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Detection of Acute Mild Hypovolemia by Nonlinear Heart Rate Variability

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The pattern of heart rate variability (HRV) has been shown to correlate well with measures of autonomic activity. In turn, changes in HRV pattern have been proposed as markers of altered physiologic states, including disease, and a variety of linear and nonlinear measures of HRV have been evaluated for this purpose. In both animals and humans, changes in minimum point correlation dimension (PD2i), a nonlinear measure of the degrees of freedom of the HRV, correlates well with the effects of severe blood loss during trauma. However, the response of PD2i to mild blood loss has not yet been evaluated. As in more severe blood loss, during even mild blood loss, such as occurs during blood donation, several neurohormonal mechanisms are called into play as the central ner-

vous system attempts to compensate and restore homeostasis. This should acutely cause a noticeable change in PD2i, which is known to decrease in the face of sympathetic stimulation.

Subjects were volunteers who presented for a standard single unit whole blood donation. A 15-minute electrocardiogram recording was made predonation and the recording was then continued during the donation period and a rest afterwards.

Eighteen subjects (mean age, 48 ± 18 years) participated. Three were taking beta-blockers and two were taking antidepressants; one had diabetes. At baseline the minimum PD2i had a mean of 2.6 ± 0.8 dimensions, whereas after donation it fell to 1.8 ± 0.5 dimensions ($P = .0011$).

The minimum PD2i is a sensitive metric for the detection of mild blood loss, as seen in the controlled environment of donation of a whole unit of blood. Thus, PD2i may serve as a marker for mild hemorrhage in hospital (eg, surgery) and trauma environments. In addition, given PD2i's association with autonomic activity, these results suggest significant sympathetic activation with even standard blood donation, suggesting that PD2i can be used to track a patient's autonomic response to insult.