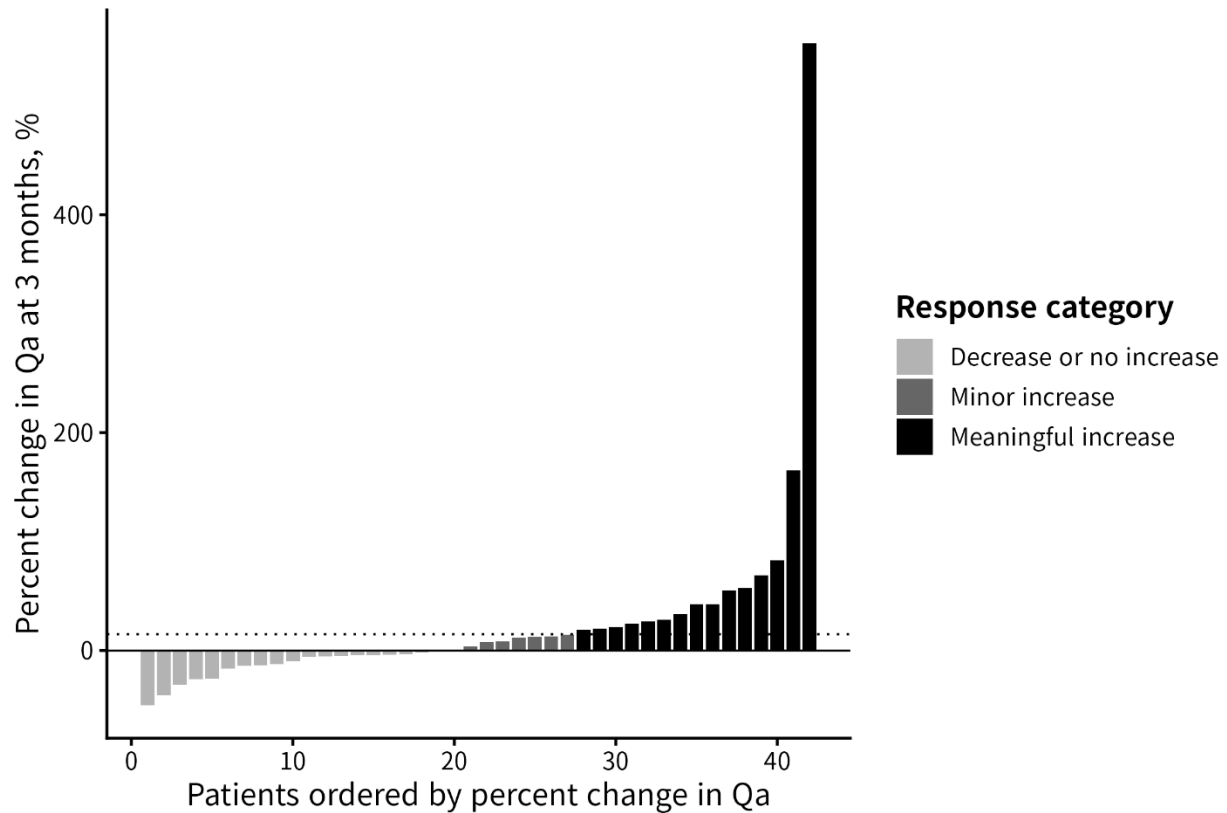
Outcome	Non-responder (n=21)	Responder (n=21)	P value
3-month Δ Kt/V	0.11 [−0.03, 0.20]	0.06 [−0.11, 0.19]	0.633
Average post-treatment Δ Kt/V	0.04 [−0.05, 0.13]	0.02 [−0.05, 0.23]	0.930
3-month Δ URR	1.9 [−0.4, 3.9]	0.8 [−2.3, 2.2]	0.302
Average post-treatment Δ URR	0.3 [−1.5, 1.9]	0.7 [−1.6, 2.4]	0.960

Values are presented as median [interquartile range].

Supplementary Figure Legends

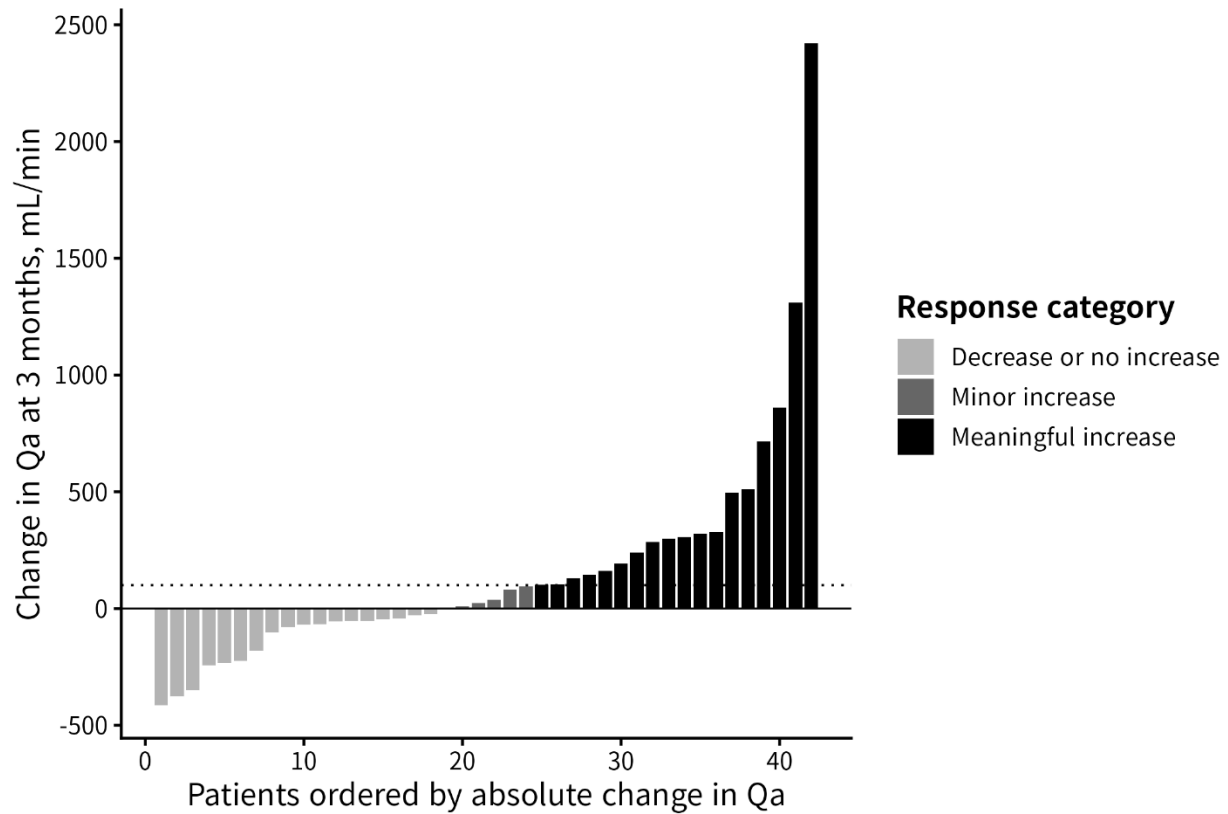
Supplementary Figure S1. Distribution of individual percent changes in vascular access flow (Qa) at 3 months.

Individual percent changes in vascular access flow (Qa) from baseline to 3 months after FIR therapy are shown in ascending order. The dotted horizontal line indicates a 15% increase from baseline. Decrease or no increase was defined as $\leq 0\%$, minor increase as $>0\%$ and $<15\%$, and meaningful increase as $\geq 15\%$.



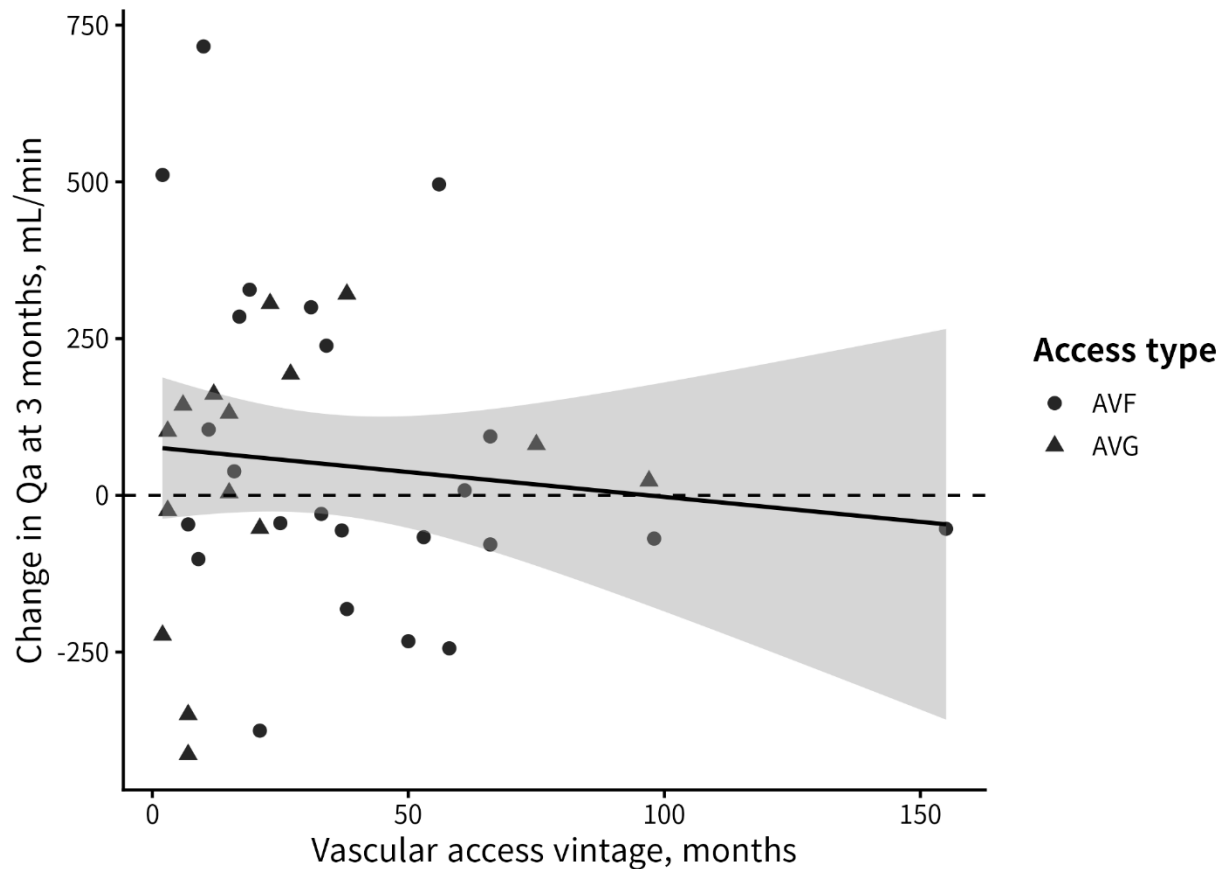
Supplementary Figure S2. Distribution of individual absolute changes in vascular access flow (Qa) at 3 months.

Individual absolute changes in vascular access flow (Qa) from baseline to 3 months after FIR therapy are shown in ascending order. The dotted horizontal line indicates a Qa increase of 100 mL/min. Decrease or no increase was defined as ≤ 0 mL/min, minor increase as >0 and <100 mL/min, and meaningful increase as ≥ 100 mL/min.



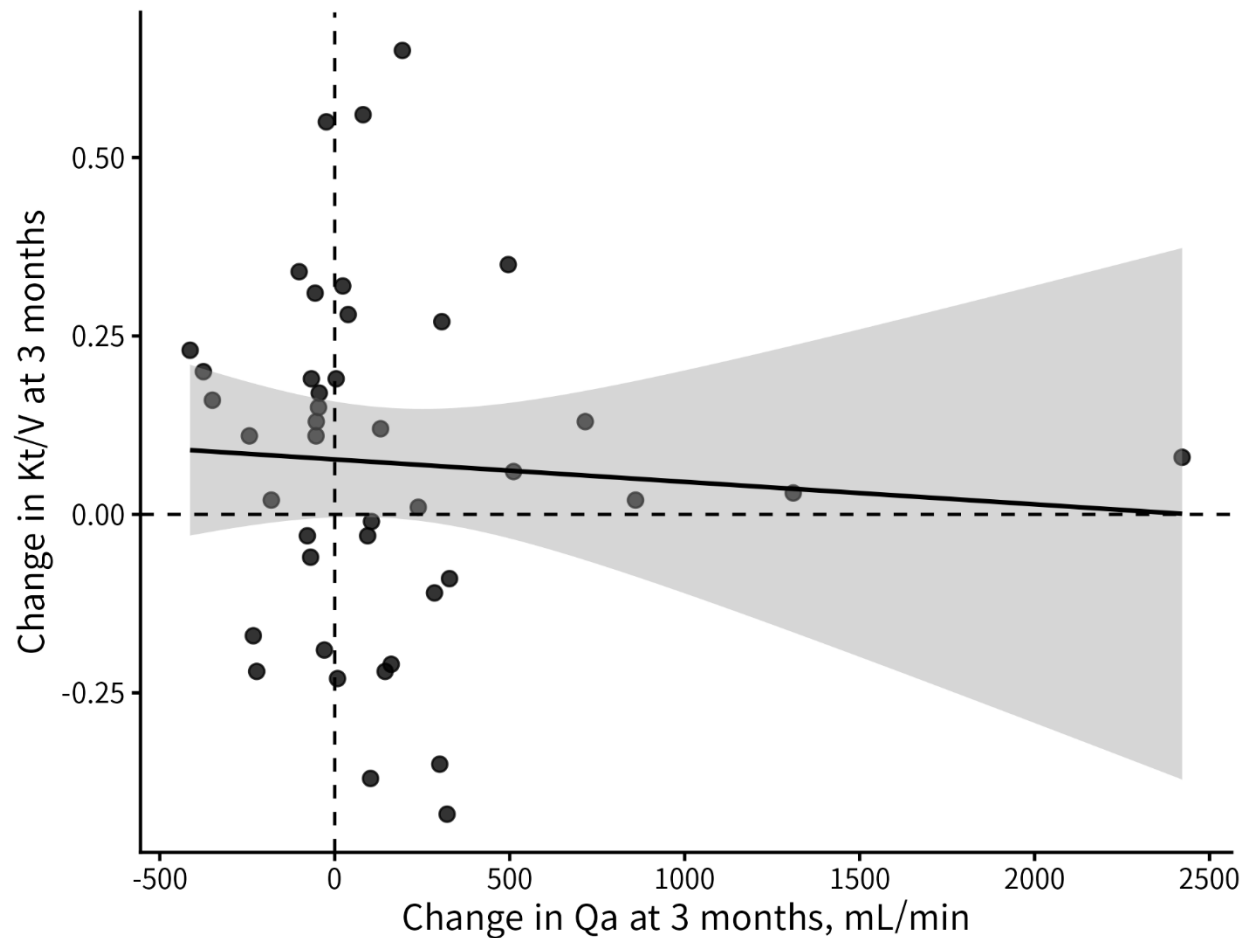
Supplementary Figure S3. Vascular access vintage and vascular access flow (Qa) change after excluding outliers.

The association between vascular access vintage and 3-month vascular access flow (Qa) change after excluding outliers is shown. Outliers were defined using the $1.5 \times$ interquartile range rule applied to 3-month Qa change. Circles and triangles indicate AVF and AVG, respectively. The solid line represents the overall linear regression fit, and the shaded area represents the 95% confidence interval.



Supplementary Figure S4. Association between vascular access flow (Qa) change and Kt/V change.

The association between 3-month change in vascular access flow (Qa) and 3-month change in Kt/V is shown. The vertical and horizontal dashed lines indicate no change in Qa and Kt/V, respectively. The solid line represents the linear regression fit, and the shaded area represents the 95% confidence interval.



Supplementary Figure S5. Vascular access flow (Qa) responder rate according to vascular access vintage and baseline Qa.

Average post-treatment vascular access flow (Qa) responder rates are shown according to vascular access vintage group and baseline Qa category. Qa responder was defined as any increase in average post-treatment Qa compared with baseline. The number above each bar indicates the number of patients in each exploratory subgroup.

