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Does a Delay in Performing an Activated Clotting (ACT) Test Really Matter? A Study in Nonheparinized Blood and a Single ACT Machine

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Abstract: Activating clotting time (ACT) is a point-of-care, blood clotting test used to monitor anticoagulation. Recently, institutional requirements have required that ACT testing be completed outside the operating room with trained, certified personnel other than anesthesia staff. For this reason, in this study, we looked at whether a delay in processing an ACT makes a significant difference to the ACT results. Twenty patients between 18 and 65 years of age consented to the study, each undergoing non-cardiac surgery, with no intraoperative administration of heparin. The study was approved by our Institutional Review Board. A blood sample was taken from the patient's arterial line in the operating room. Immediately afterward, 1 mL was placed into each of two ACT cartridges and the measurement was done in a Medtronic ACT2 machine. The first ACT value was 126.9 ± 14.5 seconds. The ACT value at ~30 minutes was 108.3 ± 20.3 seconds ($p < .0001$). The time between the first and last measurements was 29.4 ± 3.0 minutes. The results suggest that the ACT values decrease over time between sampling all measurements. At ~30 minutes, the ACT values average 15% less than the control measurements. Therefore, it would seem prudent to determine ACT values immediately in the operating room without any delay, using point-of-care testing.
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Activated clotting time (ACT) is a blood clotting test used to monitor heparin anticoagulation (1). Recently, the ACT machine was moved from the operating room to the anesthesia workroom, and staff, other than anesthesia personnel, was trained and certified to perform the ACT tests. Waiting for both a pick up of the sample to be taken to the workroom and for a certified technician to run the test was shown to take as long as 33 minutes at our institution. A delay between collecting the blood and performing the ACT measurement was created, which we thought could adversely affect the ACT results. In an effort to analyze the consequence of such a delay, we designed this study.

MATERIALS AND METHODS

The study was approved by the Stanford Human Subjects Review Panel. Twenty patients, between 18 and 65 years old, undergoing non-cardiac surgery, consented to the study. The patients did not have pre-existing clotting abnormalities and were not on any outpatient anticoagulation regimen. None of the patients received heparin intraoperatively. All patients had an arterial line placed as part of their anesthesia care, and the sampling technique was similar throughout because it was completed by two consistent researchers. A blood sample of sufficient size to permit repeated measurements was taken from the patient's arterial line. Immediately, a sample was placed into each of two ACT cartridges, and the measurement was done in a Medtronic ACT2 machine (Minneapolis, MN) (group I). The inherent variability of this equipment can be ascertained from the Medtronic website. The average of the duplicated ACT tests was recorded. Approximately 30 minutes after the first test was done, another set of ACT measurements were started in two fresh cartridges (1 mL in each) using blood from the original sample (group II). All blood samples were stored at room temperature (1).

The ACT machine was calibrated according to the manufacturer's specifications. In addition, electronic quality control and temperature validation tests were performed before use. Results are expressed as mean ± SD,

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unless otherwise stated. The two groups were compared with a paired *t* test. $p < .05$ was considered statistically significant.

RESULTS

Figure 1 shows that the ACT values in group II were significantly lower than in group I. The mean for the first ACT value was 126.9 ± 14.5 seconds. The mean for the second ACT value was 108.3 ± 20.2 seconds ($p < .0001$). The time between the first and last measurement was 29.4 ± 3.0 minutes. Because all samples were not processed at exactly 30 minutes in the 30-minute test group, there are no obvious clear analytic errors.

Figure 2 shows the Bland-Altman plot of the ACT values.

DISCUSSION

Since its introduction in 1966 (2), the ACT has become the gold standard in measuring heparin anticoagulation. The ACT machine derives an ACT number by exposing whole blood to an activator of coagulation (diatomaceous earth, kaolin, or glass particles) and measuring the time to form a fibrin clot. The normal ACT reference range is between 70 and 180 seconds.

As shown in this study, the 15% reduction in the ACT value over a 30-minute period is not surprising because coagulation starts when the blood comes into contact with a foreign surface. According to the manufacturer's recommendation, the ACT measurement must be done as soon as possible. However, the consequences of any delay between blood sampling and actual measurement have been quantified, but only up to 15 minutes (3). That study showed that there was an 11% decrease in ACT values in non-heparinized blood and 5% decrease in heparinized blood.

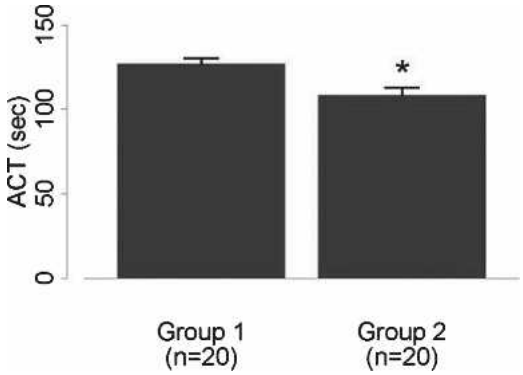

Figure 1. Group I is the ACT value determined immediately after blood sampling. Group 2 is the ACT value from the same blood sample after being stored at room temperature for ~30 minutes. Data are presented as mean ± SE. *$p < .05$ (paired *t* test).

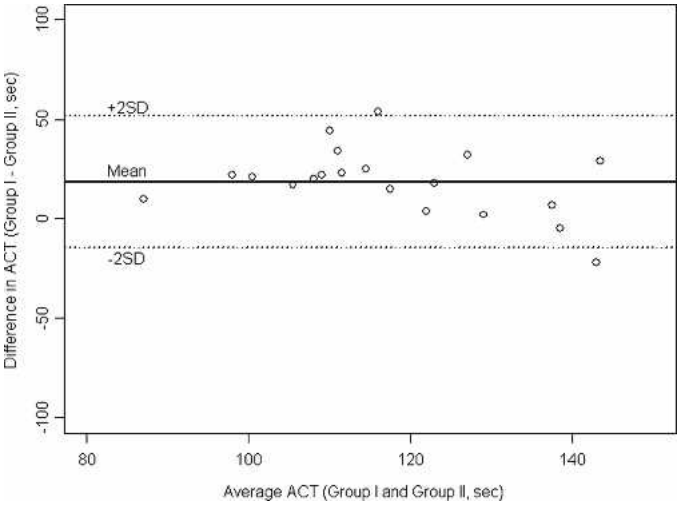

Figure 2. Bland-Altman plot of the ACT values. Group I is the ACT value determined immediately after blood sampling. Group 2 is the ACT value from the same blood sample after being stored at room temperature for ~30 minutes.

Hence, because our measurement delay was ~30 minutes, we wanted to establish what happens after this much delay. Our study showed a drop of 15% in ACT values after 30 minutes. As far as we could ascertain, this has not been reported before. In addition, this study indicated the importance that all ACT measurements for the same patient should be determined at approximately the same time after the sample is taken so that the patient's ACT values can be compared reasonably with each other. ACT is considered a point-of-care lab, meaning all testing is usually performed on a whole blood sample within close proximity to the patient. Such testing started being used in the 1970s, paralleling the growth of critical care medicine, and has since been proven to correlate with data obtained in traditional laboratories (4). As such, whenever possible, point-of-care testing is used in the operating room environment to treat hemostatic abnormalities as quickly as possible. Ideally, point-of-care testing would take place in the actual operating room to cut transportation and processing delays as much as possible. However, this is not always feasible because of non-ideal equipment placement and the hospital policy with regard to using only certified non-anesthesia personnel to run these tests.

In addition, the following variables are known to affect activated clotting times: lysed platelets, patient temperature, decreased or increased urine output, hemodilution, clots in the ACT recording chamber caused by disseminated intravascular coagulation (DIC) or transfusion of platelets, fresh frozen plasma, or cryoprecipitate (5,6). Heparin sensitivity can be affected by inherited tendencies, acquired diseases, and the presence of drugs, such as nitroglycerine or aprotinin (7,8). Finally, when making any laboratory measurement, there exists the possibility of introduc-

ing error if the measurement technique is not standardized with respect to the technician.

We have shown in this study that there is a significant decrease in ACT with time, and ACT values decrease significantly at 30 minutes. In patients where the ACT is actually prolonged, this artifactual decrease in ACT may result in an inadequate protamine reversal dose or an unnecessary heparin dose. However, our data do not permit us to derive a cut-off time beyond which ACT measurements are invalid. Thus, imposing requirements that result in blood samples being delayed for ACT measurements or other point-of-care testing may adversely affect patient care. Hopefully, as more mobile point-of-care lab testing equipment surfaces in the operating room, anesthesia providers will be certified as competent technicians, thus avoiding any delays in processing laboratory results and proceeding with patient care.

Subsequently, we have obtained mobile point-of-care laboratory testing equipment in the operating rooms in our hospital, and certified anesthesia providers can now also run these tests.

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