EDITORIAL

Ventricular Rate Patterns in Atrial Fibrillation

Atrial fibrillation has long been the intriguing subject of much speculation and investigation. In general, scientific inquiry has been addressed to two major problem areas: First, what abnormal conditions affecting the basic electrophysiologic state of the atria are responsible for the inception and perpetuation of fibrillation? Second, what factors govern the response of the atroventricular transmission system and the ventricles to the showers of impulses arriving from above? A corollary question, relating to both the atrial and ventricular manifestations of the arrhythmia, asks whether the electrocardiographic signals are indeed completely irregular as had so long been supposed, or whether they may not in fact contain at least a modicum of intrinsic rhythmicity buried within their seemingly random temporal sequences. Recent observations on this perplexing question are described in the paper by Bootsma and associates which appears in this issue of Circulation.

The problem of rhythmicity in atrial fibrillation appears to have commanded increasing attention over the past decade. In retrospect, this growth of interest is not surprising, being undoubtedly related to the progressive application of the electronic digital computer to existing problems in electrocardiography. These devices, especially in the form of so-called laboratory-oriented configurations, are readily capable of converting many minutes worth of the electrocardiographic signal into long strings of discrete, quantified pieces of sequential information. These digitized values may then be subjected to a battery of numerical procedures which are intended to test a variety of hypotheses. With such powerful analytic means at hand, one might expect clear and prompt answers to the question of rhythmicity in atrial fibrillation. Such has not been the case.

A survey of the pertinent literature provides impressive evidence for entirely random behavior, on the one hand, and convincing support for intrinsic rhythmicity, on the other. The clinician is understandably confused by this contradictory evidence. In the case of the fibrillating atria themselves, the basic mechanism would seem most likely to be the result of a random process, and indeed a computer model of atrial fibrillation based on the random assignment of electrophysiologic parameters reproduces the rhythmic vagaries of the disorder in a highly realistic manner. Yet, it is a common observation that the amplitude of the atrial deflections in fibrillation waxes and wanes intermittently, and during the periods of recrudescence the undulatory signal is stable enough to assign it a meaningful value of frequency. Rather interestingly, when the computer is programmed to examine the fibrillatory signal from the clinical electrocardiographer's point of view (by means of

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autocorrelation), it seems to confirm the impression of a truly rhythmical content within the signal and even quantifies it in a manner which corresponds roughly to subjective appraisal.3 Baffling as this contradictory situation now seems, it is our expectation that sometime in the future a unifying principle will emerge which will explain how it is that many segments of the fibrillating atria are recurrently constrained to act in concert and thus produce the typical electrocardiographic undulations which characterize the condition.

The nature of ventricular response in atrial fibrillation is equally confusing. The question of there being a hidden rhythm within the grossly irregular ventricular sequence was first raised more than 40 years ago. It also seems to be a part of clinical lore that in some patients, particularly those taking digitalis, there is a tendency for sequential beats to group together according to whether the R-R interval is long or short. This impression of "birds of a feather" behavior is reasonably well supported by a few published studies. Other reports, including the one appearing in this issue, deny its existence.

In what was evidently the first "computerized" study of ventricular response in atrial fibrillation, Braunstein and Franke4 determined autocorrelation functions in a series of digitalized patients who had this condition. Their results were "typical for a mixture of periodic and aperiodic events" in all subjects so tested. Appearing in the same issue of the same journal, a key paper by Horan and Kistler4 emphasized the likelihood that "the irregularity in atrial fibrillation is not absolute or random." Another kind of ventricular rhythmicity in atrial fibrillation is described by Urbach and associates5 who detected 18 instances of A-V junctional tachycardia and escape rhythm in 61 recordings from 31 patients. This mechanism, considered to be the result of digitalis excess had been recognized from routine electrocardiographic interpretation in only three instances.

Employing considerably more powerful computer machinery than was available to Braunstein and Franke, Goldstein and Barnett6 undertook an extensive statistical study of ventricular response sequence in 28 records of atrial fibrillation. In half of these records they discovered series of beats with almost equal R-R intervals, a phenomenon which they called "chaining." The tendency toward nearly regular behavior during periods of chaining may be so pronounced that it can produce a second mode in the conditional histograms of R-R intervals (frequency distribution of those R-R intervals immediately preceding and following a preselected, and therefore "conditional," value of R-R interval). An alternative method of study, mutual information analysis, confirmed that there was a statistically significant degree of interdependence between adjacent intervals in the 14 records in which chaining was demonstrated by the conditional histograms. At this juncture the phenomenon of chaining would seem further to confound an already confused picture.

In simplest terms one would expect a basically rapid and somewhat irregular ventricular response in atrial fibrillation. Deviations from this basic pattern would have to be in the form of slowing and should be ascribable to certain special properties of the atrioventricular transmission system. The particular electrophysiological property of the conducting tissue which has been most plausibly implicated is that of concealed conduction. The further point has been made by Moe and Abildskov7 that, once established, concealed conduction tends to be self-perpetuating. On these phenomenologic grounds, therefore, a grouping of ventricular beats into those with short R-R intervals and those with long R-R intervals is not surprising.

In the study of Bootsma and associates reported in this issue autocorrelation functions are determined in a somewhat different manner from that employed by Braunstein and Franke. The current offering brings us full circle back to the original concept that the ventricular mechanism is completely irregular in atrial fibrillation. Their findings are trenchantly summarized in the statement that "the effect of randomly spaced atrial impulses of random strength reaching the A-V node from
random directions can explain these results” (the italics are ours).

The nature of ventricular response patterns in atrial fibrillation remains a puzzle. In view of the obvious quality of the work from which the various conflicting pieces of information have been derived, it seems unlikely that the clinician would be willing to “choose sides,” at least not until there is further clarification of the problem. This clarification will consist in part upon the ventricular patterns which he himself is able to perceive in his own experience with atrial fibrillation.

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References
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