Analytical performances achieved by the 'Aria II' automatic system in an inter-laboratory survey for triiodothyronine and thyroxine assays

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Introduction

During the last decade radioimmunological techniques have become a very useful diagnostic tool and many assays are frequently performed in clinical laboratories; this widespread use has prompted numerous attempts to partially or completely automate radioimmunoassay (RIA). Recently, a fully automatic system (the Aria II*), developed by Becton-Dickinson [1], has become widely used in laboratories which assay triiodothyronine (T_3) and thyroxine (T_4).

Automatic RIA systems must be evaluated in terms of their practicability (speed, cost and technical skill requirements) and also, and most importantly, in terms of their reliability (accuracy and precision). Results produced in a single laboratory have been used to evaluate the Aria II system [2 and 3]; data gathered in inter-laboratory surveys can also provide a useful means of comparing the performances of different analytical systems [4 and 5]. This paper describes an inter-laboratory approach—the accuracy and precision of the Aria II system has been estimated using data collected during a national external quality control survey (EQCS) for T_3 and T_4 , which has been operated by the authors since January 1980.†

Materials and methods

Main EQCS data

Details of the EQCS organization and data processing have been reported elsewhere [6]. The present analysis is based on the results of 63 samples sent in 14 monthly despatches during the period April 1980 to November 1981; 31 of these samples, prepared from eight pools, were sent as hidden replicates (three to five replicates from each pool) to the participants in order to estimate their precision. The number of laboratories participating in the EQCS ranged from 39 (April 1980) to 148 (November 1981); 17 laboratories were using the Aria II system during the period November 1980 to November 1981, only one laboratory was using it before November 1980.

Data analysis

The accuracy of the Aria II system was evaluated comparing the results obtained from laboratories using the automatic system with the consensus mean of the respective EQCS samples (taken as reference values). The precision of the Aria II was estimated from the results of hidden replicates.

A CV was computed from the results of samples prepared from the same pool and a mean CV was obtained pooling the CVs of all the pools considered.

Recovery tests: preparation of samples and results

The validity of the consensus mean as a reference value was checked by nine recovery experiments. These recovery tests were carried out by sending to participants either spiked and charcoal stripped sera. The 'free' serum was prepared by recycling for 24 h 100 ml serum on a 1.5×50 cm column filled with charcoal spherules (made by BAC [grade MU-LLI], Taiyo Kaken Co. Ltd, Tokyo, Japan). The stripping efficiency was monitored by adding labelled T_3 and T_4 to serum; in two experiments 98 to

Figure 1. Regression analysis of 477 T_3 results from laboratories using the Aria II system against the respective consensus means taken as reference values. The mean values found in each EQCS sample are indicated by different symbols depending on the number of laboratories using the Aria II (●: 1–5; ○: 6–10, ▲: 11–17); regression and identity are depicted as full and dashed lines respectively.

The inset table reports the mean readings by the Aria II system (computed from the regression line) corresponding to four assigned T_3 levels. Significance of the difference from the reference value ($p < 0.01\%$; indicated by an asterisk) was estimated from the confidence limits of the regression line.

*The Aria II is manufactured by Becton-Dickinson Immuno-diagnostics, 180 West 2950 South, Salt Lake City, Utah 84115, USA.

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Table 1. Results of recovery tests from 'free serum' added to T_3 and T_4 .

Sample	T_3			T_4		
	T_3 concentration in added samples (ng/ml)	Mean of Aria II results (ng/ml)	Recovery %	T_4 concentration in added samples ($\mu\text{g}/100\text{ ml}$)	Mean of Aria II results ($\mu\text{g}/100\text{ ml}$)	Recovery %
C057	2.60	2.81	108.0	11.24	11.50	102.3
C059	3.90	4.08	104.6	16.86	16.54	98.1
C060	1.30	1.52	116.9	5.62	5.93	105.5

Figure 2. See figure 1.

99% of T_3 and 95 to 96% of T_4 could be removed. Stripped and spiked sera were added to T_3 and T_4 samples (purchased from Henning, Berlin, FR Germany) and measured by spectrophotometry. The results of the recovery experiments were $101.3\% \pm 4.3\text{ SD}$ and $101.8\% \pm 5.2\text{ SD}$ for T_3 and T_4 respectively; these findings strongly support the use of the consensus mean as reference value.

Results and discussion

Figures 1 and 2 compare all the results obtained using the Aria II with the consensus means of the EQCS samples for T_3 and T_4 respectively. It can be seen that T_3 measurements produced by the automatic system are affected by a significant positive bias, which ranges from 17% in the low concentration values to 7% in the high values. As far as the T_4 assay is concerned, the Aria II results appear to be slightly biased (from 3% to -3% in the low and in the high T_4 values respectively). However, these small biases, even when statistically significant as mean values, are of low analytical relevance. The Aria II accuracy has been also directly evaluated from recovery tests; table 1 reports the mean results obtained by laboratories using the Aria II system in

Table 2. Imprecision of the Aria II system and other methods.

Kit/method	Imprecision, T_3	CV% T_4
Ames, T_3 , Seralute column separation	17.4	12.3
T_4 , Tetralute column separation-CPBA		
Becton-Dickinson Aria II system	12.4	9.2
Biodata, PEG separation	11.9	12.9
Byk-Mallinckrodt, Spac. coated tubes	17.3	12.7
Clinical assays, coated tubes	15.2	10.6
Diagn. Prod. Corp., Double antibody with PEG separation	15.3	11.3
Lepetit, Liso-phase, column separation	15.5	13.1

The pooled CVs computed from all hidden replicates are reported for the kit methods used by a substantial proportion of participating laboratories (there were at least 150 results for each 'kit' method).

added samples, together with the spectrophotometrically measured concentrations of T_3 and T_4 . These latter findings confirm that the automatic system overestimates T_3 concentrations, but that it assays T_4 without a significant bias.

The mean imprecision of the Aria II system achieved in the EQCS pools sent as hidden replicates during the whole period is shown in table 2; for comparison the table also shows the mean imprecision achieved by the six 'kit' methods more frequently used in the EQCS (by six to 20 participants). From these findings it is evident that the Aria II system attains a between-laboratory, between-batch precision which is similar, or better, than that obtained by the more precise method used in the EQCS. This good precision could, however, be expected if one considers the better standardization of an automatic analytical system compared with manual ones.

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