Table 1. Mean Chemical Composition and Calculated Total Volume of Six Venous Samples [a]

Analysis	Specimen number and site 1 Low IVC	2 L renal v	3 L adrenal v	4 R renal v	5 R adrenal v	6 High IVC
Water, mL/L	939.7	958.9	941.3	919.7 (946.7)	937.2 (947.4)	947.6
Total protein, g/L	65.0	48.6	61.4	61.0 (62.8)	60.3 (61.0)	59.5
Total lipid, g/L	8.33	3.93	4.63	2.44 (5.67)	2.80 (4.65)	4.51
Na, mmol/L	139.7	141.3	138.3	111.7 (115.0)	120.0 (121.3)	138.3
K, mmol/L	4.03	2.89	3.73	3.18 (3.27)	3.59 (.63)	3.90
Aldosterone, pmol/L	1128	1027	821	690 (710)	1043 (1054)	738
Renin, pmol/h per mL	0.98	1.15	not assayed	1.08 (1.11)	1.00 (1.01)	1.03
Total vol	100.19	100.39	99.67	97.15	98.92	100.14
SE of mean	±0.11	±0.28	±0.40	±0.21	±0.39	±0.23

[a] Mean of triple analyses. Estimated values in brackets.

laboratory; the other analyses were performed in triplicate in our laboratory (Table 1). To convert the mass analyses from mass per 100 mL to mL/100 mL, the relative volume for proteins was taken as 0.75 and for lipids as 1.1; for the electrolytes, Na and K were added and calculated as 75% NaCl and 25% $NaHCO_3$, with a relative volume of 0.46. The standard error of the means for the total volumes was estimated by treating each of the triplicate analyses as separate series. Only specimens 4 and 5 had a total volume significantly less than 100 mL. Assuming that specimen 4 contains 2.85 mL of contrast medium per 100 mL and specimen 5 contains 1.08 mL per 100 mL, the measured data for these two specimens were recalculated per 100 mL of plasma; these calculated data are displayed in parentheses. The total lipids for these two samples have been recalculated by using the equations provided above.

Use of the standard t-test to appraise the corrected data, and taking $p < 0.02$ as significant gave the following results: for water, 2>6≈5≈4≈3≈1; for protein, 1>4>3≈5>6>2; for total lipid, 1≈4>5≈3≈6≈2; for Na, 2≈1≈3≈6>5>4; and for K, 1>6>3>5>4>2. For aldosterone and renin, an F-test with the highest and lowest values consecutively excluded showed none of the results to differ significantly at the $p < 0.2$ level.

It is not surprising that blood from the renal veins or from the upper part of the inferior vena cava should differ significantly in composition from blood drawn at other sites. However, the numerous differences between the six samples cannot be rationalized by any simple hypothesis. Nonetheless, the data do show clearly that comparing a specific analysis on blood taken from two or more sites could be misleading unless attention is paid to the composition of the samples as a whole.

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A Standard Curve Stored in the Syva CP-5000 Clinical Processor Can Be Updated

To the Editor:

In our recent Note (*1*) concerning the stability of standard curves prepared for EMIT® homogeneous enzyme immunoassay kits, we stated that it was "virtually impossible" to update a standard curve stored in the memory of Syva's CP-5000 Clinical Processor (Syva Corp., Palo Alto, CA 94304). According to the operator's manual, our statement was correct, but we have since been informed by another CP-5000 user that it is indeed possible to update the existing curve with a new zero calibrator at any time. To do so, run the zero calibrator and note the rate ($\overline{\Delta A_0}$). Press the key labelled "SET $\overline{\Delta A_0}$" and enter the new rate from the key board. Then run controls and patients' samples as usual. Concentrations printed by the calculator will then be based on the new $\overline{\Delta A_0}$. The updated zero must be re-entered each time there is a change of operating mode or of drug assayed.

This procedure can correct for a change in y-intercept but not for a change in slope. Because it is not always possible to correct completely for aging of the reagents by using a new zero calibrator, it is our understanding that the procedure was purposely omitted from the operator's manual.

Reference

1. Bach, P. R., and Larsen, J. W., Stability of standard curves prepared for EMIT homogeneous enzyme immunoassay kits stored at room temperature after reconstitution. *Clin. Chem.* **26**, 652–654 (1980).

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Excessive "Performance Ranges" Specified for Control Material by the Supplier

To the Editor:

"Performance ranges" specified by producers of assayed control material may reflect a range of reproducibility that is broader than the range considered clinically acceptable (*1–3*) and (or) the performance range specified by the manufacturer of instrument-adapted methods.

Thus, additional studies by the users of such control materials may be necessary, to establish less-generous limits. A case in point follows.

Beckman Instruments, Inc., Fullerton, CA, 92634, produces and distributes an assayed control serum named "Decision." The package insert (document 015-555645-A for product lot C8009221A, level 2, issued 12/78) specifies "performance ranges" for various test methods, including those adapted to the SMAC analyzer (Technicon Instruments Corp., Tarrytown, NY 10591). Table 1 lists coefficients of variation (CVS) derived from "performance ranges" specified in the Beckman package insert. For the purpose of determining the CVs, it is assumed that the "performance ranges" in the insert represent a range of ±2 standard deviations from the mean. Furthermore, Table 1 lists the CVs considered maximal for clinical acceptability of results for patients, according to several investigators (*1–3*). For each of the analytes listed, the CV derived from the "per-

Table 1. CV Determined from Beckman Specified "Performance Ranges" for their Control Product Compared with "Clinically Acceptable" Ranges, Technicon SMAC-Specified Ranges, and Observed SMAC Ranges

Analyte (method)	CV (and mean) Beckman product (see text)	Westgard[a] (ref. 1)	Cotlove[a] (ref. 2)	Barnett[a] (ref. 3)	Technicon SMAC (see text)	Observed SMAC[b]
Chloride mmol/L	3.1 (97)	1.1 (90)	0.9 (105)	2.2 (90)	1.9 (98)	1.5 (103)
(mod. Zall)	91–103[c]	0.9 (110)			1.6 (130)	1.1 (115)
CO_2, mmol/L	9.1 (22)	2.5 (20)	2.9 (27)	—	4.3 (17.3)	3.4 (29)
(phenolphthalein)	18–26[c]	1.7 (30)			6.3 (31.7)	
Calcium, mg/L	2.6 (115)	1.1 (110)	1.6 (100)	2.3 (110)	2.3 (93)	1.8 (81)
(*o*-cresolphthalein complexone)	109–121[c]				2.2 (120)	2.0 (120)
Phosphorus, inorg., mg/L	7.1 (28)	2.8 (45)	6.6 (35)	5.6 (45)	1.6 (53)	2.4 (31)
(mod. Amador)	24–32[c]					1.5 (68)
Aspartate aminotransferase, U/L	7.5 (53)	3.8 (50)	—	—	4.5 (83)	4.3 (87)
(mod. Henry)	45–61[c]				3.5 (140)	
Lactate dehydrogenese, U/L	6.6 (378)	2.5 (200)	—	—	6.3 (113)	2.8 (260)
(mod. Wacker)	328–428[c]				2.8 (361)	2.7 (465)

[a] Proposed reproducibility of method reported as clinically acceptable. [b] Actual performance of Technicon SMAC analyzer at McKeesport Hospital (see text). [c] Actual "performance range" specified by producer.

formance range" specified by the producer exceeds the maximal CVs for clinical acceptability. Table 1 also shows that the CVs derived from the "performance ranges" specified by Beckman for their control product exceed the related CVs specified for SMAC methods by Technicon ("Summary of Method Performance Characteristics for the Technicon SMAC System," document 4443-R4-5/9-4, issued 1975), the manufacturer of the instrument whose test methods are under consideration.

In most instances the CVs specified by Technicon in Table 1 for SMAC test methods also exceed the corresponding CVs for clinical acceptability. However, our actual experience (Table 1) with a SMAC analyzer (six-month study period, based on the routine use of unassayed Dade Monitrol I, lot XLT-386, and Monitrol II, lot XPT-9583) shows that results obtained with it compare well in many instances with the range of reproducibility considered clinically acceptable by the various studies noted in Table 1.

References

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3. Barnett, R. N., Medical significance of laboratory results. *Am. J. Clin. Pathol.* 50, 671–676 (1968).

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A representative of Beckman Instruments (Quality Assurance Department) responds:

To the Editor:

We are in substantial agreement with Dr. Bogdan. Critical examination of commercial products by the user and subsequent sharing of such work with fellow laboratorians is an important contribution to improving the quality of laboratory performance. As we understand it, Dr. Bogdan's concern and experience can be summarized as follows:

1. Performance ranges on package inserts for control sera may exceed those specified by instrument manufacturers.
2. Performance ranges are stated as ±2 SD from the mean.
3. A case in point is the Beckman Control Sera product "Decision" (*1*).
4. Experience indicates that, in contrast, product performance in an individual laboratory can comfortably reach clinically acceptable levels.

To clarify these issues, it is important to put into perspective the fundamental assumption: that performance ranges are stated as ± 2 SD. In the case of Decision, this is not correct. The performance range is a "state of the art window," or total error envelope, and is an expression of total allowable measurement variations. It includes both intra- and inter-laboratory variances due to variations in instrument, reagent, technique, etc. Laboratories recovering values outside the specified window are urged to investigate the possible cause. This, in fact, is one of the principle benefits of an assayed control product. The performance range is established before, not after, the product is put into use.

The factors contributing to "state of the art" measurement errors are well documented by R. K. Gilbert in his report at the proceedings of the 1976 Aspen Conference (*2*). Recent publication by Elion-Gerritzen (*3*) summarizes such variation in terms of ± 3 CV and discusses utilization in patient care.

Thus, once it is understood that measurement variations incorporate a number of component variables and that the performance range on "Decision" represents the total error envelope, it is easily seen that this corresponds well with both the "state of the art" measurement and a clinically acceptable CV. By way of example, a medically significant analyte that requires the application of clinical relevancy in daily quality control is calcium. The performance range for Beckman's product "Decision," the clinically acceptable range as published by Barnett (*4*), the 1979 CAP survey results (*5*), and D. P. Bogdan's within-laboratory performance on SMAC are tabulated below. These data demonstrate how the performance range for "Decision" correlates with the cited references and how the concept of total error compares with the