Enhanced External Counterpulsation

Waveform Interpretation and Clinical Application

A PRIMER AND CASE-BASED TROUBLESHOOTING GUIDE

Dr. S. Ramasamy

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International Cardiology
EECP/ECP Society

Heal Your Heart®
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Dedication

The book is possible due to the inspiration from my mentor and teacher, Late Dr. John CK Hui, and Dr. Joseph J. Tartaglia. Without support from my father, mother, wife, and friends, it will not be possible to bring this work to thousands of EECP centers operational worldwide.

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FOREWORD

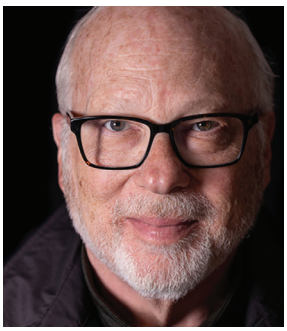
"Facts do not cease to exist because they are ignored."
– Aldous Huxley, Complete Essays 2, 1926-29

There are some truths that remain with you, reverberate within you and become foundational within you over a career, even a lifetime. For me, that has been my experience with the novel therapy known as External Enhanced Counterpulsation (EECP). As a young fellow, EECP's introduction into the United States was as refreshing as it was academically stimulating. And now, decades later, I continue to watch it deliver on its promises of a highly effective therapy for multiple disease states that is cost-efficient, safe and, unfortunately, often under-utilized. The reasons for the latter are simply our desire for "newness" within healthcare delivery systems despite the massive literature supporting EECP is powerful and grows daily. The good news, however, is the rekindling of interest in EECP by thoughtful clinicians and systems of cardiovascular care that recognize the value of EECP in large populations loaded down with an epidemic of cardiovascular disease.

The question then is, why this book now? The answers are multiple, but in brief, while EECP therapy is safe, cost-effective, and easy to deliver, it still requires a strong knowledge base to provide consistent outcomes to patients. In short, like everything else in life, there is a need to learn the "tricks of the trade". And hence, the purpose of this book is to fill the gaps in learning so as to provide excellent EECP treatment and outcomes. One may pick up this book as an EECP novice and quickly gain an understanding and knowledge base that will allow them to perform EECP effectively and hence become part of the solution to our epidemic of cardiovascular disease.

And a word about the author, Dr. S. Ramasamy. He is pre-eminent in his leadership in the understanding and expansion of EECP therapy worldwide. Perhaps no one more than him could have envisioned the need for this book and provided the information with such clarity.

So, I am so pleased that my personal reverberation of faith in EECP continues, that it exists in Dr. S. Ramasamy, and that it is now in this book to be shared with you.



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I first met a young Dr. Ramasamy (I call him Ram for short) when a nurse I used to know as Das asked me if his friend from Chennai could intern with me and observe my cardiology practice. It was sometime after 1997, and I was a solo practitioner in White Plains, New York, but I had privileges in two community hospitals and two major medical centers of New York Medical College and Weill Cornell Medical College, so I had an ample range of teaching experiences to offer Ram. The first day I met him, he was eager to get experience and try to apply for residency in the USA. He had some post-graduate anesthesia residency training, but my impression of him was that he still was looking for something else to grab his attention. He wanted something more interesting and he wanted to be part of something bigger. For Ram, medicine was more than a mere job; it was a calling, and I had introduced him to the amazing world of the rapidly advancing field of cardiovascular medicine.

Therefore, it was with his optimism and enthusiasm that he became particularly interested in a new treatment I had started in New York United Hospital, which was a Cornell affiliate at the time. The treatment was brand new, and it was a paradigm shift in our approach to coronary artery disease because it was believed to increase collateral circulation in the heart without the use of angioplasty or heart surgery. The treatment was called Enhanced External Counterpulsation, or EECP. It was the concept of Dr. Clifford Birtwell at Harvard. Although the original machines used hydraulics to generate pressure, it quickly changed to air pressure and was being reintroduced to the United States from China.

The procedure was non-invasive, relatively low risk, and as it turned out, effectively relieved heart angina pain. Most cardiologists had forgotten that it had been used in the 1980s but had fallen by the wayside when bypass surgery became popular. However, it was resurrected in China by a graduate student of Dr. Clifford Birtwell, Dr. Zheng, in China, where it was improved upon and flourished. Then, John Hui, a colleague of Stony Brook Medical Center, had reintroduced it to America. In China, it had become quite a popular treatment, being used for all types of vascular disorders in thousands of clinics. EECP was an effective treatment, but its mechanism of action was poorly understood. It was thought to increase collateral circulation, but that was just a theory at the time. There were some scientists who said it was merely an elaborate exercise machine. Up until that time, the world of cardiology was focused on improving the techniques of coronary angioplasty. It was a struggle to get physicians to accept and utilize the non-invasive alternative treatment for angina.

Needless to say, Ram was quite enthusiastic and undeterred by the skepticism about the treatment. He studied all he could about it. He immediately grasped the importance of it and formulated a plan in his head to bring the treatment back to India. Together, Ram and I did some research with it as the first commercially available site for EECP in the U.S., and we published some studies on its effectiveness in patients with chronic stable angina.

Dr. Ramasamy, to his credit, became a major advocate of EECP and managed to overcome all the hurdles and barriers to start selling it in India. This was no small task for a young recent medical school graduate. He was persistent and had good management skills as well as scientific acumen. He became a representative of Vasomedical, Inc. and eventually left his research with me in the United States to return to India to distribute the machines and to help establish it there. Under his direction, many hospitals adopted Enhanced External Counterpulsation, and he was instrumental in treating a multitude of patients in India and helping them recover from disabling refractory angina pectoris.

His first two machines were taken from United Hospital when our hospital bought new machines. I provided them to Dr. Ram to enable him to get started in India. From there, the process took off, and now Ram has numerous treatment sites in India. Ram continues to develop EECP, creating a database for research and publishing many articles regarding the treatment. He has been amazing in his enthusiasm and efforts to expand EECP.

To this day, my friend has accomplished a fantastic amount of work in both promoting as well as researching the procedure and elucidating its effectiveness. There is still much to do, and we have just begun to understand how important the microcirculation is in restoring a healthy heart. Ram has established the treatment in India and is widely known as one of the leading experts in EECP in India, as well as in the United States.

The book Ram has written is an important primer for those who wish to learn how to apply the treatment to patients. His writing is clear, methodical, and concise. It's a must-read for all technical personnel who wish to provide EECP. Dr. Ramasamy has many years of experience in teaching and developing EECP treatment centers. His experience and breadth of knowledge are assets for the reader of this primer on EECP.

Dr. Joseph Tartaglia MD FACC,
Assistant Clinical Professor of Medicine,
Weill Cornell Medical College,
New York.

CHAPTER 01

PREFACE & INTRODUCTION

PREFACE

The management of coronary artery disease non-invasively by counterpulsation is fast emerging as another acceptable treatment option. However, there is no clear, internationally accepted training program that can teach health care professionals to understand the pressure waveform and its clinical applications. Many of the manufacturers' printed and widely circulated training guides only cover the patient preparations, chest leads application, cuff wrapping techniques, pressure delivery, and basics of finger waveforms. They all conveniently ignore the change in cardiovascular physiology and its impact on the pressure waveforms during counterpulsation. When I speak to the manufacturers, surprisingly, many of them have no clinical application specialist who can teach waveform interpretation to their system operators. Some manufacturers who have clinical application specialists still couldn't explain the complete waveform interpretation due to its complexity and stipulated short 3-5 day clinical training program, which they usually conduct.

We strongly believe this results in ineffective waveform interpretation and cuff timings and can affect the patient's clinical response to the treatment. The inability to understand waveform may be one of the most significant drawbacks of the clinical application of non-invasive counterpulsation worldwide. The reported wide variation of the clinical response is partially due to a different type of counterpulsation being utilized, along with a lack of proper training guide.

This gap in understanding has motivated me to write this clinical training program book, which extensively covers waveform interpretation and clinical application. This book will urge the health care professionals to associate the change in waveform with physiological changes that occur in the cardiovascular system due to cuff inflation and deflations. The book covers various clinical modules with illustrations for easy understanding of the key concepts. The modules contain clinical materials that can help the treatment providers to understand the finger plethysmography waveform better and gain advanced clinical knowledge in relevance to the application of the counterpulsation treatment timing. We have made considerable effort to provide actual waveform recorded during patients' treatment for the readers to understand the different types of waveform patterns easily. It should be known to physicians now that even though the non-invasive Enhanced External Counterpulsation (EECP) principle is similar to that of the intra-aortic balloon pump, the additional increase in venous return and cardiac output makes the waveform interpretation and timing optimization complex. The complete reliance on IABP waveform timing and its application in non-invasive external counterpulsation are best avoided.

The objective of the manual is to provide the healthcare professionals confidence in adjusting the inflation and deflation timing accurately while treating eligible cardiac patients with counterpulsation. This book can serve as a reference guide and a close companion for the physicians who run refractory angina or a heart failure clinic where counterpulsation treatment is included in their clinical practice as another treatment option. We sincerely thank our biomedical department staff, clinical nurses, and doctors who have worked to give suggestions and provide illustrations for the book. We welcome any feedback and recommendations from the readers to enhance the book and to be incorporated in a future revision of the book when it becomes available.

INTRODUCTION

Enhanced External Counterpulsation (EECP) is a non-invasive, pneumatic assisted, angiogenesis promoting, mechanical treatment, which has shown promising results in patients with symptomatic stable coronary artery disease. The treatment is currently in the guideline of the American College of Cardiology Foundation for patients with stable ischemic heart disease with Level of Evidence B and class of recommendation IIb. In the European Society of Cardiology for the management of stable coronary artery disease, EECP achieved Level of Evidence B and class of recommendation IIb. This inclusion in the guidelines shows greater faith in EECP as another evidence-based strategy in managing patients with coronary artery disease.

Currently, many publications, review articles, and cardiology textbook chapters have been done to support a practice guideline for patient selection for EECP treatment. The treatment is currently practiced as a daycare procedure in many countries across the world. The patients who are advised for EECP treatment initially are refractory angina patients with preserved left ventricular function, and later, due to its safety in patients with heart failure, refractory angina patients with severely compromised left ventricular function also became eligible treatment candidates. These cohorts of patients pose a significant challenge to interventional cardiologists, cardiothoracic surgeons, general physicians, insurance companies, and hospitals, as they utilize more resources but fail to achieve complete control of symptoms or repeated hospitalization. The demography of these patients is usually a combination of the following factors: complex multi-vessel disease, diffuse lesions with poor target vessels, microvascular angina, partial revascularization, post interventional recurrent symptoms with demonstrable residual ischemia, graft occlusion, stent restenosis, advanced age, chronic renal failure, severe left ventricular dysfunction, other comorbid conditions, and patients waiting for a heart transplant. Further, many of these patients, due to high risk, are not willing for PTCA or CABG based revascularization.

In these groups of patients when they undergo EECP treatment, despite their high-risk condition, the procedural cardiac events reported are less, but the effectiveness of improving clinical symptoms vary from center to center. These variations in the patients' clinical responses are attributed to a different type of counterpulsation system utilized and also due to the lack of a proper clinical training guide and patient selection. Since most of the patients who are advised for EECP have advanced and aggressively progressing coronary artery disease, the physician caring for these patients and the therapist who applies the treatment pressure and adjusts the waveforms should be well trained.

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Enhanced External Counterpulsation Waveform Interpretation and Clinical Application

Dr. S. Ramasamy has 20 years of experience in the field of non-invasive cardiology as a researcher, academic speaker, clinical trainer, and treatment provider—this has a tremendous impact on the uniqueness of this book. The book seamlessly provides golden rules for EECP waveform adjustments. Internationally, one of the significant issues in EECP treatment implementation is a definitive lacuna in training cardiologists, general physicians, clinical experts, and nurse practitioners in the clinical application of EECP. This book addresses these issues by being a great training companion and serves as a teaching tool for beginners as well as those who want to advance their knowledge in EECP treatment. It contains beautiful color illustrations and flowcharts to make complex principles easy to understand.

The author has given more attention by placing actual waveforms obtained during treatment to reinforce the practical problems encountered during EECP and how to correct it. The case-based approach followed in the book will help the readers to understand as well as learn quickly and effortlessly. Overall, it is a book every practicing physician and EECP provider should have with them as a one-point reference guide.

Dr. S. Ramasamy is one of the international experts in EECP therapy and a reputed non-invasive cardiologist, now pursuing a Ph.D. in heart failure. He is the founder and chairman of the International Cardiology EECP/ECP Society (ICES). Currently, he works as a director of Heal Your Heart EECP Center. He also serves as an EECP heart failure consultant in Frontier Lifeline Hospital and a research fellow in Chettinad Hospital and Research Institute. His achievement in treating heart failure patients was recognized, and he received the "Best Achiever Award" in July 2019 from Lions Clubs International.

He runs the world's largest EECP centers with one of the states of the Indian Government, as a project director. His chain of EECP centers' information can be found at the website www.healurheart.com. He has contributed EECP chapters for cardiology textbooks and has more than 40 original research publications in peer-reviewed journals. He is an international speaker in many cardiology forums. He also has conducted many EECP workshops and has trained hundreds of doctors in the EECP clinical application. He, his wife, Dr. Priya Devi, and their only daughter, Deepti, live in Chennai in India.

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