

Hemodynamic monitoring of hemodialysis patients and predictors of drop in cardiac index during hemodialysis

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Introduction: Measuring the cardiac index using ultrasound dilution-technique during hemodialysis (HD) can be used to detect patients with an excessive access flow and cardiac impairment.

Methods:

In a prospective cross-sectional study we measured cardiac output (CO), cardiac index (CI) and access flow (AF) at the start and end of a HD session in a large cohort (n=185) of stable HD patients using the Transonic HD03 monitor and correlated the results with clinical parameters, bioimpedance measurements (BCM, Fresenius), high sensitive troponin I and mortality.

Results:

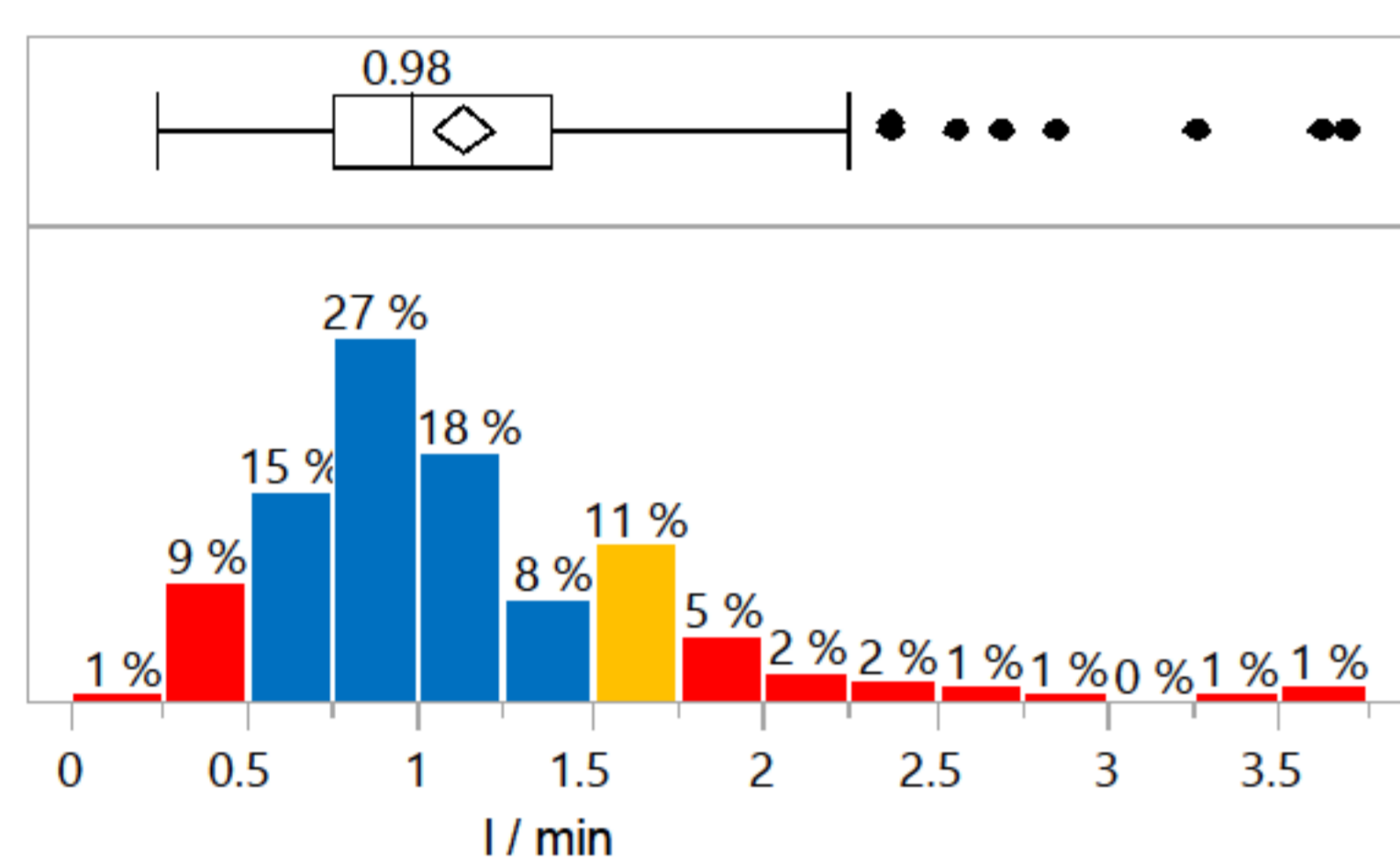


Fig. 1: Distribution of access flow (AF)
Elevated AF >1.75 l/min was found in 24 % of patients whereas 10% had low AF..

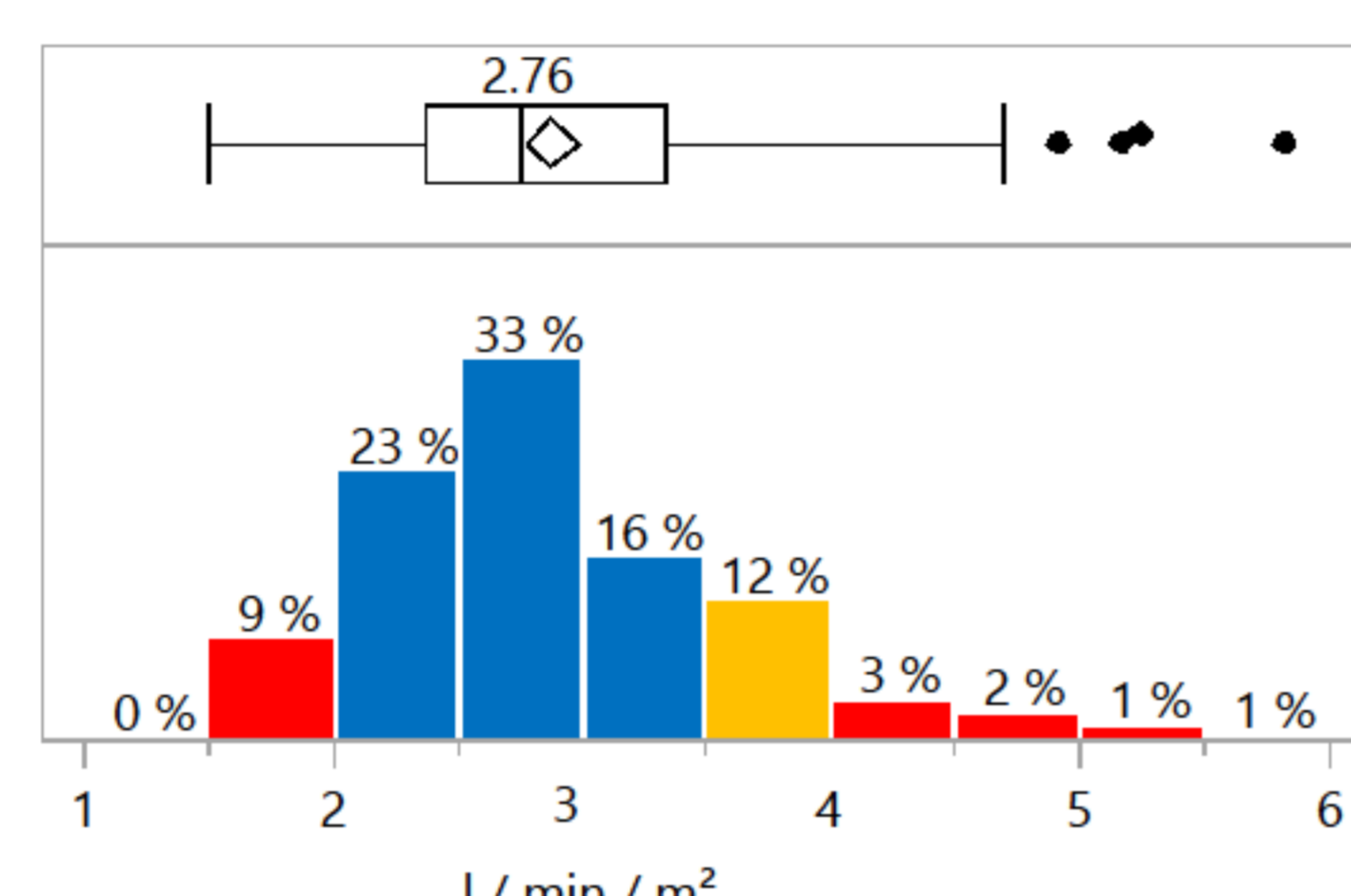


Fig. 2: Distribution of cardiac index (CI)
In 7% of the patients, CI was elevated over 4 l/min/m² whereas 9% had low CI. 17% of the patients had an increased AF/CO ratio (> 30%).

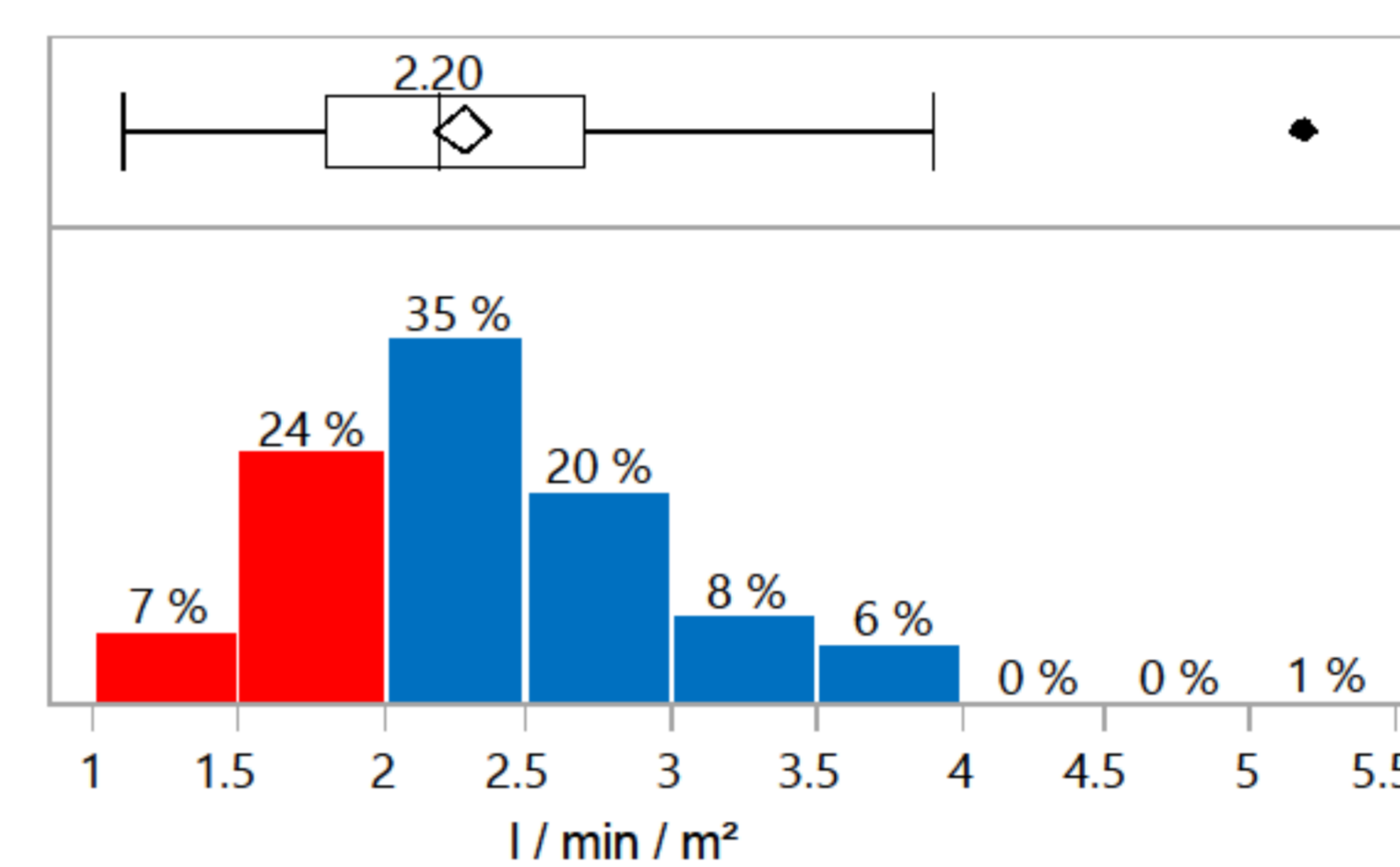


Fig. 3: Distribution of systemic cardiac index (SCI)
The systemic CI (corrected for AF) was reduced in 31% of the patients.

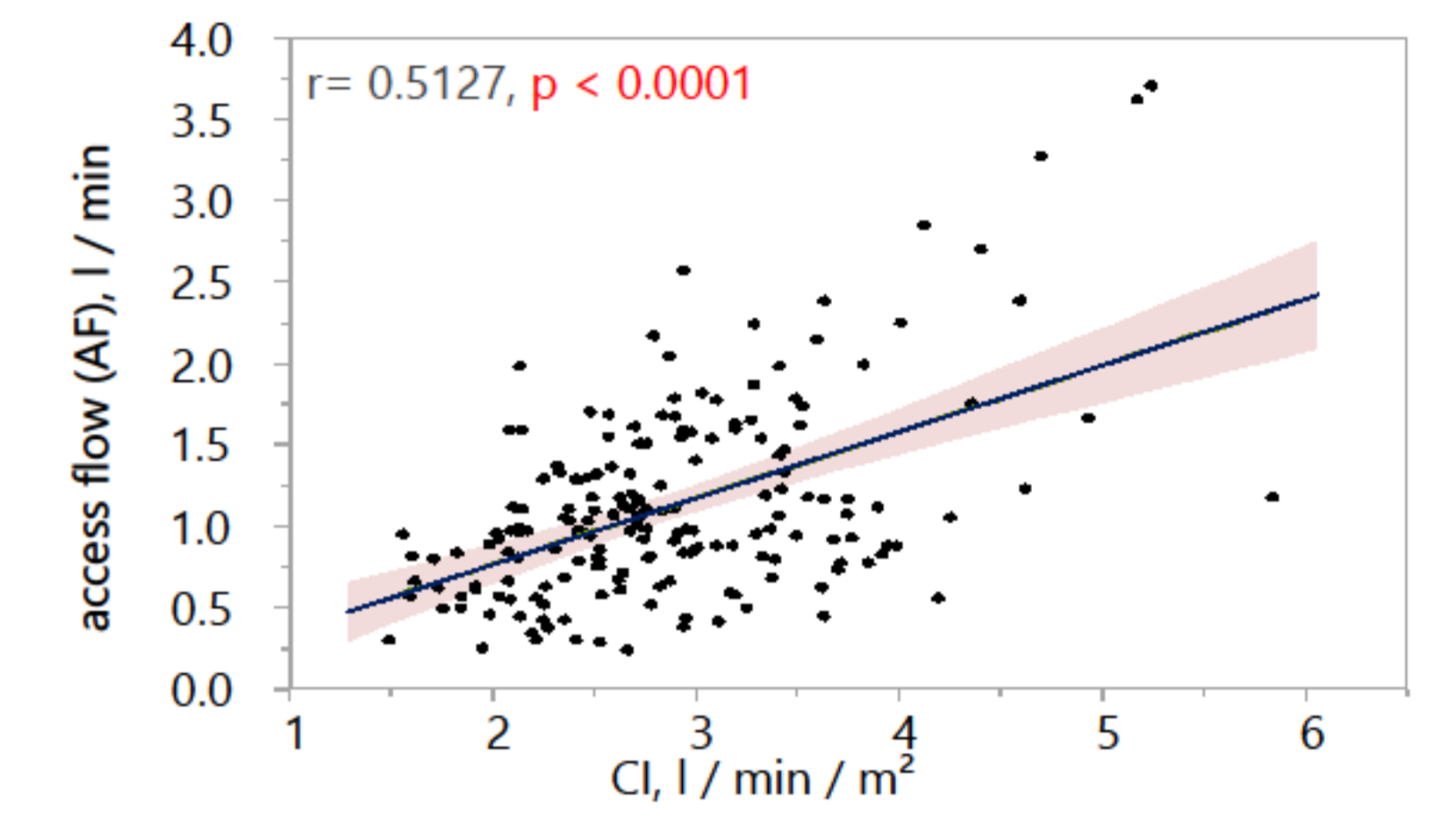


Fig. 4: Correlation AF with CI
AF and CI have a strong correlation. SCI (Systemic cardiac index) no longer correlates with AF.

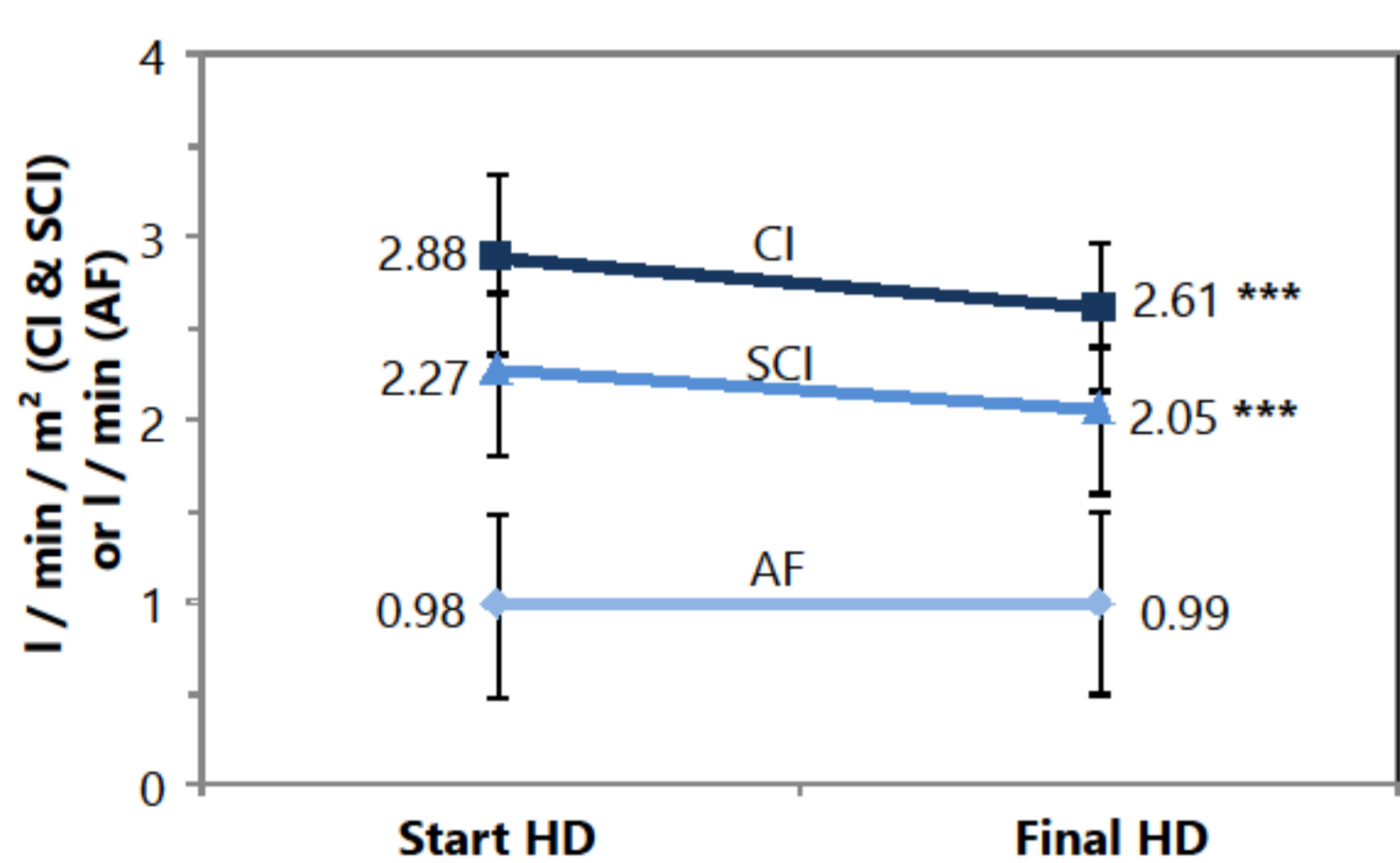


Fig. 5 and 6: Course of hemodynamic parameters
At the end of HD the CI and SCI fell while the AF remained constant. Peripheral resistance and heart rate did not change causing systolic blood pressure to fall.

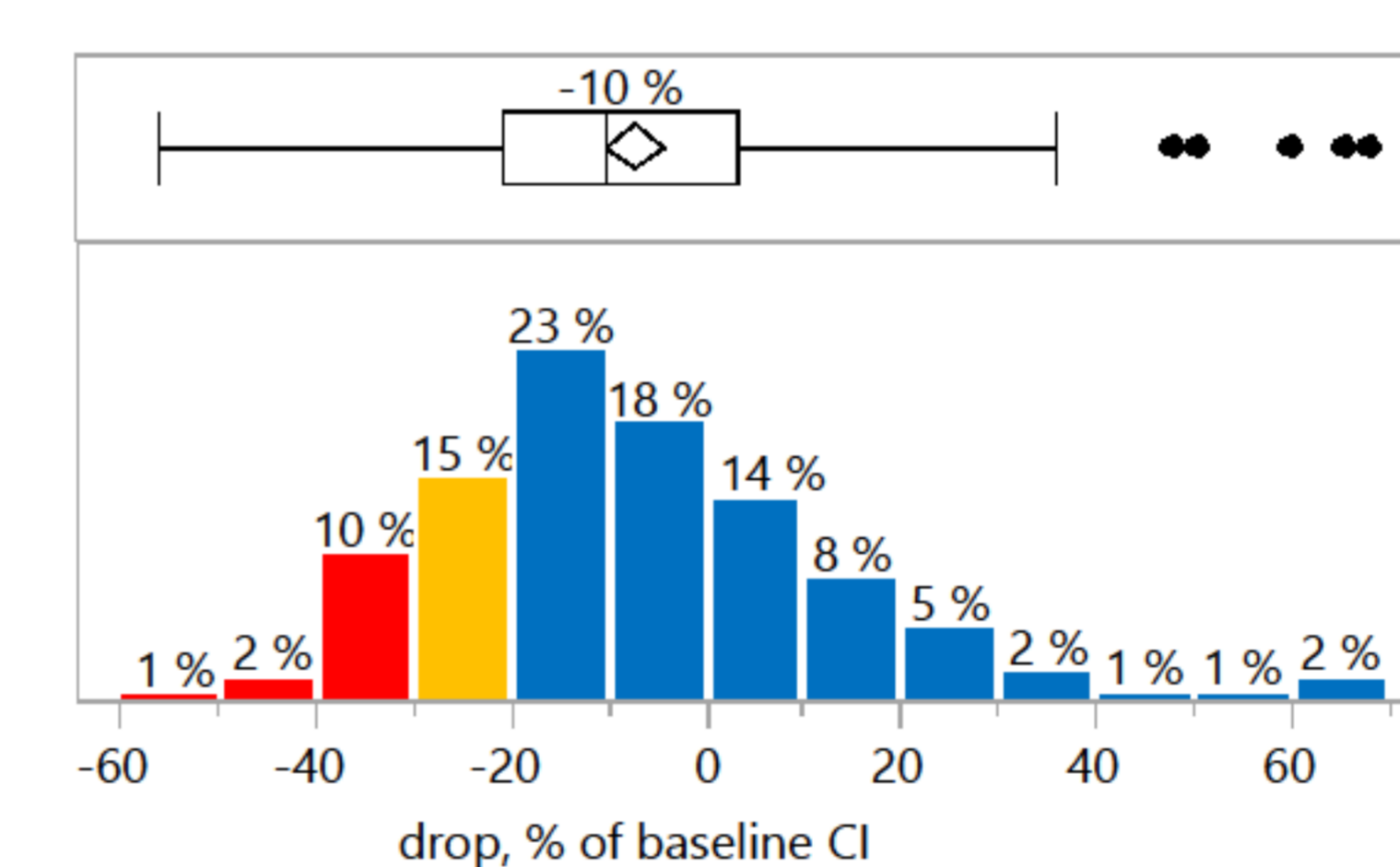
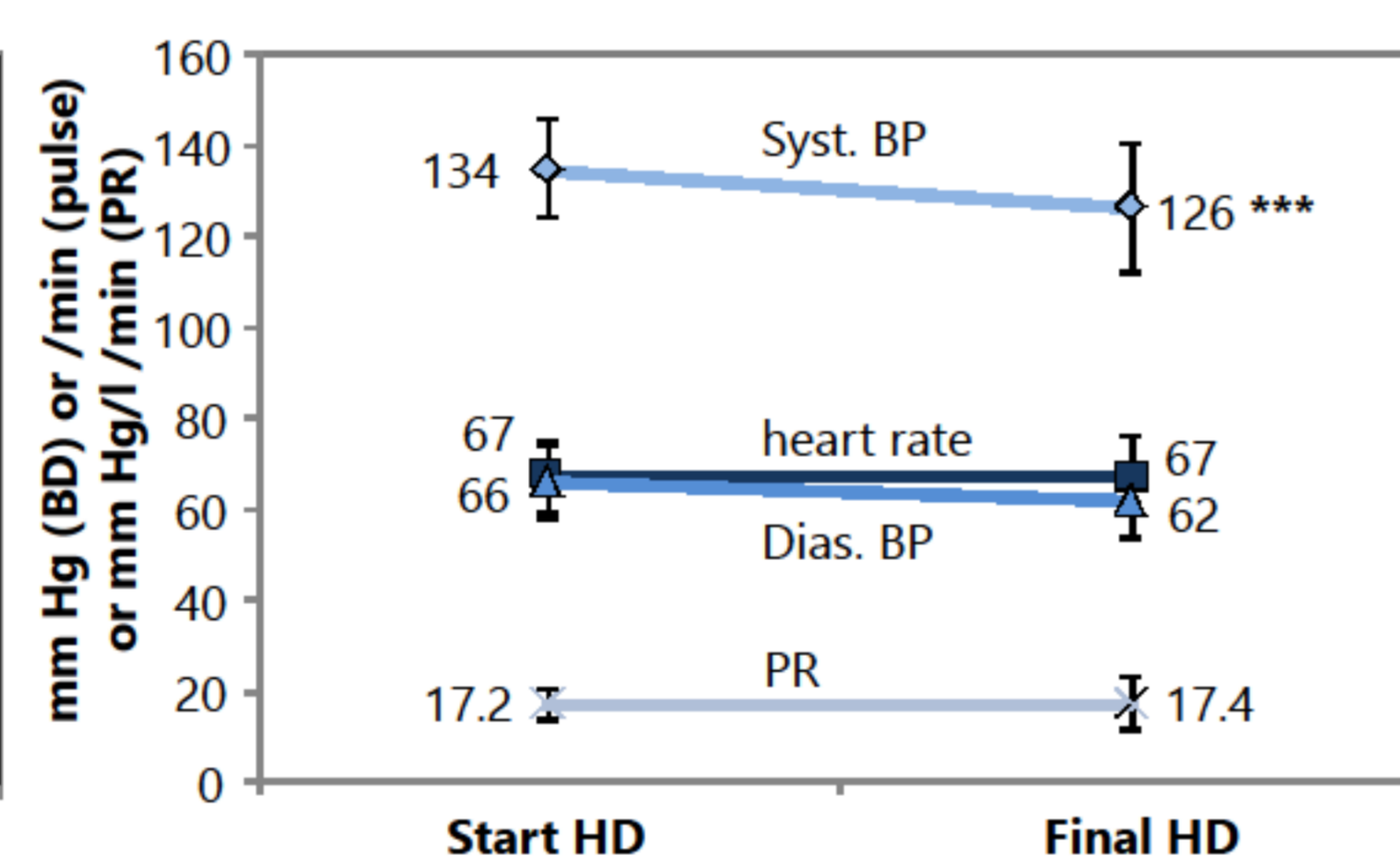
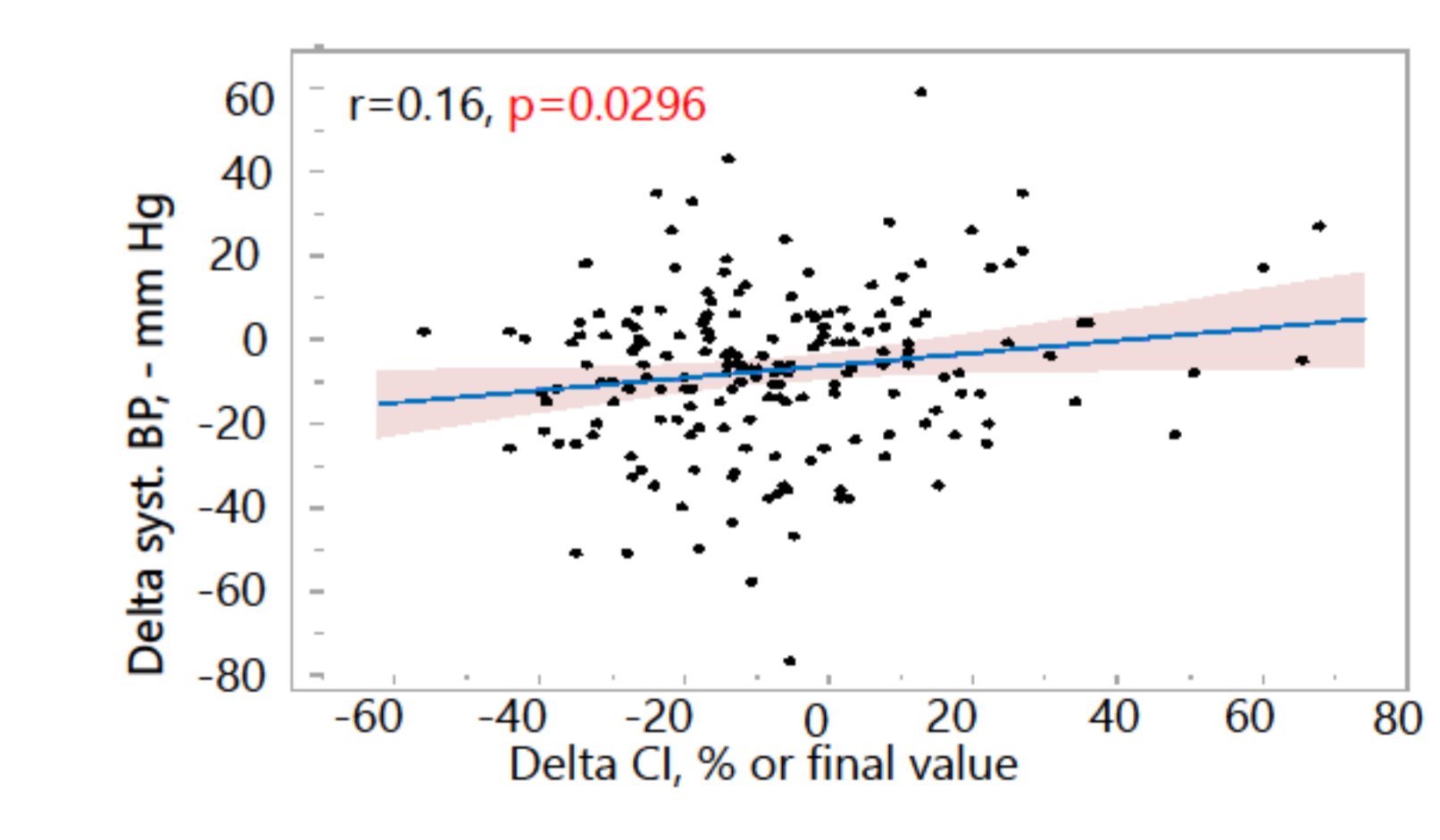


Fig. 7 and 8: Distribution of CI drop and correlation of CI fall with drop in syst. BP
For 28 % of the patients the CI fell by more than 20 % and was associated with a drop in systolic blood pressure of 7.5 mmHg. CI fall had only a weak correlation to the drop in systolic BP.



variable	standardized beta	p
age	-0.2138	0.0020
gender	0.00297	0.6503
overhydration (OH)	0.2889	<0.0001
ultrafiltration (UF)	-0.4360	<0.0001
peripheral resistance at start	0.4126	<0.0008
access flow at start	0.2108	0.0031
systolic BP at start	-0.1107	0.1055
diastolic BP at start	-0.1038	0.1904
heart rate at start	-0.033	0.5984
CI at start	-0.1925	0.1266

Table 2: Multivariable linear regression model for predicting CI drop.
Independent predictors were high age and high UF. An increased access flow, OH and peripheral resistance proved to be protective.

Parameter	AUC (95% confidence interval)	p	cut-off value	Sens. %	Spez. %
CI	0.594 (0.519 to 0.665)	0.0883	< 2.49 l/min/m²	48	72
SCI	0.649 (0.575 to 0.717)	0.0128	< 1.8 l/min/m²	52	80
Delta SCI	0.633 (0.599 to 0.703)	0.0121	> -0.20 l/min/m²	67	60
Troponin I	0.700 (0.629 to 0.765)	0.0001	> 18 pg/ml (0.0018 µg/l)	82	51

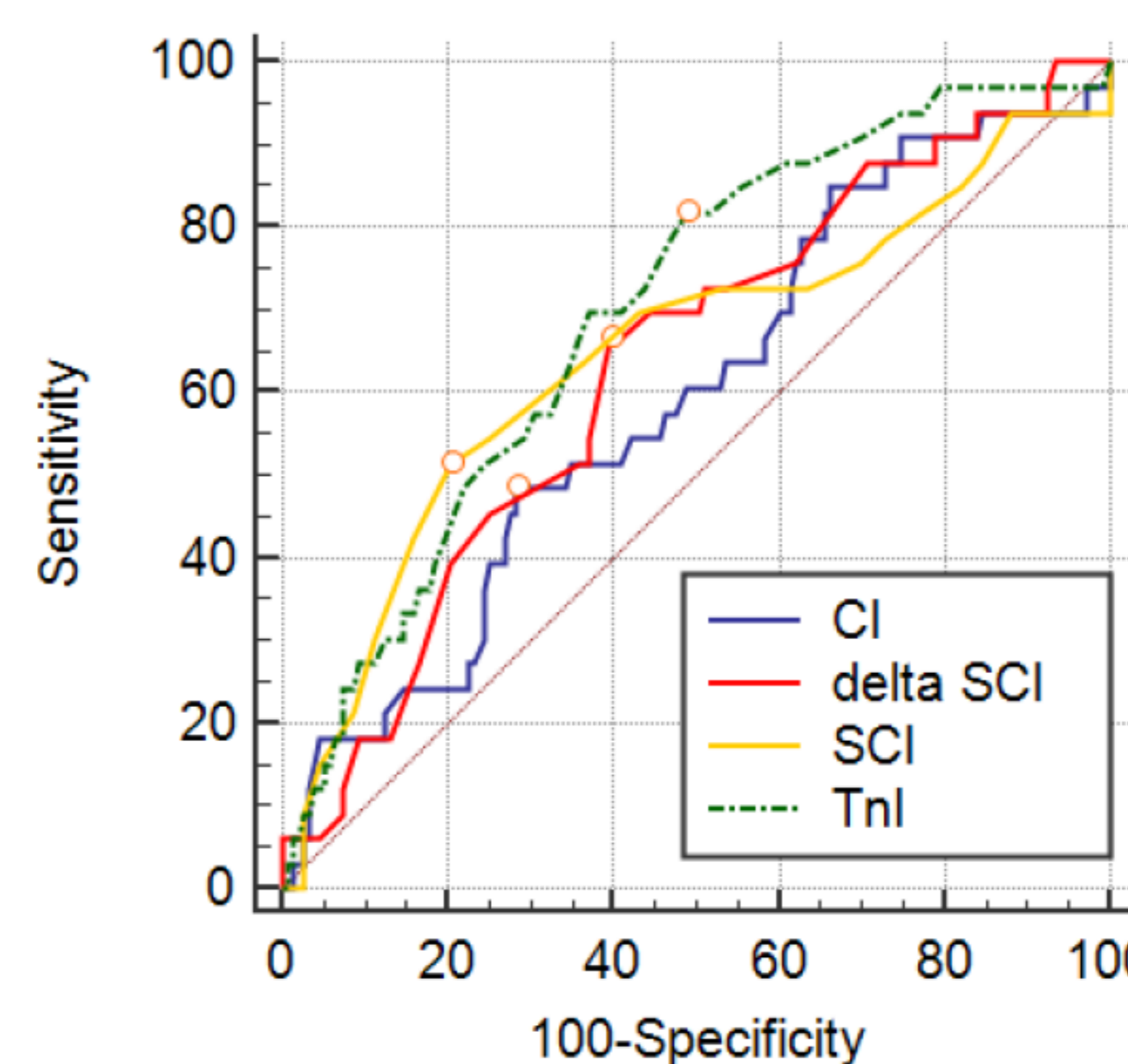


Fig. 9 & Table 3: Prognostic significance of CI, SCI and delta SCI compared to TnI
Follow up: 606 days (593; 621), 33 deaths (18%)
The cardiac indices (SCI, delta SCI, CI) are associated with mortality. By comparison, TnI shows the highest AUC as a established parameter for mortality in HD patients. There is no significant difference between the AUC of SCI and TnI (diff. AUC 0.05; p 0.49).

Conclusion: The proportion of patients with reduced SCI, increased relative access flow and drop in CI during HD is high and can be validly recorded using hemodynamic monitoring with the HD03. SCI and Delta SCI are associated with mortality.