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Electromagnetic field therapy in cardiovascular diseases: A review of patents, clinically effective devices, and mechanism of therapeutic effects

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Abstract

In recent years, electromagnetic field (EMF) therapy has gathered much attention for its protective effects on cardiovascular functions. From reviewing the literature, it is evident that exposure to specific EMF spectrums, such as static- and extremely low frequency (ELF)- EMFs, by EMF-generating devices can be considered as a safe method for therapeutic means in various cardiovascular diseases, including heart failure, cardiac arrhythmias, and hypertension. This review article will describe registered patents and non-invasive clinically effective devices that generate EMF to target various cardiovascular diseases based on their mechanism of therapeutic effects.

Introduction

The electromagnetic field (EMF) is a wireless physical phenomenon created by movable electric charges produced by natural sources, such as the earth's atmosphere or certain man-made appliances such as magnetic resonance imaging (MRI). The literature on the health effects of non-ionizing EMF shows various protective and pathologic effects, depending on multiple spectrums and characteristics of these fields [1]. Non-ionizing EMF spectrum is defined according to different ranges of frequencies, including static magnetic field (SMF) at a frequency of 0 Hz, extremely low frequency (ELF) field at ranges of 0–300 Hz,

intermediate frequency (IF) field at ranges of 300 Hz–100 kHz and radiofrequency (RF) field at ranges of 100 kHz–300 GHz [2]. The therapeutic efficacy of EMFs depends on their technical parameters, including, but not limited to, frequency, intensity and method of application, and also the biological targets.

In recent years, much attention has been paid to ELF-EMF use to the extent that several experimental studies have found their safety and protective effects on cardiovascular functions [3,4]. These types of EMF can provide a non-invasive method to affect multiple cardiovascular therapeutic targets directly and seem to be potentially used as an alternative or adjunctive therapy in different cardiovascular diseases such as heart failure, hypertension, and rhythm disturbances. Although the exact mechanism of these protective effects has not yet been entirely determined, modulating autonomic nervous system (ANS), angiogenesis, and nitric oxide (NO) synthesis, and also anti-oxidant and anti-inflammatory properties are thought to be the primary mechanism of actions. Such studies have provided the basis for several inventions in this field. In this review article, we searched the patent databases of USPTO, Google Patent, and Espacenet to find the filed patents relevant to EMF-generating devices having beneficial effects on cardiovascular functions and described their technical parameters and mechanisms of therapeutic effects. We also found non-invasive EMF-generating devices used in cardiovascular clinical studies and reviewed their characteristics and therapeutic effects.

Section snippets

Patents and non-invasive devices: description and mechanism of therapeutic effects

Here we describe the clinical application of filed patents and non-invasive clinically effective devices by which EMF is generated, based on their mechanism of cardioprotective effects. We also illustrate their general appearance and specific characteristics to gain a better understanding of how they work....

Expert opinion on present achievements and future perspective

There has been considerable interest in developing non-invasive therapies to manage cardiovascular diseases [4,40]. EMF-based interventions have attracted much attention among researchers due to their potential therapeutic advantages in some medical conditions. The same is true for cardiovascular diseases, where EMF therapy can provide new insights and strategies for prevention and treatment. Over the past decades, some inventions have been patented in this field of research, only a few of...

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