Abstract:
The stability of erythrocyte sedimentation rate (ESR) results obtained from Streck ESR-Vacuum Tubes and the ESR-Auto Plus™ was examined over a range of temperatures to determine whether variable temperatures affect ESR data. The Modified Westergren method was employed as a benchmark method to generate data for comparison. It has been previously established that variable temperatures negatively impact manual ESR results1. Streck ESR-Vacuum Tubes, in conjunction with the ESR-Auto Plus, yield stable ESR results at temperatures ranging from 6°C to 30°C.

Introduction:
ESR tests are used to evaluate inflammation that may occur in conditions like infection or cancer. The Modified Westergren method is the benchmark method for ESR analysis. However, this method has limitations. The Modified Westergren method is extremely sensitive to temperature. Therefore, the tubes used for ESR testing should not be placed in direct sunlight or near air conditioning or heating vents1. Temperature fluctuations can cause adverse and unreliable ESR results.

ESR-Vacuum Tubes and the ESR-Auto Plus offer the laboratory a significant advantage because they automatically compensate for temperature changes. The technologist or nurse can be confident that their ESR results are accurate and not influenced by temperature variability.

Methods:
Sample Collection
Blood from two healthy donors was collected in three 1.2mL Streck ESR-Vacuum Tubes and three standard EDTA tubes. Samples collected in ESR-Vacuum Tubes were inverted six to eight times after collection, allowing the air bubble to reach the end of the tube with each inversion. Tubes were held at a 35° angle to facilitate proper mixing. Samples collected in EDTA tubes were inverted six to eight times after collection.

Sample Preparation for Modified Westergren Test Method
Blood samples collected in standard EDTA tubes were mixed on a rotator for two minutes. A 2.0mL aliquot of blood was transferred into 13x100mm tubes containing 0.5mL of 0.85% sodium chloride. The Westergren pipettes were filled to the zero mark and placed in level Westergren ESR racks. ESR tests from the appropriate sample were performed at 6°C, 20°C and 30°C (±1°C). ESR levels were recorded in mm/hr after the pipettes were allowed to stand for exactly 60 minutes.

Sample Preparation for ESR-Auto Plus Test Method
The ESR-Auto Plus instrument was also incubated at 6°C, 20°C and 30°C (±1°C) for four hours prior to testing. ID numbers associated with each donor were entered into the ESR-Auto Plus instrument. When prompted, samples in ESR-Vacuum Tubes that had been mixed for at least three minutes using the Streck ESR-657 Mixer, were inserted into a free position in the ESR-Auto Plus and testing was initiated. The ESR-Auto Plus automatically scanned each sample and printed the results at the conclusion of the 30 minute test.

Results:
Blood samples from two donors were drawn into EDTA tubes and ESR-Vacuum Tubes. One tube of each type was incubated at 6°C, 20°C and 30°C for four hours prior to ESR analysis (Figs. 1, 2). ESR values from samples in EDTA tubes analyzed by the Modified Westergren method for donor #1 were 21 mm/hr at 6°C, 33 mm/hr at 20°C and 46 mm/hr at 30°C (Figure 1). ESR values for donor #2 were 29 mm/hr at 6°C, 38 mm/hr at 20°C and 54 mm/hr at 30°C (Figure 2). The manual ESR values were significantly influenced by storage and analysis temperatures.

ESR-Auto Plus vs. Modified Westergren

<table>
<thead>
<tr>
<th>Instrument</th>
<th>6°C</th>
<th>20°C</th>
<th>30°C</th>
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<tbody>
<tr>
<td>M. Westergren</td>
<td>21</td>
<td>33</td>
<td>46</td>
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<tr>
<td>ESR-Auto Plus</td>
<td>33</td>
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Figure 1. Temperature Effect on ESR Recovery for Donor #1. ESR values obtained using the Modified Westergren method are in blue. ESR values obtained using the ESR-Auto Plus are in red.
In comparison, samples collected in ESR-Vacuum Tubes and analyzed with the ESR-Auto Plus at temperatures of 6°C, 20°C and 30°C yielded stable results (Figs. 1, 2). ESR values for donor #1 were 33 mm/hr at 6°C, 34 mm/hr at 20°C and 36 mm/hr at 30°C, varying by only +3 mm/hr over a temperature range of 24°C (Figure 1). ESR values for donor #2 were 35 mm/hr at 6°C, 37 mm/hr at 20°C and 40 mm/hr at 30°C (Figure 2). Donor #2 showed slightly more variation in ESR data values over the same temperature range, however, values of -5 mm/hr from the data point obtained at 30°C should be considered minimal. This variation is not likely to alter the physician’s diagnosis.

Discussion:
The data presented in this technical manuscript illustrate the stability of ESR from blood samples collected in ESR-Vacuum Tubes and analyzed with the ESR-Auto Plus at a variety of temperatures.

Manual ESR methods, like the Modified Westergren, have many limitations, one of which is temperature sensitivity. Even relatively small fluctuations in temperature can affect ESR results. In this study, temperature changes from 6°C to 30°C caused variations in ESR data of up to 25 mm/hr. The largest ESR difference observed with Streck ESR-Vacuum Tubes and the ESR-Auto Plus was 5 mm/hr, indicating that temperature variation does not significantly affect this ESR method.

Streck ESR-Vacuum Tubes and the ESR-Auto Plus offer a novel and convenient technology that eliminates the temperature sensitivity disadvantage of manual ESR methods. The data in this technical manuscript clearly illustrate that Streck’s unique ESR products produce stable results over temperature differences of up to 24°C. ESR-Vacuum Tubes and the ESR-Auto Plus will provide the laboratory with new confidence in ESR data reporting.