Evaluation of a 200 mm long vacuum aspiration tube for measurement of erythrocyte sedimentation rate

M Caswell, J Stuart

Abstract
The ESR-T-system 200 comprises a 215 mm long vacuum aspiration venepuncture tube which contains anticoagulant diluent for the measurement of the erythrocyte sedimentation rate (ESR) without direct handling of the blood sample. This combines the advantage of a tube of "Westergren" length with a reduction in biohazard risk. Blood from 160 patients (ESR range 2-135 mm/first hour) was tested in parallel with the selected Westergren ESR method of the International Committee for Standardization in Haematology (ICSH) and a close correlation (r = 0.967) between the two methods was obtained. A second Westergren ESR, using anticoagulated but undiluted blood, was measured on 58 specimens to give an ICSH "expected" ESR. The ESR-T-system 200 result was within 12 mm/first hour of the "expected" result for 91% of the specimens. This new ESR system is simple to use, does not require mathematical correction of the ESR reading for tube length, and gives results that are comparable with those obtained with the ICSH Westergren method.

Erythrocyte sedimentation rate (ESR) remains the most frequently used laboratory test of the acute phase inflammatory response. Recently the ESR was reported to be the most effective test for monitoring rheumatoid arthritis as it is influenced by the fluctuations in both acute phase plasma proteins and haematocrit of this illness. The selected ESR method of the International Committee for Standardization in Haematology is that of Westergren and is essentially unchanged since the original description in 1921. Awareness of the biohazard risk associated with handling blood samples has led to improved safety of the ESR, including the development of vacuum aspiration venepuncture tubes which are then used unopened to perform the ESR. Such tubes are shorter (60-100 mm scale) than the recommended Westergren scale of 200 mm, however, and the mathematical correction required to give values comparable with the Westergren ESR can reduce test accuracy.

We assessed the performance of a new vacuum aspiration tube with a 200 mm scale which has been introduced to combine the advantages of low biohazard risk with the length of a standard Westergren tube.

Methods
The ESR-T-system 200 (LAB import KB Diagnostics, S-43201 Varberg, Sweden) comprises a glass vacuum tube (215 mm long and 6 mm internal diameter) containing 1.06 ml sodium citrate anticoagulant (3.2% w/v) and 17 µmol "AFST" anti-foaming agent. It is designed to aspirate 4-16 ml blood. After automated mixing (Labmix; LAB import KB Diagnostics) for two minutes, or manual inversion 10 times, the tube is placed in a rack so that the upper limit of the blood is level with the zero mark on the scale. After 60 minutes sedimentation is read directly in mm/first hour equivalent to the Westergren ESR.

Blood was taken using this system and into 0.34 M K₂EDTA (0.054 ml per 4.5 ml blood; Becton Dickinson Vacutainer Systems, Oxford). The EDTA anticoagulated blood was then used to perform a standard Westergren ESR, using glass pipettes conforming to British Standard 2554 (Travenol; Stone, Staffordshire) and after a 4 in 1 dilution with sodium citrate 3.28% w/v. For comparability according to ICSH guidelines, a second ESR was performed with these Westergren pipettes, but using undiluted EDTA anticoagulated blood, on 58 samples that had an haematocrit in the range 0.33 +/- 0.03. The undiluted ESR for these samples was converted to an "expected" ESR according to the ICSH formula:

\[ \text{"Expected" Westergren ESR (mm/l h)} = (\text{undiluted ESR} \times 0.86) - 12. \]

Any ESR system under evaluation should give a result within 12 mm of this expected Westergren ESR.

Venous blood was taken from 160 patients with: (a) elective abdominal surgery (n = 61); (b) lymphoma undergoing chemotherapy (n = 38); (c) acute bacterial infection (n = 28); (d) peripheral vascular disease (n = 33). ESR samples, tested within two hours of venepuncture, were mixed for two minutes using the Labmix, set vertically as checked by a spirit level, and read at 60 minutes. Stability of ESR-T-system 200 samples was assessed after storage at 4°C for 24 hours; the blood was then allowed to return to room temperature over 30 minutes, mixed as before, and a second ESR measurement made.

The internal diameter of 50 ESR-T-system
The internal diameter of 50 ESR-T-system 200 tubes was calculated from the volume of distilled water required to fill each tube to 200 mm.

Results

For each of the 160 samples (Westergren ESR range 2-135 mm/1 h), the mean of the ESR-T-system 200 and diluted Westergren ESR results was plotted against the difference between the two results (fig 1). This is a more sensitive method than the correlation coefficient ($r = 0.967$) for comparing two techniques. As ESR values do not conform to a normal distribution, logarithmic values were used. The figure shows that only nine results by the two methods were outwith 14 mm/1 h (2 SD) of one another.

The ESR-T-system 200 results for the 58 specimens with an original haematocrit of 0.33 $+/-0.03$ compared with the calculated “expected” Westergren ESR for undiluted blood (fig 2). Fewer than 9% of ESR-T-system 200 values were outside the ICSH7 error range of $+/-12$ mm/1 h, with no single result being very different from that expected.

With few exceptions, there was a fall in ESR value after storage for 24 hours at 4°C. The mean fall was 6.7 mm/1 h (95% confidence interval 5.0 to 8.4) and the range was from a decrease of 44 mm to an increase of 15 mm.

The mean internal diameter of 50 ESR-T-system 200 tubes was 5.69 mm (SD 0.04, range 5.56 to 5.79). This allowed the calculation of the mean volume of blood aspirated into 50 tubes to be 3.99 ml (SD 0.01, range 3.66 to 4.23).

Discussion

There is a continuing need for a reliable and safe method for measuring the ESR. The ICSH7 selected method is based on that of Westergren and any new method should be comparable with it. Such a comparison can be made using undiluted blood with an haematocrit of 0.33 $+/-0.03$, with the result converted to give an “expected” value for the Westergren ESR.

The ICSH guidelines recommend that the internal diameter of ESR pipettes be within limits of 2.55 mm $+/-0.15$. ESR-T tubes were 5.69 mm $+/-0.04$ in internal diameter, but earlier descriptions of ESR techniques found that diameters up to 11 mm did not influence the sedimentation rate.

The ESR-T-system 200 reduces the biohazard risk associated with performing the ESR. Use of a vacuum extraction venepuncture method also ensures that the correct dilution of blood with sodium citrate is obtained. Mixing of the blood sample influences the rate of sedimentation by determining the degree of red cell aggregation, and a standard mixing technique, ideally using an automated mixer for a fixed time, is therefore beneficial. A potential problem with a vacuum extraction system is foaming of the sample which can make the upper level difficult to read; this was prevented by the use of “AFST” as an anti-foaming agent.

The only drawback found in using a long (215 mm) vacuum tube was the anxiety of the patient about the volume of blood being drawn, although most were easily reassured. It was initially felt that such a long tube would be liable to breakage but none occurred during the study. The ESR-T-system 200 therefore reduces the biohazard risk of measuring the ESR, does not require mathematical adjustment of the result, and performs well compared with a quality controlled Westergren technique.

We are indebted to LAB import Diagnostics KB for supplying ESR-T-system 200 tubes for this study.

References