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An evaluation of the Diesse Diagnostica Ves-matic 20, an automated system for the determination of the Erythrocyte Sedimentation Rate (E.S.R.)

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Abstract
The Ves-matic 20 is an automated ESR instrument which can process and print out ESR results comparable to the Westergren (International Committee for Standardisation Haematology approved) (I.C.S.H.) method within 24 minutes. A closed tube system is used which eliminates the risk of staff contamination from high risk blood samples.

The evaluation compared:
- Ves-matic 20 ESR results with the manual Westergren ESR results.
- ESR results from Vacu-tec tubes filled from an EDTA sample to those collected directly into the Vacu-tec tubes.
- The effect of time delay on the ESR when the Vacu-tec tube is stored at room temperature and at 4 degrees.
- The cost differences between the Ves-matic 20 and the Westergren method.

Introduction

The Ves-matic 20 is a bench top analyser designed to automatically determine the ESR of a maximum of 20 samples per cycle, and provide results with an actual sedimentation time of 20 minutes that are comparable to those obtained by the I.C.S.H. approved 1 hour Westergren method. The analyser has the facility to perform ESR's that are comparable to the 2 hour Westergren method, but as most laboratories do not perform the longer ESR, we did not carry out a comparison for this.

The freeing up of technologist time and staff safety are important issues for laboratory managers at present. The Ves-matic 20 has addressed these issues in our laboratory. Because samples are collected into specially designed tubes, less time is spent in the retrieving of EDTA samples; loading the analyser requires little time, and the result turnaround is reduced by half. The collection of the sample into Vacu-tec tubes at the time of venepuncture and the automated system overcomes the problems associated with sample handling.

Methods

The Ves-matic 20 uses specially designed tubes of which there are two types. The Vacu-tec tubes are filled by vacuum aspiration at the time of venepuncture (they can be filled manually at the bench from an EDTA sample), and the second type of tubes are the Ves-tec tubes which require manual filling from an EDTA sample. The Ves-tec tubes are currently not available in New Zealand.

Both tubes have the same dimensions and are enclosed in a removable sleeve to which the patient I.D. is attached. Both contain the same amount of anticoagulant/diluent, 0.35ml sodium citrate — 105mmol/L. The sample volume required to fill them to the intended height of 60mm is 1.1ml, this gives a final ratio of 3.1: 1 of blood to diluent. The tube can be filled to a maximum of 5mm above or a minimum of 12mm below the mark, and the instrument will still perform a reliable ESR. Because of the narrow tapering shape of the tubes it is important that the samples are mixed well at time of collection.

The Ves-matic 20 operates on the principle that erythrocytes will sediment at a greater rate if the tube they are contained in is deviated from vertical. In this instrument the tubes are held at an angle of 18 degrees from vertical, and associated with the design of the tube, and blood to diluent ratio, the time required for sedimentation is 20 minutes compared to the Westergren method which is 1 hour.

The analyser operations are very simple. A sample holder plate holds the tubes at the deviated angle. A motor then moves the holding plate at 90 degrees from its resting position where it rotates around its shaft for a fixed time, allowing standardised mixing of the samples. After returning to its horizontal position a photoelectric sensor passes up the outside of each tube and records the height of the RBC column i.e., at what point there is an increase in light transmission. After 20 minutes of sedimentation the photoelectric sensor passes up the side of each tube again and records the new height of RBC's. The analyser using the decrease in height along with a mathematical calculation gives a printed ESR result. The whole procedure takes 24 minutes, and is electronically timed.

Evaluation and Results

The evaluation of the Diesse Ves-matic 20 involved four areas, as mentioned previously. In all these evaluations, the venous EDTA specimens were collected using vacuum aspiration tubes containing Freeze-dried EDTA (Na_2) (Becton Dickinson Vacutainer Systems, New Jersey). The ESR tubes used were 90mm long Diesse Vacu-tec containing citrate as discussed above. (Expiry Dec. 1992). The Westergren ESR's were performed using the I.C.S.H. recommended procedure, using 300mm long plastic Westergren pipettes.

The EDTA sample was diluted with sodium citrate (109mmol/L), in a ratio of 4:1 immediately prior to performing the one hour Westergren ESR. The first comparison was to establish that the Ves-matic 20 ESR results were in fact comparable to the Westergren ESR results. The I.C.S.H. recommends that the validity of any method other than the Westergren may be acceptable for performing ESR's provided the validity is established (1). 124 ESR's were performed by both methods under normal working conditions. The criteria set for a comparable result, was that when the Ves-matic 20 ESR results were plotted against the Westergren ESR results on a linear regression plot, that the correlation coefficient be approximately 1.0. The resulting correlation coefficient of these results was 0.96 (Figure 1).

55 ESR's were performed in the comparison of ESR results using Vacu-tec tubes, which had been either filled from an EDTA sample, or collected directly. Both were compared to the Westergren method. The correlation coefficient of the Vacu-tec tubes filled under vacuum, compared to the Westergren ESR results was 0.97 (Figure 2). The Vacu-tec tubes filled manually, also gave a correlation coefficient of 0.97 when compared to the Westergren ESR results (Figure 3).

In the third comparison, the effect time delay has on the ESR result; 64 ESR's were performed with each Vacu-tec sample being retested every hour for 24 hours. The storage over this time was at room temperature. The results were then divided into three categories depending on their original ESR result:

Normal	0-15 mm/hr.
Moderate	16-50 mm/hr.
High	51 mm/hr.

Over the 24 hour period a drop in all the ESR results was noted, with some falling from the moderate to high ranges, into the normal range. This is demonstrated in the plot for the category which had an original ESR result greater than 51 mm/hr (Figure 4).

Fig 1

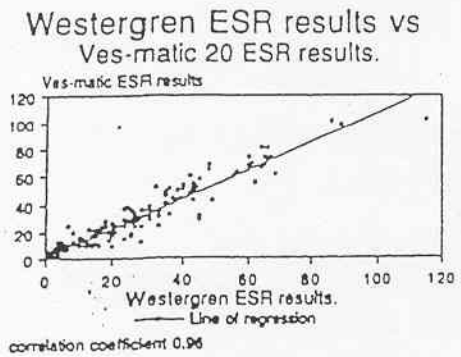


Fig 2

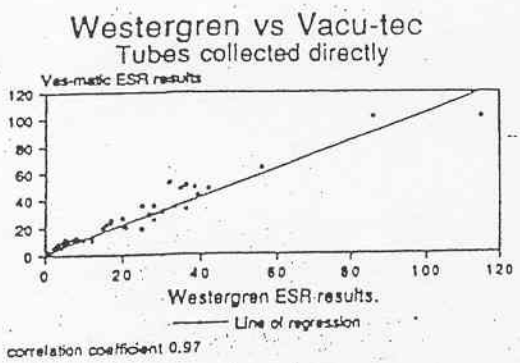


Fig 3

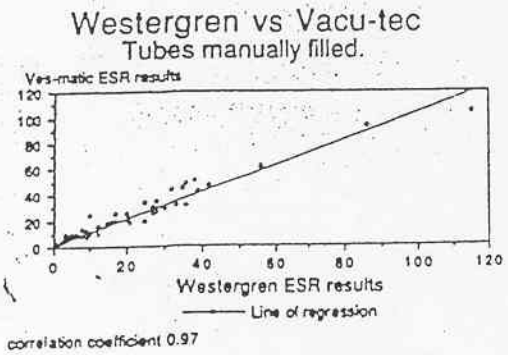


Fig 4

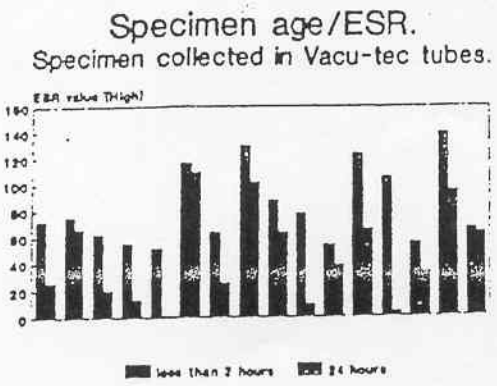
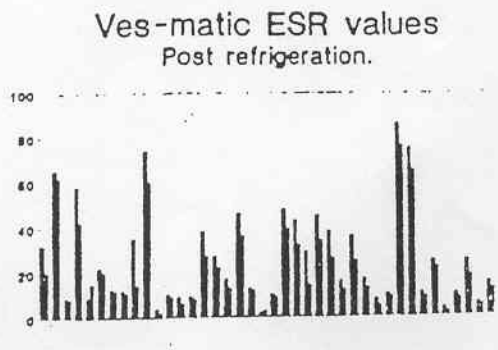


Fig 5



Having demonstrated a significant decrease in the ESR results following a time delay at room temperature, the stability of the Vacu-tec tube had to be established when stored at 4 degrees. 40 Vacu-tec tubes were stored at 4 degrees for at least 8 hours, the resulting decrease in ESR results we considered to be minimal (Figure 5).

The within batch precision was evaluated by collecting 12 samples from both a known normal patient and a known abnormal patient. The ESR's were then performed within 2 hours of collection, on the same run, and thus under the same conditions. The mean of the normal results was 5 mm/hr, with the 2 standard deviation range 2-8 mm/hr. The mean of the abnormal results was 48 mm/hr, the 2 standard deviation range was 42-54 mm/hr. With both sets of samples, all results were within the 2 standard deviation range.

Discussion

A costing exercise was done to find out what our expected costs would be when using the Ves-matic 20 compared to the Westergren method. The time interval for the exercise was over a 5 year period, this being the time allocated in our laboratory for the depreciation and writing off of the analyser. With reference to Table 1 (showing the expense during the first year of purchase), we based the consumable costs on the number of ESR's we performed last year, which was just under 14,000. A time and motion exercise was done to work out how much technologist time was spent per day performing the ESR's for both methods, (approximately 50 ESR's per day). The $13.50 is the hourly rate of a first year Staff Technologist, this rate was used because it is the average wage of the range of staff who perform routine ESR's. At the end of the first year it was obvious that due to the initial cost of the analyser the Westergren method expenses are less. Table 1 also looks at years 2 to 5. We have not taken into account price increases for consumables and technologist time, because both methods are subject to the same increases and therefore balance one another out. However, one factor that does need consideration but we were unable to cost, is that of any maintenance and repair work on the Ves-matic 20. Therefore at the end of the 5 year period the cost of performing Ves-matic ESR's compared to Westergren ESR's is $15,266 less.

There are things which cannot have a unit price put on them which we feel need some degree of consideration. They are the reduced biohazard risk to staff, the increased turn-around in producing a result and the freeing up of technologist time to perform other duties.

The main advantages in this system are obvious and have already been mentioned. Others include better standardisation of the ESR, printed results, the facility to interface the analyser with a computer or attach a bar code reader, and a compact and easy to operate analyser.

The disadvantages we have found. With reference to our paediatric samples, we are not able to perform micro ESR's on the Ves-matic and therefore rely on doing a micro Westergren ESR. Because the tubes are read optically, patient I.D. labels must be attached to the removable sleeve. When the sample arrives at our laboratory, laboratory I.D. labels are then attached to both tube and sleeve. The disadvantage is that if the sleeve is removed during transit there is difficulty in positively identifying the sample.

Lastly, a study done by Caswell and Stuart, University of Birmingham (2) showed that if there was prolonged storage of the plastic tubes there was either progressive loss of vacuum, loss of water vapour through the plastic, or absorption of citrate to the plastic. This could result in a change of blood to anticoagulant ratio and thus affect the result. To overcome this problem in our laboratory we have smaller and more regular orders of tubes from the suppliers. Refrigeration can also prolong the expiry date on the tubes.

The number of ESR's performed in our evaluation was not great, other evaluations have been performed on this instrument by laboratories with a larger turnover of ESR's than ours. Their results support our findings (3, 4). The main reason for our evaluation was to give us confidence in the

Table 1. *Cost comparison of the Ves-matic 20 to the Westergren method for ESR's over a five year period.*

Ves-matic 20		Westergren	
First Year			
Apparatus			
Analyser	$8500	Racks X2	$516
Consumables			
Vacu-tec		Dispettes	
14000 × 50c	$7000	14000 × 29c	$4060
Paper		Cups	
3 × $20	$60	14000 × 2c	$280
		Pipette Tips	
		14000 × 2.5c	$350
Technologist Time			
1 hr/day		3 hr/day	
5 day/week		5 day/week	
260 hr pa		780 hr pa	
@$13.50/hr	$3510	@$13.50/hr	$10530
Total after First Year			
	$19070		**$15736**
Second to Fifth Year			
Expenses less Apparatus			
4 × $10570	$42280	4 × $15220	$60880
Totals	**$61350**		**$76616**

Conclusion

The Ves-matic 20 showed that it produces accurate results in terms of the comparison to the Westergren method. The Vacu-tec tubes have the ability to be filled either under vacuum, or manually from an EDTA tube, and refrigeration of the ESR sample allows for delayed testing, (this requires further evaluation to determine the maximum delay). The Ves-matic 20 provides us with a safe, efficient, and cost effective method for performing ESR's in our laboratory.

Acknowledgements

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