



A New Theory for Acupuncture: Promoting Robust Regulation

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Abstract

Robustness, an ability of biological networks to uphold their functionalities in the face of perturbations, is a key characteristic of all living systems. Acupuncture is a procedure in which fine needles are inserted into an individual at discrete points and then manipulated, with the intent of preventing and curing diseases. Acupuncture does not directly eliminate pathogenic factors or pathological tissue; rather, acupuncture enhances the ability of the human body to self-medicate itself by activating complex regulatory systems and by maintaining physiological homeostasis to prevent or treat diseases. From this point of view, the effect of acupuncture on the human body is more likely a kind of regulation to promote robustness. That is to say, acupuncture has the ability to promote robustness. In this article, we review the properties and functions of acupuncture in preventing and treating diseases and in maintaining health by enhancing robustness.

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1. Introduction

Robustness, an ability of biological networks to maintain their functions in the face of perturbations, is a key characteristic of all living systems [1]. It is one of the fundamental and ubiquitously observed systems-level phenomena that cannot be understood by simply looking at the individual components [2]. The human body is an open, complex, and gigantic machine that has the following characteristics: (1) It includes many systems, such as the nervous system, endocrine system, and immune system. (2) It can exchange materials, energy, and information with the surrounding environment. (3) Its systems are not independent; rather, they interact and exchange information [3]. The communication between these systems is believed to be essential for maintaining physiological homeostasis and good health [4]. When the external environment changes, or in pathological cases, some of the systems in human body function in such a way as to counter those changes; in this way, the body is protected and is effectively able to remain in a state of good health. This regulation can be regarded as the embodiment of the human body's robustness.

Acupuncture is a procedure in which fine needles are inserted into an individual at discrete points and then manipulated, with the intention of preventing and curing diseases [5]. Although acupuncture does not directly eliminate pathogenic factors or pathological tissue, it does enhance the ability of the human body to self-medicate by activating the complex regulatory systems and by maintaining physiological homeostasis to prevent diseases or to treat patients with diseases [6]. This is its role as a regulator of robustness.

Over the 2500-year development of acupuncture, a wealth of experience has been accumulated from the practice of acupuncture and that experience attests to the wide range of diseases and conditions that can be effectively treated with this approach. In recognition of the increasing worldwide interest in acupuncture, the World Health Organization conducted a symposium on acupuncture in June 1979 in Beijing, China. Physicians practicing acupuncture in different countries were invited to identify the conditions that might benefit from this therapy. The participants drew up a list of 43 suitable diseases. The World Health Organization published "Acupuncture: Review and Analysis of Reports on Controlled Clinical Trials" in 2002; that report focused on data collected from controlled clinical trials. The participants then expanded the list to 107 suitable diseases [7].

In this article, we review the properties of acupuncture and explain how acupuncture can be used to prevent diseases or to treat patients with diseases; moreover, on a theoretical level, it can be used to enhance robustness, thereby helping an individual to remain healthy.

2. Acupuncture has the ability to regulate robustness

The regulatory features of robustness and of acupuncture have many similarities. (1) Robustness enables the system to maintain its functionalities against external and

internal perturbations [8,9]. When the human body is in homeostasis (a stable state), its ability to fight against diseases is much stronger than it is when the body is in an unstable state. Acupuncture regulates the numerous factors that cause internal environments to continuously change. Thus, the ability of acupuncture to regulate robustness indicates that it can be used to promote the human body's self-regulation so that it can maintain homeostasis. (2) System control is a prominent implementation mechanism of robustness. System control consists of negative and positive feedback to attain a robust dynamic response as observed in a wide range of regulatory networks, including the cell cycle, the circadian clock, and chemotaxis [2]. Acupuncture has a similar bidirectional feedback regulation to maintain homeostasis. Positive feedback contributes to robustness by amplifying the stimulus. However, negative feedback contributes to a reduction in the activity of an overactive system. (3) Redundancy generally refers to a situation in which several identical or similar components/modules can replace one another when one of the components fails [2]. It plays an important role in reducing the influence of internal and external disturbances on the whole system. Acupuncture has the characteristic of regulating multiple pathways. When a pathway is impaired, acupuncture can promote other pathways so that the body's functions are maintained.

3. Acupuncture regulates robustness under pathological conditions

3.1. Preventing diseases

Acupuncture has been used throughout the world. The application of acupuncture is not limited to the treatment of diseases; it also plays a role in the prevention of disease. A recent randomized, controlled trial confirmed the effectiveness of acupuncture in preventing or reducing the risk of certain conditions or diseases, such as uncomplicated recurrent lower urinary tract infections in adult women [10], postoperative nausea and vomiting after gynecological [11] or breast surgery [12], atrial fibrillation (AF) recurrence after electrical cardioversion [13], stroke in patients with traumatic brain injury [14], and emergence agitation in children [15]. As to disease prevention, acupuncture regulates robustness mainly by improving stability in the body. For instance, studies on AF have shown that an autonomic nervous system is present in the heart and always maintains a dynamic balance. An imbalance in the autonomic control mechanisms due to either an increase in vagal or sympathetic neural activity will lead to abnormal cardiac electrophysiology, favoring the initiation and maintenance of AF episodes [16–18].

In Chinese medicine, an obvious correlation exists between the nerve segments of the human meridians and the visceral organs to which they correspond [7]. Thus, acupuncture at PC-6 (Neiguan), HT-7 (Shenmen), and BL-15 (Xinshu) has been shown to have an antiarrhythmic effect through its effect on the autonomic nervous system (Table 1, Fig. 1). Compared with the side-effects of drugs, those of acupuncture are very few, so acupuncture can be regarded

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