

## **The Economical and Practical Evaluation of Reflectance Spectroscopy**

Göran Östling

*Department of Clinical Chemistry, Örebro Medical Center Hospital, Örebro, Sweden*

When evaluating the feasibility of reflectance spectroscopy equipment (RSE) there are many conditions and questions to be considered. Without taking into account questions concerning the quality, speed and availability in clinical situations, the economical consequences need to be analysed. The costs are dependent on the reagents used but mostly on the labour required. In general terms, it is often more economical to run a series of tests in an automated way in the laboratory rather than perform them one by one manually. Consequently, it must be cheaper to perform a few tests on the RSE than to start up a large machine to do the same job. Ascertaining the number of tests necessary to the economical threshold can be determined by practical experiments, but it can also be done theoretically using only the operation manuals of the equipments.

The Swedish Planning and Rationalization Institute for the Health and Social Services (Spril) has published a method of measuring the manual labour involved in the analysis work based on the industry's MTM (Method-Time Measurement). The method is applicable to clinical chemistry laboratories and a data base of so called elements, operational steps and operations typical for the chemistry laboratory has been collected. Simply by reading the operation manual for the apparatus, it is possible to add up the time needed for the sequences of events in the analysis procedure, both regarding the series related, e.g. warming-up time, calibration time etc, and the specific handling time per test. The time is also cataloged as personnel-bound and unbound time.

The evaluation was performed on a common analysis, blood glucose, and we chose one of the instruments currently available on the market, Reflotron<sup>R</sup> marketed by Boehringer Mannheim Scandinavia AB. As a comparison we used a commonly accepted glucose oxidase method, using self prepared reagents and run on an automated photometer, Calculating Absorptiometer 2074<sup>R</sup>, LKB-Produkter AB.

## RESULTS

The time for the work elements and the operational steps are added up and expressed in time measuring units, TMU. One hour represents 100 000 TMU, e.g. 1 minute is about 1 667 TMU. The results for one analysis with Reflotron and LKB 2074, respectively, are shown in Tables I and II. It should be noted that there is mainly only handling time per test involved with RSE (5 855 TMU = 3.5 minutes) whereas the routine laboratory method consists of a relatively long series related time (7 039 TMU = 4.8 minutes) but a shorter time per test (1 138 TMU = 41 seconds).

Table III shows the difference between running a single test on the two equipments and running a typical day's series of 100 tests.

Figure 1 shows that the traditional automated method will be cheaper per year than the RSE alternative as soon as there are more than 20 tests per day. The curves will have to be modified according to local rules concerning annual devaluation rates for both apparatuses. The results are based on the assumption that the technician is working 2 000 hours per year for a salary of 120 000 SEK and the RSE is bought for approximately 20 000 SEK and the Calculating Absorptiometer for 200 000 SEK at an interest rate of 13 %.

Table I. ANALYSIS OF B-GLUCOSE WITH REFLOTRON

Prerequisite sample collection: Blood collected in EDTA anti-coagulant in test tubes in racks. Marked tubes and request forms.

	SERIES TIME	SAMPLE TIME
Take out container		61
Open lid		174
Take out carrier		61
Place carrier in holder		61
Take off cap from one tube		174
Take out pipette		57
Take out disposable tips, mount tip, aspirate sample volume	(100)	100 224
Expirate onto carrier		77
Place carrier in apparatus		61
Close adapter		61
Reaction time (read)		4195
Preparing to read, reading, transference to request form	(200)	200  102
Open adapter		61
Remove adapter		61
Inspect and dispose expendables		22
TOTAL TMU	(300)	5855

Table II. ANALYSIS OF B-GLUCOSE WITH LKB 2074

Prerequisite sample collection: Capillary blood drawn into capped test tubes, containing sodium hydroxide, in test tube racks. Marked tubes and request forms.

$N$  = number of samples       $M = N + N/10 + 9$        $R = N/10 + 1$

	FREQUENCY	SERIES TIME	SAMPLE TIME
Collect tubes for calibrating solutions and standards		300	
Collect calibrating solutions and control serum		600	
Mark 9 tubes as calibrators and controls		532	
Fill 9 tubes with calibrating solutions and controls		1040	
Take off caps from sample tubes	N		174
Fill zinc sulphate solution	M	100	77
Mix with vibrator (2 at a time)	M/2		156
Load centrifuge (2 tubes at a time)	M/2		61
Centrifuge (5 minutes)		unbound time	
Load empty cuvettes in racks (10 at a time)	M/10		149
Empty centrifuge (see loading)	M/2		61
Pipette from tubes to cuvettes	M	100	138
Incubate (25 minutes)		unbound time	
Dark current adjustment (time measured)		1667	
Running calibrators and standards (time measured)		2500	
Load racks into photometer	R		111
Running samples (automatically)	N		45
Transference of results	N	200	105
Dispose cuvettes	R		61
TOTAL TMU		7039	1138

Table III. COMPARISON OF ANALYSES OF B-GLUCOSE WITH REFLOTRON AND LKB 2074

INSTRUMENT	TIME IN TMU (and HOURS, MINUTES) FOR:	
	<u>SINGLE SAMPLES</u>	<u>SERIES, N = 100</u>
REFLOTRON	0 + 5855 (3 min)	300 + 555500 (5 h 30 min)
LKB 2974	7039 + 4678 (7 min (+ 30 unbound))	7039 + 78343 (47 min (+30))

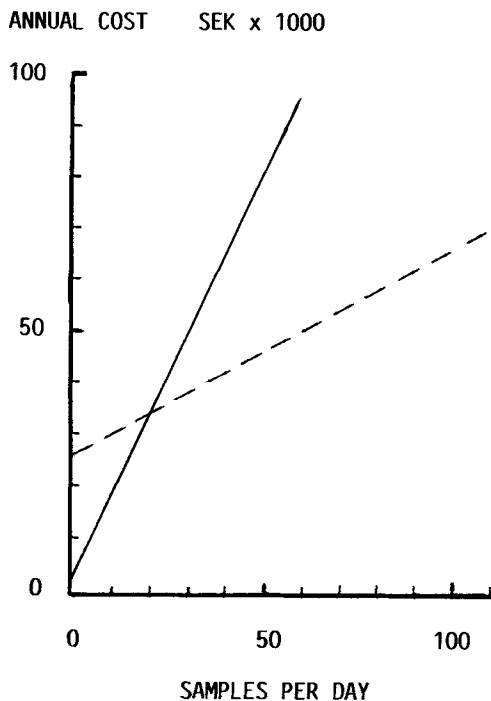


Fig. 1 Annual cost for the RSE and an automated method as a function of the size of a daily series of samples.  
 Reflotron: —————  
 LKB 2074: - - - - -

The results per se must not be taken too seriously but merely serve as an example of a method to calculate the economy of reflectance spectroscopy equipments compared to conventional laboratory methods. It is clear that the RSE can be of value when a few results are demanded quickly but will be rather slow and expensive when there are long series to be analyzed.

#### REFERENCES

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