Day-to Day, Week-to-Week, and Day-of-Week Variation in Tests of Anemia and Iron Status in Hemodialysis Patients

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INTRODUCTION

To make informed decisions in dosing ESA and IV iron therapy, clinicians must determine whether differences between current and previous test results for anemia and iron status markers reflect a trend or, alternatively, are within expected degrees of variability. However, information on expected day-to-day within-patient variability in the hemodialysis setting is lacking.

METHODOLOGY

We determined Hb, Hct, reticulocyte Hb (Ret He or Chr; Sysmex XE2100), TSAT and ferritin on 12 consecutive treatment days in 30 patients undergoing thrice-weekly hemodialysis. We held ESA doses constant and withheld IV iron. We measured same-sample analytic variation (σ_{anal}) and within-patient biologic variation (σ_{biol}). We then calculated the number of sampling days (D) needed to determine the "true average value" for each analyte with a 5% significance level and 80% power, from the equation

$$D = (Z^2 \times \sigma^2_{day})/(A^2 \times \text{total analyte mean}^2)$$

where Z = 1.96 for a level of significance set at 0.05, σ_{day} is the sum of σ_{anal} and σ_{biol} and A is the level of accuracy (A = 0.2). [Belza et al. Br J Nutr 94:551-556, 2005]

Table 1: Source & magnitude of variation

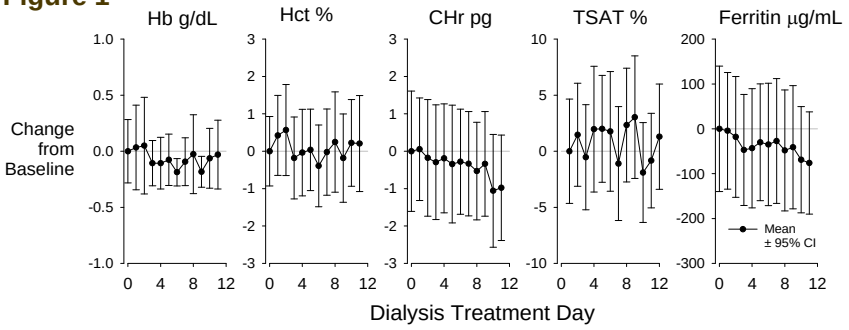
Variation	Hb	Hct	CHr	TSAT	Ferritin
Analytic (%)	2.0	2.2	2.4	2.7	6.9
Biologic (%)	4.0	4.0	4.8	38.2	15.1
Total (%)	6.0	6.2	7.2	40.9	22.0

Table 2: Number of draw days needed to determine true average value

Level of Accuracy	Hb	Hct	CHr	TSAT	Ferritin
50%[1]	1	1	1	3	1
80%[2]	1	1	1	15	10
90%[3]	1	1	2	57	10
95%[4]	4	4	5	226	40

Example for Hb: [1]10.0 ± 5.0 g/dL; [2]10.0 ± 2.0 g/dL; [3] 10.0 ± 1.0 g/dL; [4] 10.0 ± 0.5 g/dL

Figure 1



RESULTS

Biologic variation exceeded analytic variation for all analytes, especially TSAT and ferritin.

Hb and Hct but not other analytes were affected by day of week draw. Hb levels obtained midweek averaged 0.06 g/dL higher than those obtained the first dialysis day of the week (p<0.05).

CONCLUSION

- High biologic variation requires multiple test days to determine true average results within clinically meaningful levels of accuracy
- Hb, Hct and reticulocyte Hb (Ret He or CHr) but not TSAT or ferritin are useful analytes to guide dose adjustment for ESA or IV iron
- TSAT and ferritin are unsuitable to guide month to month dose adjustment in individual patients; rather, their utility lies in assessing iron status or setting broad therapeutic targets in large patient populations
- Day-of-week effects are minimal for Hb and Hct and undetectable for other analytes

We thank the patients for their participation, Sysmex America Inc. for providing study support, and DaVita Clinical Research® for poster preparation. DCR is committed to advancing the knowledge and practice of kidney care.

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Presented at the National Kidney Foundation Spring Symposium, March 26-29, 2009.

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