

## PREFACE

After a number of years at Baylor College of Medicine, in Houston, Texas, under the mentorship of Drs. Hebbel E. Hoff and Leslie A. Geddes, my family and I returned to our native country, Argentina, in 1972, about one year after the return of Dr. René G. Favalaro, who also had been in the USA for considerable time, at the Cleveland Clinic, Ohio, where he developed the coronary by-pass surgery. Hebbel and Les deeply influenced my academic life and introduced me to cardiac fibrillation–defibrillation. Vivid in my memory still are the many experiments carried out over the years . . . and I brought the subject over to Tucumán, well kept in my portfolio of plans and dreams. Those were not easy years in Argentina, plagued with upheaval, social unrest, and increasing violence. The country was taken over by a cruel military dictatorship, which fortunately ended in 1983, when democracy came back after the disastrous and insane Malvinas’ Islands War of 1982. How many sad, dramatic stories we could tell!

In 1981, while struggling to hold and put things together in a rather indifferent and even hostile environment, I was lucky enough to meet René in Buenos Aires through a common old friend, Dr. Ricardo H. Pichel, now President of the Favalaro University. That was the beginning of scientific collaboration between his group and ours, both in their early stages yet, that lasted for several productive years working on the intra-ventricular pressure–volume loop concept, as a tool to better grasp cardiac performance. His ideas and ideals as well as mine, so many times discussed in private informal chats, either over the phone or facing a cup of tea, matched perfectly, we were meant for each other. He had a clear understanding of what academic life, scientific research, technical development, bioengineering, medical practice and human sympathy and empathy are about. His influence was also profound, and I will never stop mourning his undeserved abrupt departure (Pichel and Valentinuzzi, 2001).

Mainly based on a first period of research and development at the Laboratory of Bioengineering of the *Universidad Nacional de Tucumán*, roughly between 1974 and 1984, always signed by shortage of funds, meager overall support and recognition, a small book was published in Spanish

in 1986, I dare say in spite of the streams against. A small group of young and enthusiastic collaborators plus a few dedicated believers, all hard workers, were no doubt an essential driving force. René, kindly, wrote a nice presenting prologue reminiscing some of his own experiences (Valentinuzzi *et al.*, 1986). That book (Geddes, 1987), well received by the medical and bioengineering audiences at that time (its publisher, -INTERMEDICA-, kindly authorized the reproduction of several of its figures) was the seed, indeed, of the present new one, now fully updated and revamped, for many advances and changes took place in the elapsed 25 years or more. Our laboratory added also some results because we continued to be active in the area for a few more years after the book was out in the market.

Hence, the product is here and a brief overall introductory description appears convenient so that the potential reader/user has a picture of what the book is about. Let us start with its sources, which are recognized as four,

- Personal experience in the subject as active researcher for many years;
- The regular literature published in main stream journals and books;
- The World Wide Web (often downloading pieces clearly indicating their origin); and
- Personal contacts with a few authors.

All these are carefully referenced as the text develops. Such bibliography is not exhaustive because this book, I emphasize, does not intend to be a review. Moreover, by now after more than 100 years of laboratory and clinical research and technological development of so many people in so many places, the amount of material found in the specialized literature is so huge that I think it defies the would-be intention of any serious author who might dare into such project. As a consequence, we apologize for those and to those whose contributions are not discussed, quoted, or referred to herein, either by sheer ignorance or for not having considered them as necessary.

INTERNET has played a fundamental role in the process of globalization and its impact on scientific literature is impressive and in growing process, even though sometimes not always is fully reliable. Through it, several databases are available, too, some with open access abstracts or full texts or with some restrictions (PubMed, MEDLINE, SCOPE). WIKIPEDIA is another nice and easy source, widely accessed by students, which quickly orients the searcher where to proceed (but do not take as granted everything it says). Papers and books nowadays

make use of specific websites as references and this book is no exception to that tendency. Recall that a great amount of information is freely and generously offered, as the true scientific spirit is (contrasting with the patent spirit, which tends to hide in the expectation of future potential profits). These words intend to neutralize possible and probable criticisms when readers discover that this or that paragraph is similar to one found in INTERNET... well, yes, it is true, and no shame about it, no plagiarism at all, full credit is given and full recognition is made to the many often unknown authors. To them all, and deeply, thanks a lot! And if something or someone was unwillingly or inadvertently skipped, please, let me know, and accept my sincere apologies. However, even though gratuity of such publicly available information is granted, in all cases the Website address is given and many times the scientific and technical papers' references too, where full details are to be found. Where copyright was needed and required, proper permission was requested to either the authors or the editors or publishers.

Given the characteristics of the subject at large, almost all chapters show a certain degree of repetition, sometimes in more detail or in other places rather superficially, and such repetition is good and acceptable from a didactic point of view. It is, for example, unavoidable to refer to time as one of the fibrillation variables and to come back to it when dealing with cardiopulmonary resuscitation, or to speak of the impedance seen by the defibrillating paddles and to return to it when defining the load presented to the machine or when insisting on the different components of that load. Besides, the book is *interdisciplinary*, *multidisciplinary*, and *transdisciplinary*, as any bioengineering product should be, and recognizing the relatively minor etymological and linguistic differences in the meanings of these words; the suffixes *inter-*, *multi-* and *trans-*, respectively, indicate crossing from one discipline into other, participation of more than one discipline, and the latter a form of knowledge integration.

Historically, the advances in fibrillation–defibrillation knowledge may be divided into three intermixed aspects:

1. Recognition of fibrillation as a unique life threatening cardiac arrhythmia;
2. Discovery of the electric discharge in its double role of culprit and savior; and
3. Technological and steadily improved contributions, from very crude and rudimentary equipment, to the automatic external pieces, to the recent

very small and “clever” implanted combined models of defibrillator–pacemakers. The word “clever” above is shyly and respectfully employed after reading a little and difficult book by a group of highly recognized neuroscientists and philosophers (Bennet *et al.*, 2007), for its many implications could greatly complicate the scenery. Thus, since no other better word seems available, “clever” is simply used as technological qualification.

The last two broad types, external and internal defibrillators, will continue to be produced, used, and improved for they have very specific applications: the former are intended for the open-chest surgery room and the domestic or industrial or public cardiac emergency, while the latter is specific to the ambulatory risk cardiac patient.

Injuries due to defibrillating shocks will be only marginally mentioned, for two reasons: First, the subject has been discussed at large by several authors (Tacker and Geddes, 1980; Valentinuzzi *et al.*, 1986; Wilson *et al.*, 1989), and second, advances in electrodes, leads and technology, especially with the implanted type, have considerably reduced the applied energy levels, so that now the problem has relatively taken a backward step. Nonetheless, post-defibrillation cardiac damage continues to be a risk, even at the low intensities so far achieved. Selection of waveforms may help but there is not yet a definite fully preventive prescription.

The book is composed of an INTRODUCTION and eight CHAPTERS. The INTRODUCTION sets up the subject, especially within the overall context of the Framingham Study. The first CHAPTER deals with fibrillation, including its definition, mechanisms, causes, types, clinical significance, variables, and thresholds. Chapter 2 takes care of defibrillation, as an intervention. Definition and early developments, chemical and electrical defibrillation, variables, thresholds, and the concept of dose are introduced, proceeding thereafter with cardiopulmonary resuscitation (CPR) and cardioversion or atrial defibrillation. Finally, ablation is also touched.

Defibrillators are the well-controlled generators to deliver the reversing discharge; they are described in Chap. 3, which is divided into five sections: types of defibrillators, external defibrillators, internal defibrillators, implantable defibrillators and, finally, the defibrillator’s cousins, the pacemakers. However, do not expect to find the latest model in it. This book is NOT a prescription; besides, technologies constantly evolve.

Chapter 4 deals with the touchy detection of fibrillation. It is coauthored with a young and able researcher, specialist in cardiac signal processing, Dr. Eric Laciari, currently a Professor and Investigator at the Engineering School of the *Universidad Nacional de San Juan*, Argentina. The criteria for detection, parameter evaluation, and several algorithms are presented, closing with the possible defibrillation pain that may occur when the shock is applied too soon.

Interfaces are often, if not always, a bottleneck, so that ELECTRODES and PASTES constitute the subject matter of Chap. 5, where the electrode-tissue impedance is considered along with the type of electrodes and the electrolytic material needed to reduce electric current hindrance during transchest shocks, for the direct procedure, being intrinsically wet, does not require any.

A Clinical Engineering concern regarding medical equipment lies on how efficacious and safe the procedure is, and no wonder, since the subject is strongly linked to legal liabilities. Hence, Chap. 6 defines and discusses safety levels (patient, operator, and equipment), the concept of isolation, electromagnetic interference, and possible incompatibility with other devices. Standards are briefly touched ending with any possible pain (here we find a repetition, as mentioned before). A former student of mine, Juan M. Olivera, EE, MSc, currently Assistant Professor at the Department of Bioengineering of the *Universidad Nacional de Tucumán*, lent me a kind hand, especially in those aspects dealing with standards.

Not every reader will be attracted to or interested in or even may not be prepared for Chap. 7 because it handles theoretical models. Such reader can skip the chapter without losing touch with the overall subject. It is coauthored with Drs. Diego Gonzalez and Simone Giannerini, longstanding investigators at the University of Bologna, in Italy.

The final Chap. 8 attempts to lump everything in few essential concepts trying also to show new avenues for research, development, and possible applications. A definite and not yet resolved area is a good theoretical background which might lead to better predictions. So far, the area is rather empirical.

Interspersed in the text, subjects are also seen from their historical side for often, beyond mere curiosity, such view helps understanding and setting them up. Moreover, each chapter is preceded by an abstract and finished with conclusions and a set of simple review questions.

This book is addressed to undergraduate and graduate biomedical engineering students, physicians going into cardiology, clinical engineers

and clinical engineering technicians, nurses, paramedics, and emergency medical personnel. Those who are interested only in the practical aspects, may skip Chaps. 4 (detection) and 7 (theoretical models), which are more demanding in terms of previous knowledge. Full requirements call for algebra, differential and integral calculus, basic circuit theory, cardiovascular physiology, electrophysiology, and elementary physics, but with the exception of the two mentioned chapters, any nurse or physician or technician or undergraduate student of any level can delve into the rest without problem. The book stands on the well-known philosophy of Education Based on Problems (or EBP), that is, take fibrillation as a medical daily problem and search for that knowledge, technique or principle, no matter where it comes from, that solves it, either partially or fully, and most of the time the advance is in small partial steps. In simple words, you must be an active reader and, if possible, an actor!

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