

Original Article

Estimation of Minimum Heparin Circulation Time for Activated Clotting Time Determination

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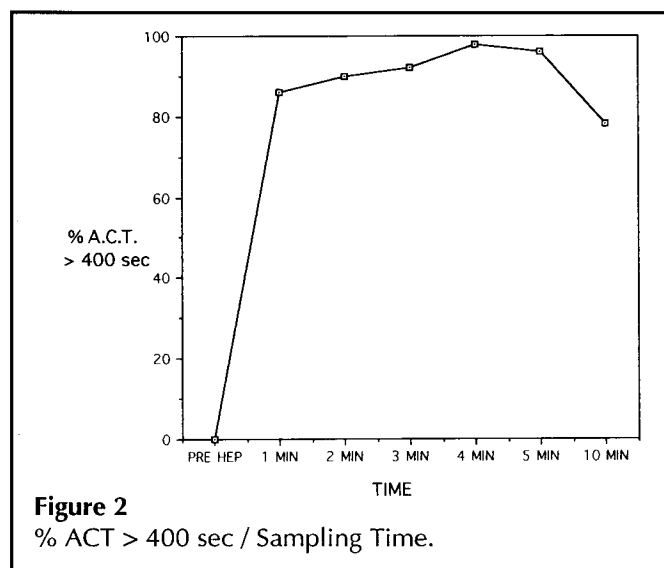
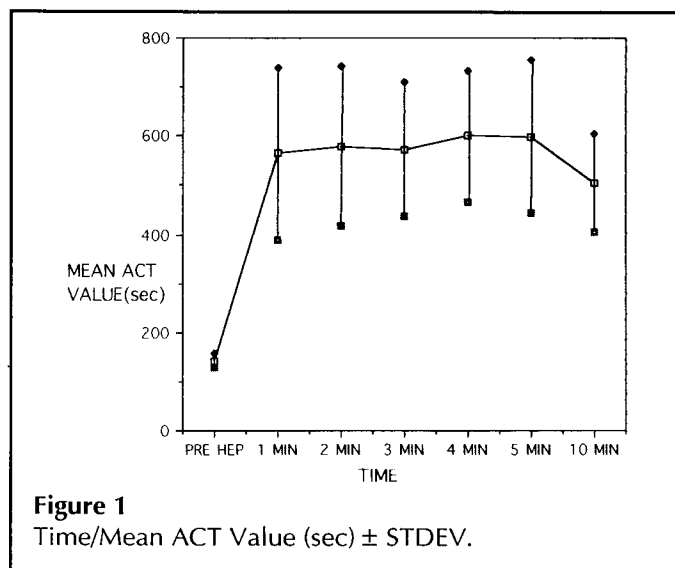
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ABSTRACT

Prior to commencing cardiopulmonary bypass (CPB) anticoagulation is generally monitored by the activated clotting time (ACT). Serial ACT estimations at one minute time intervals were performed on 50 CPB patients following heparinization to establish the time required for heparin circulation and for elevation of the ACT to a preset target value of 400 seconds. The results showed that adequate anticoagulation for cannulation to proceed was achieved in 86% of samples taken one minute following heparinization. Confirmation of adequate anticoagulation at one minute would allow earlier cannulation in an emergency situation and alert the cardiac team if the heparin failed to enter the systemic circulation. Patients in whom ACT values failed to reach the target value at one minute subsequently required additional heparin, immediately, or at a later stage.

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INTRODUCTION

Adequate anticoagulation prior to commencing cardiopulmonary bypass (CPB) is achieved by administering the appropriate dose of heparin. Many aspects of this systemic heparinization have been studied and documented including standard dosage (1), dosage requirements with membrane oxygenators (2) and heparin monitoring (3). It is standard practice to wait a certain time interval post-heparinization, to allow the heparin to circulate and mix, before measuring its effect. This time interval has never been accurately determined. With recommended protocol, an initial dose of 3000 units per kilogram (i.u. per kg) is given (1) and after a 5 minute interval (2) an activated clotting time (ACT) test is performed. Our study was performed to establish the minimum time taken for the heparin to circulate and for the recommended ACT value of 400 seconds (3) to be achieved.

MATERIALS AND METHODS

Fifty consecutive adult patients undergoing elective CPB surgery were studied. For each patient, a 2 ml sample of blood was withdrawn and a pre-heparinization ACT performed. Patients were heparinized with a dose of 3000 i.u. per kg of bovine lung heparin, given over one minute via the central venous pressure (CVP) line. ACTs were performed using three pre-calibrated Hemochron[®] Model 801 instruments and flip-topcelite-activated (FTCA 510) test tubes. A timer was started immediately after the heparin infusion finished.

Blood was continuously withdrawn from the inferior vena cava (IVC) into a 40 ml syringe via a 20 gauge spinal needle connected to a 200 cm length of Vygon[®] tubing (line volume 1.7

ml). The aspiration rate was 10 ml per minute. A three-way stopcock allowed aspiration of 2 ml blood samples, at one minute intervals, over the following 5 minutes. Sampling time was 12 seconds and sample withdrawal was begun at 6 seconds to the minute. A further sample was taken at 10 minutes. ACTs were performed immediately on the samples, giving a total of seven values for each patient.

RESULTS

Table 1 shows the mean ACT values obtained at various time intervals during surgery. When plotted on a graph (Figure 1) it can be seen that mean values increased progressively up to 4 minutes (mean 600; range 294-960), but subsequently fell to a lower value at 10 minutes (mean 505; range 263-713). In Figure 2 the percentage of samples with an ACT greater than 400 seconds is plotted for each sampling time. It can be seen that the highest percentage of samples exceeded 400 seconds at the 4 minute sampling time. Figure 1 and 2 demonstrate that maximum ACT values occur 4 minutes post-heparinization in the vast majority of cases.

DISCUSSION

It is essential that the patient is fully heparinized prior to the insertion of any venous or arterial bypass cannulae into the circulation (4). The ACT test, being the standard test of heparin effectiveness during CPB, is always performed before cannulation commences. Reed (5) has recommended that between 3 and 5 minutes should elapse before heparin status is verified. On initiation of ACT determination, a delay of 2 to 3 minutes occurs before pre-heparinization ACT values are exceeded. Therefore cannulation cannot proceed until a minimum of 5 to 8 minutes have elapsed.

The results of this study showed that the recommended

a International Technidyne Corporation, Edison, NJ, 08820

b Vygon, 95440, Ecoen, France

Table 1

SAMPLING TIME	MEAN ACT VALUE (\pm SDEV)
pre heparin	142 \pm 15 seconds
1 min	564 \pm 175
2 min	579 \pm 164
3 min	573 \pm 136
4 min	600 \pm 134
5 min	579 \pm 156
10 min	505 \pm 100

ACT value of 400 seconds was achieved or exceeded at one minute post-heparinization in 86% of cases. There is a progressive increase in ACT values, with maximum values being achieved at 4 minutes post-heparinization in most cases. However this is a short-lived peak, with earlier and later sampling times giving lower values. The ACT value at one minute approximates closer to a sample taken at ten minutes, a time when bypass is likely to be initiated. Therefore the one minute measurement gives a better indication of long term ACT values than that taken at 4 minutes. As the minimum ACT value is of primary importance, the result of a sample taken at one minute is the best indication of heparinization.

An acceptable ACT result obtained at this time permits safe cannulation, saving up to four minutes in an emergency situation. An ACT value less than recommended, detected at one minute

sampling, is an early indication that additional heparin will be required prior to or during CPB.

Inadvertent administration of heparin into a blocked CVP line, resulting in inadequate heparinization, has been reported (5). Such an occurrence will be detected and rectified earlier by ACT measurement at one minute.

Further investigation would be necessary to establish minimum heparin circulation time in patients with very low cardiac output or those requiring internal cardiac massage.

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