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Selected Contributions from Western Europe

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Abstract. This paper discusses selected contributions to the field of electrocardiology presented at meetings of the International Society of Electrocardiology over the three decades of its existence. The domain assigned to this particular contribution was that of authors resident in the western part of Europe. This restriction solves to some extent the problem of how a selection may be made from the around 3000 contributions documented. Having just two pages at one's disposal imposes a further restriction. In this paper I will confine myself to some fundamental contributions that have had a real impact on ways of thought in my own area of interest: the theoretical basis of electrocardiology.

1. Introduction

The diagnostic application of the electrocardiogram (ECG) can be roughly divided into two sub-domains: rhythm analysis and waveform analysis. The contributions discussed here mainly relate to the problems underlying waveform analysis. The major features of the ECG used in clinical electrocardiography are duration and amplitude of the various wave elements PQRST and their respective timing. The use of these features has yielded diagnostic accuracies of up to 90% for some types of disease, for other types much less. The improvements that have been realized in the past decades are based on advances in the fields of signal recording, signal analysis, modeling and electrophysiology. These developments are interactive, ongoing, and have been greatly stimulated by the lively interactions that took place frequently during the annual meetings of the ICE.

2. Body Surface Potential Mapping: Taccardi et al.

Insight into the nature of the cardiac electric field as expressed on the body surface greatly benefited from the study of body surface potential maps (BSPMs). It was mainly as the result of the work by Taccardi and his group in Parma [Taccardi, 1963] that the idea has been granted the attention that it deserves. By measuring the signals at multiple sites on the thorax, up to 200 in the work of Taccardi, the full spatio-temporal nature of the potentials was revealed. Initially these signals were recorded sequentially and the subsequent processing in the format of a sequence of BSPMs was a highly time consuming job, which the group performed with great dedication and accuracy. Following their pioneering work, advances in the technology of lead placement, electronics and computer science have made it possible to record all signals simultaneously and almost instantaneously produce the BSPMs.

3. The Missing Information: Kornreich

Surface potential mapping has not been introduced on a wide scale into clinical cardiology. Initially the recording procedure as such was considered to be too time-consuming. Moreover, it was not clear which features should be extracted as diagnostic criteria from the numerous data that became available. One of the indirect applications of body surface mapping data was proposed and worked out by Kornreich [Kornreich, 1985]. By using large BSPM databases, collected and documented by colleagues from within the ICE community, Kornreich identified specific sites (lead positions) on the body surface at which signals should be recorded. Combined with the signals from the standard 12-lead system, the signals at these specific sites yielded an improved accuracy for specific classes of cardiac disease as compared to using just the standard 12 leads.

4. The Pavia Connection: Colli-Franzone et al.

Various biophysical models of the genesis of the electrocardiogram have been employed in the study of the body surface potential distribution and the underlying cardiac activity; see the discussion on this topic in this issue [van Oosterom, 2003]. Faced with the interpretation and possible application of BSPMs, Taccardi soon sought contact with mathematicians in Pavia, Colli-Franzone and his colleagues [Colli-Franzone, 1978]. Together, they adopted an idea first proposed in the work of Martin [Martin, 1970] in which the entire electric activity of the heart is expressed by means of the potential distribution on a closed surface bounding the heart. To check if the inversely computed sources made sense, tank experiments were carried out in which potentials close to the heart surface were recorded simultaneously with potentials on the thorax (the tank) [Taccardi et al. 1972]. The same type of data facilitated the development of various methods for solving the associated inverse problem [Colli-Franzone, 1985].

5. Watchdog: Macfarlane

The developments listed above have been scrutinized continually by the world of clinical cardiology. Unfortunately, the improvements made have not always been so convincing that cardiologists have embraced them. At the same time, the enthusiasm of the people working in the theoretical field has frequently led them away from the ultimate goal of clinical applicability of their results. To keep these two worlds together, Macfarlane and Veitch Lawrie [Macfarlane and Veitch Lawrie, 1989] ensured that a comprehensive overview of clinically relevant data, knowledge and criteria became available. This work should be consulted whenever some new diagnostic criterion is about to be proposed, thus reducing the danger of reinventing the wheel.

6. Lower Level Contributions from the Low Countries: van Dam

Descending from the level of body surface potentials, bypassing the level of the potentials on the heart surface, we reach the level of the electric activity within the myocardium. At this level the macroscopic manifestation of cardiac electric activity has been studied by means of intramural needles carrying 10 to 20 small electrodes. These intramural electrodes were applied by Durrer and his group in Amsterdam, which led to the well-known publication on the depolarization sequence of the ventricles [Durrer et al, 1970]. One of the chief "harpooners" inserting the multi-electrode needles was van Dam. As a clinician and an electrophysiologist, he was always interested in the application of basic science to the development of new diagnostic criteria. Much of his earlier work relates to refractoriness and T-wave morphology. In 1974 he performed the experiments in the dog ventricle that led to the estimate of 40 mV characterizing the double layer strength at the depolarizing wave front inside the ventricles of the dog [van Oosterom and van Dam, 1976].

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