Biofield Science and Healing: An Emerging Frontier in Medicine

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BIOFIELD SPECIAL ISSUE NOVEMBER 2015

Biofield Science and Healing: Toward a Transdisciplinary Approach

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EDITORIAL

Exploring the Biofield

Mary Jo Kreitzer, PhD, RN, FAAN; Rob Saper, MD, MPH

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Those of us who have been in the field of integrative health and medicine for a decade or two vividly recall the era when there was great enthusiasm and hope for therapeutic approaches that fell into the realm of complementary and alternative medicine. Healthcare clinicians and scientists worried about unsubstantiated claims and so-called therapeutic approaches—historically popular among consumers but largely untested by scientists—that might not be helpful and may even be harmful. Much has changed over the decades. The field was more controversial than it is today due to growing public and private funded research showing both what has promise and what does not. Thirty years ago, there was little to no research on acupuncture and mind-body approaches. If it had been proposed that meditation could impact neurological and immune function and literally change the structure and function of the brain, the idea would have been considered ill informed and even outlandish. Science has caught up in this case, and breakthroughs in neuroscience have well documented the impact of meditation on the brain.

The field of integrative health and medicine is still relatively new, and the evidence base, while growing, is not mature. Though there is strong evidence for some therapeutic approaches including acupuncture and mind-body therapies, there is very modest evidence in other areas such as the biofield. *Global Advances in Health and Medicine* is very committed to inquiry, discovery, and open discourse. While this special issue will be heralded by many as capturing breakthrough thinking and ideas, we acknowledge that others may find the evidence base weak or even implausible. This strikes us as not unlike the reaction to acupuncture and mind-body approaches in the 1980s and early 1990s.

This special issue of *Global Advances in Health and Medicine* brings together many of the experts in the nascent area of biofield theory. Articles cover a range of topics including foundational concepts from physiology and physics, preclinical and clinical research, diagnostic and therapeutic devices, and opportunities and barriers to mainstream integration. For example, Rubik and colleagues provide an overview of the history of biofield theory and the evolving terminology used to describe it. The term originated out of a group convened by the National Institutes of Health (NIH) Office of Alternative Medicine in the early 1990s in an attempt to provide an organizing schema for a wide range of healing practices, often referred to as energy medicine or bioenergetic therapies. Reiki, therapeutic touch, and *qigong* are several examples. Originally defined as a "massless field, not necessarily electromagnetic, that surrounds and permeates living bodies and affects the body," the biofield has evolved to a "multi-scale concept that offers a broader context for understanding biological regulation and information flow." Gronowicz et al summarize preclinical studies attempting to measure the impact of healing intentions from experienced biofield practitioners. Suggestions on how future research can address methodological challenges, such as designing the best in vitro and in vivo models, standardizing interventions, and improving reproducibility, are addressed. Jain and colleagues summarize research studies on the clinical effects of biofield therapies, defined as "noninvasive, practitioner-assisted therapies that explicitly work with the biofield of both the practitioner and client to stimulate a healing response in the client." Pain and cancer are the conditions most studied, with a few studies in the areas of arthritis, dementia, and heart disease. The authors call for larger, more rigorous interdisciplinary trials to allow better understanding of clinical impact, cost-effectiveness, and mechanism.

Complex interactions involving transfer of energy abound in daily life, medical care, and health. Many of these can be explained by well-established concepts in biochemistry and physics. For example, photosynthesis uses light to help convert carbon dioxide and water into carbohydrate and oxygen. Animals require food to manufacture energy in the form of adenosine triphosphate to carry out vital functions involving motility and brain activity. Well-established diagnostic techniques in medicine measure the electrical activity of the heart and brain. Advanced imaging technology takes advantage of differential effects of magnetic fields on water and tissue. Radiation is used to effectively treat cancer. Transcranial magnetic stimulation is now being found to be effective for a wide range of neurological and psychiatric conditions. Deep brain electrical stimulation has had remarkable effects on movement disorders.

Other interactions are more challenging to explain. We all have had the experience of having our wellbeing impacted by the actions of others. The impact can be negative, such as when a patient encounters a healthcare provider who is stressed, distracted, or unnecessarily pessimistic. Conversely, we experience an improvement in our wellbeing when we are in the presence of a compassionate, caring person who holds our needs as most important. Some less common phenomena are even more difficult to explain scientifically: someone not well known "reads our mind"; love that grows between two people; feeling "connected" to complete

strangers following a group meditation; and spiritual experiences when one feels communion with a divine force or being. Though our understanding of how these interactions occur is increasing through diverse disciplines such as social psychology, neuroscience, and psychoneuroimmunology, much more remains to be explained.

Can all of these complex interactions—especially those involving energy healing modalities—be explained by current well-established mechanisms? The biofield theory suggests provocatively that these phenomena may be mediated, at least in part, by forces and processes yet to be discovered and well-characterized. In this way, biofield theory may become like many examples in the history of science and medicine where theories once considered implausible become accepted through research and practice. Proponents of hand washing to prevent maternal sepsis, the role of bacteria in the pathogenesis of peptic ulcer disease, and utility of beta blockers in congestive heart failure were all looked upon incredulously. As several of the contributors to this issue point out, perhaps rather than identifying a new heretofore undiscovered subtle field of energy that can be manipulated for healing, we can look upon the biofield theory as a unifying concept to encompass the wide variety of physical, emotional, social, and spiritual forces and factors that contribute to health and wellbeing.

We hope this collection of papers will stimulate discourse and research that over time will ultimately lead to a better understanding of how to promote health and wellbeing.

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INTRODUCTION

Biofield Science and Healing: An Emerging Frontier in Medicine

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We live in an age of unparalleled technological and scientific progress, juxtaposed with a cascading series of poor social, health, and environmental choices that could bring our species to the brink of catastrophe. Within the past 100 years alone, we have created significant advances in technologies to better control disease outbreaks, extend our lifespan, enhance global communication, increase our work productivity, and improve our overall quality of life. At the same time, we are facing major healthcare crises including diabetes, cardiovascular disease, cancer, and mental illness. Despite our best efforts and technological advances, we have not yet conquered these and other life- and health-interfering disorders. In addition, health disparities are increasing and the 100 year rise in life expectancy is flattening.[1] This continuance of human suffering, in the face of all our advancements, is leading to substantial and exponentially growing costs to individuals and to society.

A key ingredient in the recipe for advancing the evolution of human health is self-empowerment, which can only emerge with a clear recognition of one's own capacity for healing. Examples from clinical and research areas such as mind-body medicine, placebo, psychoneuroimmunology, and neuroscience, remind us that our capacity to activate our own internal healing response is within our human capabilities. Just a few decades ago, the theory that the nervous system was directly connected to the immune system was highly controversial; today, it is mainstream science—with recent scientific studies uncovering deeper discoveries of vagal-immune and vagal-microbiome communications,[2,3] and a most recent scientific report suggesting functional lymphatic vessels may reside within the brain.[4] The idea that our mental and emotional states impact our immune and cardiovascular systems in a manner that could influence disease progression as well as health, has moved from fringe to fact,[5,6] thanks to decades of careful, interdisciplinary research by scientists who continued to test their initially unpopular hypotheses. These scientists' empirical advances founded and advanced the now well-established field of psychoneuroimmunology (PNI).

Despite these groundbreaking scientific discoveries, translation of these data into interventions for patients to facilitate their own health and healing remain limited. To empower healthcare providers, their patients, and the general public to facilitate their own healing requires an advancement in knowledge and practice that can only occur through the multidisciplinary integration of perspectives on mechanisms of healing and health maintenance. Such an integration is rather daunting to embark upon, given the current culture of academic and clinical specialization, as we are taught to specialize early in our careers as academics and clinicians, and rarely have the opportunity for cross-disciplinary dialogue.

While specialization is intended to lead to discoveries through complete focus and immersion in a single area, the emergence of significant breakthroughs in science and medicine has often occurred as a result of interdisciplinary communication and collaboration. Indeed, Dr Robert Ader, cofounder of PNI, understood that the advances in his field would begin with interdisciplinary inquiry and later lead to a dissolution of arbitrary borders between disciplines, leading to a more global, networked understanding of health:

> *Disciplinary boundaries and the bureaucracies they spawned are biological fictions that can restrict imagination and the transfer and application of technologies. They lend credence to Werner Heisenberg's assertion that "What we observe is not nature itself, but nature exposed to our method of questioning." Our own language, too, must change. The signal molecules of*

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the nervous and immune systems are expressed and perceived by both systems. Therefore, it may no longer be appropriate to speak of "neurotransmitters" and "immunotransmitters." Also, to speak of links or channels of communication between the nervous and immune systems perpetuates the myth that these are discrete systems (or disciplines). On the contrary, the evidence indicates that relationships between so-called "systems" are as important and, perhaps, more important than relationships within "systems"; that so-called "systems" are critical components of a single, integrated network of homeostatic mechanisms."[7]

In the latter part of this quote, Ader suggests that what we have viewed as discrete systems are in fact parts of a larger, holistic network that guides an organism's homeostasis. We propose that such a network may be found in what is currently being termed the *biofield*, a field of energy and information that reflects and guides the homeodynamic regulation of a living system, and as such influences and is influenced by consciousness.

While the term *biofield* itself is fairly new (coined in 1992 at a National Institutes of Health meeting; see Rubik et al, this issue), discussion on the importance and role of consciousness, energy, and information to create and guide emotional, mental, and physical functioning has been described by numerous diverse cultures and used in medical systems for thousands of years (Jain et al, this issue). Despite the careful definition and description of biofield-related concepts in these cultures, our modern descriptions and understandings of such concepts and how they may relate to healing processes are still in their nascent stages. As is evident in this Special Issue, even among biofield science researchers, there is disagreement about whether vitalistic concepts such as *chi* and *prana* are essential for describing the biofield, whether the biofield can be reduced to bioelectromagnetic emanations on different levels of scale, or whether the understanding of the biofield at its core demands a new understanding of physics and biology that incorporate models of consciousness (eg, see papers by Jain et al, Rubik et al, Kafatos et al in this issue). Further, it is not well understood whether mechanisms underlying results from proximally practiced biofield therapies in pre-clinical and clinical studies (see Gronowicz, Bengston, and Yount and Jain et al, in this issue) are at all related to laboratory studies examining the effects of distant healing intention (see Radin, Schlitz, and Baur, this issue). A thorough understanding of how biofield therapies might "get under the skin" and affect physiological processes is still needed (see Hammerschlag et al, this issue). Significant issues remain in understanding whether practitioners' concepts of the biofield are aligned with researchers', as well as with each others' (see Warber et al, this issue). The questions of how to best integrate biofield practitioners into healthcare systems are crucial to address (see Guarneri and King, this issue). In addition, the increasing use of devices that are used to influence aspects of the biofield to enhance a healing response (see Muehsam et al, this issue), represents yet another frontier with respect to research and clinical application.

Biofield science, then, currently finds itself in a highly controversial, not-yet-well-understood, and sometimes academically contentious environment. Regardless of the evidence, this area is viewed by many scientists as too "fringe" to merit serious consideration (see Hufford et al, this issue for discussion of paradigm shifts). Current funding for the field of biofield science is more strongly directed toward industry applications and less toward basic science and clinical application.

Given the current controversies, challenges to conceptualization and measurement, and general lack of funding, why should we consider advancing the field of biofield science? First, the roots of biofield concepts and practice have persisted for thousands of years and remain the basis for many medical interventions and self-healing practices across the globe. Biofield concepts are rooted in indigenous schools of medicine, as evidenced by "whole medical systems" practices such as Chinese, Tibetan, Native American, African, and Ayurvedic medicine. The ongoing use of biofield-based healing practices, in terms of both self-practice and practitioner-assisted modalities, has continued to flourish over time, with increasing evidence to support their use in certain difficult-to-treat clinical populations, with no known adverse effects (see Jain et al, this issue).

Arguably, the use of biofield systems and therapies over millennia, while provocative, may not in and of itself warrant scientific investigation. However, in addition to this preponderance and longevity in clinical application based on concepts akin to biofield, recent empirical advances in bioelectromagnetics suggest that perturbation of electromagnetic aspects of the biofield (involving very weak physical energies) can substantially impact health processes (see Muehsam et al, this issue). These findings are driving industry innovation. The application of bioelectromagnetics in psychiatric and neurodegenerative disorders is growing rapidly. The global industry of neuromodulation (the use of externally applied electromagnetic signals for treatment of central nervous system-related disorders) is predicted to move from 2015 estimates of $3.65 billion to $6.20 billion by 2020.[8] Some scientists have heralded "electroceuticals" as the next wave of "big pharma," with the National Institutes of Health as well as several large pharmaceutical industries investing significant resources in mapping the body's bioelectromagnetic fields for development of further devices for medical application.[9,10] Finally, some of these approaches are becoming more readily available to consumers directly: over-the-counter neuromodulation products are now being marketed heavily by certain groups, with some questioning the ethics and

safety of such use.[11] To this end, it is essential that both the gross and subtle aspects of the biofield be mapped as clearly as possible by varied approaches.

In the spirit of fostering collaborative inquiry and accelerating strong empirical research in the area of biofield science, several organizations came together to sponsor an interdisciplinary scholarly meeting, termed "Biofield Science and Healing." The meeting, sponsored by the Miraglo Foundation, the Institute of Noetic Sciences, the Chopra Foundation, and the Samueli Institute, was held at the Pacific Pearl Center in La Jolla, California, in September 2014. As respected leaders who have been forwarding the science and practice of biofield-related areas for decades, each of these organizations saw the value in a collaborative acceleration of biofield science and practice.

Invited researchers and scholars represented a wide range of scientific disciplines, including biophysics, physics, biology, clinical psychology, psychoneuroimmunology, psychoneuroendocrinology, neurosciences, engineering, and medicine. They were joined by leading biofield practitioners who were specifically selected for having been involved in scientific studies of biofield therapies.

This special issue on Biofield Science and Healing reflects the rich, ongoing exchanges within this interdisciplinary group. It is hoped that this issue will catalyze discussion and advance multidisciplinary inquiry into biofield science. This multidisciplinary effort will be supported through the emergent collaborative backbone organization,[12] the Consciousness and Healing Initiative (CHI), which fosters interdisciplinary science and provides scientifically-based educational resources in consciousness and healing across institutions and disciplines.

Biofield research is certainly a "work in progress" and is not without its share of scientific complexities. However, its potential payoff in terms of service to society could be transformative. This special issue on Biofield Science and Healing is the reflection of a growing interdisciplinary, collaborative effort to advance this rapidly evolving science and discipline. We look forward to collectively supporting these efforts and facilitating the individual and societal health empowerment that may emerge with a clearer understanding of the biofield.

REFERENCES

1. National Center for Biotechnology Information. US health in international perspective: shorter lives, poorer health. http://www.ncbi.nlm.nih.gov/pubmed/?term=Shorter+Lives%2C+Poorer+Health+from+2013+by+Steven+Wolff. Accessed September 25, 2015.
2. Sundman E, Olofsson PS. Neural control of the immune system. Adv Physiol Educ. 2014;38(2):135-9. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4056170&tool=pmcentrez&rendertype=abstract. Accessed September 25, 2015.
3. Dunn AJ. Nervous and immune system interactions. In: eLS. Chichester, England: John Wiley & Sons Ltd; 2005.
4. Louveau A, Smirnov I, Keyes TJ, et al. Structural and functional features of central nervous system lymphatic vessels. Nature. 2015;523(7560):337-41. doi:10.1038/nature14432.
5. Slavich GM, Cole SW. The emerging field of human social genomics. Clin Psychol Sci. 2013 Jul;1(3):331-48. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3707393&tool=pmcentrez&rendertype=abstract. Accessed October 6, 2015.
6. Taylor AG, Goehler LE, Galper DI, Innes KE, Bourguignon C. Top-down and bottom-up mechanisms in mind-body medicine: development of an integrative framework for psychophysiological research. Explore (NY). 2010;6(1):29-41. doi:10.1016/j.explore.2009.10.004.
7. Ader R. Historical perspectives on psychoneuroimmunology. In: Friedman H, Klein TW, Friedman AL, eds. Psychoneuroimmunology, Stress, and Infection. Boca Raton: CRC Press; 1996:1-24.
8. Neuromodulation market by technology (deep brain stimulation, spinal cord stimulation, transcranial magnetic stimulation) & by application (depression, Parkinson's, tinnitus, alzheimer's, epilepsy, ischemia, obesity) Trends & Global Forecast to 2020. 2015. http://www.researchandmarkets.com/research/7txm6d/neuromodulation.
9. GSK. Bioelectronics. http://us.gsk.com/en-us/media/press-kits/bioelectronics/. Accessed October 6, 2015.
10. Reardon S. Electroceuticals spark interest. Nature. 2014;511(7507):18.
11. Cabrera LY, Evans EL, Hamilton RH. Ethics of the electrified mind: defining issues and perspectives on the principled use of brain stimulation in medical research and clinical care. Brain Topogr. 2014;27(1):33-45.
12. Turner S, Merchant K, Kania J, Martin E. Understanding the value of backbone organizations in collective impact: part 2. Stanford Soc Innov Rev. 2012. http://ssir.org/articles/entry/understanding_the_value_of_backbone_organizations_in_collective_impact_2. Accessed October 6, 2015.

ORIGINAL ARTICLE

Biofield Science and Healing: History, Terminology, and Concepts

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ABSTRACT

Biofield science is an emerging field of study that aims to provide a scientific foundation for understanding the complex homeodynamic regulation of living systems. By furthering our scientific knowledge of the biofield, we arrive at a better understanding of the foundations of biology as well as the phenomena that have been described as "energy medicine." Energy medicine, the application of extremely low-level signals to the body, including energy healer interventions and bioelectromagnetic device-based therapies, is incomprehensible from the dominant biomedical paradigm of "life as chemistry." The biofield or biological field, a complex organizing energy field engaged in the generation, maintenance, and regulation of biological homeodynamics, is a useful concept that provides the rudiments of a scientific foundation for energy medicine and thereby advances the research and practice of it. An overview on the biofield is presented in this paper, with a focus on the history of the concept, related terminology, key scientific concepts, and the value of the biofield perspective for informing future research.

INTRODUCTION

Medicine is in transition. Conventional biomedicine is giving way to an expanded, integrative medical model that emphasizes healthcare as well as illness care, treats people not just diseases, and incorporates multiple therapeutic approaches, old and new, to offer patients greater choice.[1] This emerging model questions the dominant biomedical paradigm of molecular reductionism that focuses on genes, proteins encoded by genes, and molecules synthesized by proteins and that is based on an inherent belief that complex systems can be understood by identifying their components. By contrast, an integrative model of health and medicine appreciates the complexity of our biology, which can give rise to emergent phenomena that are not, in general, predictive from isolated parts. Such a model also views healthcare from several perspectives beyond the molecular approach, including what has been called energy medicine.[2] Advances in biophysics, biology, psychology, and the developing fields of mind-body research such as psychoneuroimmunology and psychosocial genomics have helped substantially to form a foundation for this expanded integrative medical model.

In addition to biochemical signals, the idea that living systems generate and respond to energy fields as integral aspects of physiological regulation reflects a convergence of several disparate paths. Numerous spiritual traditions describe modes and pathways of energy within and surrounding the physical body (Jain et al, 2015, this issue). Many complementary and alternative medicine (CAM) therapies utilize variants of "laying-on-of-hands" and other minimally invasive procedures to improve endogenous energy flows. Moreover, Western biomedicine routinely examines electrical fields from the heart (via electrocardiogram [ECG]) and brain (via electroencephalogram [EEG]) as indices of clinical pathology. Furthermore, contemporary cell biology and biophysics provide evidence that endogenous electromagnetic and other types of fields play active roles in development, tissue repair, and an array of homeodynamic processes.[3-5]

The term *biofield* fills the need for a unifying concept to bridge traditional and contemporary explanatory models of energy medicine and provides a common language for aspects of both clinical practice and scientific research that focus on energy fields of the body. This paper summarizes the recent origins of the biofield concept and describes the levels of scale for which the term has been applied, from biophotons and cell membranes to whole organisms to Gaia and the *Tao*. Working definitions of *biofield* and related terms are offered with the proviso that such descriptions are and should be based in the cultural and scientific vantage points of the observers and may not always be completely comparable. In this light, in their descriptions of "the biofield," a Tibetan Buddhist, a neurologist, a Reiki practitioner, a cell biologist, and a physicist (classical or quantum) enrich us all and bring us closer to a complete understanding of this emerging concept.

A BRIEF HISTORY OF THE TERM *BIOFIELD*

The term *biofield* was proposed in 1992 by an ad hoc committee of CAM practitioners and researchers convened by the newly established Office of Alternative Medicine (OAM) at the US National Institutes of Health (NIH). The committee was one of several meeting as part of an NIH/OAM-hosted conference in Chantilly, Virginia, to inform the OAM as it established its program priorities and initiatives. The committee had a dual focus on "manual medicine"—consisting of structural and manipulative approaches such as chiropractic, classical osteopathy, and massage—and "energetic therapies" such as Reiki, Therapeutic Touch, and external *qigong*. Most of the latter group of healing modalities were founded on a concept of a vital force, although each has its own explanatory model and terminology that reflect a particular cultural context. The committee sought to bring unity to the diversity of energetic practices by creating a term that would be amenable to the scientific and broader healthcare communities. Such a term was also needed to describe a central organizing biological field that healers were detecting and interacting with in their practice. The term *biofield* was coined for these purposes with the hope that it would be generic and malleable enough to fit differing explanatory models of therapy.

The committee defined biofield as "a massless field, not necessarily electromagnetic, that surrounds and permeates living bodies and affects the body."[6] Subsequently, one committee member succeeded in getting the term *biofield* accepted as a Medical Subject Heading (MeSH term) at the National Library of Medicine so that it became an official search term for scholars to locate peer-reviewed literature. Further, the committee sought to consolidate the diverse modes of energetic healing under the single term *biofield therapies*, which was also accepted by the NIH. An additional realization was that both diagnostics and therapeutics may be involved in these biofield modalities. Subsequently, a round of frontier medicine research grants in biofield science was funded by the National Center for Complementary and Alternative Medicine, the successor to the OAM.

Simultaneously, another of the 1992 ad hoc committees advising the OAM categorized "distant healing" or "distant healing intention"—remote healing over a distance performed through intention and/or intercessory prayer—as a mind-body modality. Thus, energy healing that was performed locally by healers directly on patients, which had been termed biofield therapy, was separated from distant healing due to this initial categorization. A rationale for this separation between local and distant healing was that they may operate by different modes of action. Whereas local or proximal energy healing might involve electromagnetic fields (EMFs) that diminish over distance by an inverse square law, the same fields are unlikely to be involved in healing across large distances. However, local and distant healing are commonly performed by the same practitioner, such as in Reiki, which poses a conundrum.

HISTORY OF EARLY BIOLOGICAL FIELD CONCEPTS

Since antiquity, there have been 2 opposing views on the nature of life. Democritus, who coined the word *atom*, maintained that everything, including organisms, is reducible to its constituents, while Aristotle held that life processes are autonomous and organisms are integral wholes. These 2 viewpoints remain today, with the biochemical view of life represented by molecular reductionism and a holistic view that embraces a field concept of life.

In science, the notion of a vital force or *élan vital* dates back to the 1600s. In vitalism, living matter was believed to involve a life force: a metaphysical entity intrinsic to life that renders it alive. This force was initially considered immeasurable and outside the scope of science. Yet discoveries of bioelectricity challenged the notion that this force was immeasurable. By 1850, experimental electrophysiology had replaced the notion of vital force with electricity, effectively banishing vitalism from biological science.[7]

Nevertheless, many contemporary CAM practitioners continue to use terms from non-Western explanatory models and medical systems to evoke a vital force or vital energy. For example, there is *qi* (chi) in Chinese medicine, *ki* in Japanese medicine, *prana* in Ayurveda, and similar terms in other traditions of indigenous medicine. These descriptions of life energy originated from metaphysical considerations of the nature of consciousness and its interaction with mental, emotional, and physical systems (Jain et al, 2015, this issue) and were based on first-person observations by adept spiritual practitioners. In the modern age, the notion of a universal life energy is nearly ubiquitously employed by energy healing practitioners, who often describe energy coming from their hands and other parts of the body. These same practitioners report utilizing energy awareness not only to sense imbalances in patients' energy fields but to regulate energy flow and release energy blockages perceived to be impeding the healing process. Most traditional healing practices maintain that disease starts with an energetic imbalance such as a blockage or other irregularity in the energy flow through the body. Modern CAM systems such as chiropractic,[8] homeopathy,[9] and classical osteopathy[10] are also founded on principles of a vital force. Therapeutics in these practices involves restoring or rebalancing the vital force to promote healing.

The scientific concept of force, however, is very much in the physical realm, whereas the vital force at the basis of many CAM therapies is considered by mainstream science to be a metaphysical concept. Force, as well as field and energy, are fundamentals of physical theory. Force refers to any interaction that tends to change the motion of an object. The concept of a field from physics refers to a spatially distributed nonmaterial element that is able to impart a force upon

an object within it. Therefore, a field cannot be detected directly but only through its action upon a suitable probe—for example, a charge in an electric field. Contemporary physics holds that there are only 4 types of force operating throughout nature: gravity, electromagnetism, and the strong and weak nuclear forces, the latter 2 having a range limited to the atomic nucleus. A particular form of energy (defined in physics as the ability to do work: ie, to move a particle through a distance) is associated with each force: for example, electric, magnetic, and electromagnetic energies are associated with the electromagnetic force, which is most important in living systems. The concept of the biofield as proposed herein is firmly grounded in science, although other putative fields, as yet unknown to science, may also be involved.

The concept of a biological field first arose in embryology as an underlying informational template to explain the developmental process. The Ukranian histologist Alexander Gurwitsch, PhD, coined the term *morphogenetic field* to describe the highly coherent and dynamic process that appeared to be guiding development of the unfolding embryo as well as biological regeneration. Gurwitsch also discovered mitogenetic radiation, ultraviolet light emission during cell division in onion roots.[11] From 1900 to 1950, other prominent developmental biologists including Hans Driesch, Paul Weiss, and others worked from this same perspective.[12] Weiss, who discovered that the morphogenetic field was unchanged if he removed portions of embryonic tissue, proposed that the biological field was a holistic property of the entire organism.[12] These early embryologists formed the concept of a morphogenetic field guiding development but did not determine its physical basis.

SCALABILITY OF THE BIOFIELD CONCEPT

The biofield concept soon gained traction and was extended from an entity "that surrounds and permeates living bodies" to include a more extensive variety of endogenous phenomena generated by living bodies. It has also been "scaled-up" to test its fit to macrolevel concepts including Gaia, a model of our planet as a complex, self-regulatory system. Thus, at this point in time, the concept of "biofield" may be better considered in its plural form of "biofields." From this perspective, the term may continue to be usefully applied across a broad range of disciplines, in manners both evidence-based and speculative, including biophysics, cell biology, therapeutics, and ecology.

One line of research on endogenous biofields followed from the early discovery by Gurwitsch, as mentioned above, of ultraviolet light emission during cell division. Recent studies have reported evidence for a variety of biophoton-mediated regulatory processes, including cell-cell communication, cell-cell orientation sensing, secretion of regulatory neurotransmitters, modulation of respiratory activity in white blood cells, and accelerated seed germination.[13] These findings, as well as results of research correlating biophoton emission with human physiology, suggest the existence of coherent biophoton fields that play fundamental roles in intercellular signaling[13,14] and human health.[15]

More generally, a wide variety of bioelectromagnetic activities has been identified, often associated with interaction energies substantially below that of thermal noise, which produce clinically significant effects, including enhancement of growth, wound repair, regeneration, and the reduction of pain and inflammation.[3,16-18] In addition, field-like phenomena appear to contribute to the underlying principles of biological organization, including embryonic development and the coordinated maintenance of biological structure and function. For example, regenerative healing of whole limbs in animals such as salamanders has been shown to involve EMFs,[19] and limb regeneration in higher animals has also been stimulated by means of externally applied EMFs.[20] More recently, the patterning of arrays of cell membrane resting potentials has been shown to play key roles in directing stem cell behavior during embryogenesis and in complex organ regeneration.[21,22]

The biofield, or information associated with it stemming from multicellular electrical activity, is also the basis of a decades-old clinical tool most commonly in the form of the ECG (the detector of electrical wave forms generated by synchronous activity of heart muscle cells) and EEG (the detector of wave forms reflecting summative spontaneous or evoked electrical activity of neuronal arrays). While the ECG and EEG are readily detected from the body surface, the heart's magnetic field, generated by moving electric charges associated with electrical activity, can be recorded up to several feet from the body surface via a magnetocardiogram.[23] Magnetic fields produced by the heart appear to carry information that may be detectable by other persons or animals.[24] An example of the informational potential (bioeffectiveness) of these heart fields is cardiac-induced entrainment (or frequency locking) detected when the R-waves of one subject's ECG become precisely synchronized with the onset of EEG alpha waves of another subject at a distance up to 5 feet.[25]

At the interpersonal level, the biofield concept encompasses a large body of research on the effects of biofield therapies, as practiced both locally with the practitioner in the same room as the patient (Jain et al, 2015, this issue), animals, or cell cultures (Gronowicz et al, 2015, this issue), and nonlocally, which includes distant mental interaction with living systems, as well as intercessory prayer and distant healing (Radin et al, 2015, this issue). Studies with biofield therapies in clinical settings reflect the propensity of certain practitioners and schools of healing to perform therapy with hands on and/or hands off the body,[26] therapeutic touch, and healing touch which raise questions about the physical effects of touch itself on biofield interactions and outcomes. However, recent reviews examin-

ing nontouch biofield therapies also report significant changes in outcome measures, suggesting that effects of biofield therapies on outcomes may not be ascribed only to effects of physical touch,[27,28] and an explanation in terms of quantum entanglement or other nonlocal causes may be needed.[29]

Biofield interactions also extend from molecular to planetary levels. At the molecular level, the term biofield may even be invoked to explain fundamental properties of individual molecules by considering them as "ordered electromagnetic structures."[5] The argument can be made that molecular interactions, such as between hormone and receptor, are those usually described at close range—eg, ionic, hydrophobic, and aromatic pi-electron interactions. Such properties, however, do not explain how molecular partners attain proximity to each other; the necessary preludes to docking are unlikely to occur via simple diffusion and Brownian motion.[30] Rather, one proposal is a "resonant recognition model" in which molecules are attracted to their targets by a form of electromagnetic resonance,[30] which clearly falls within the biofield rubric. At the planetary level, there is increasing evidence that the biofield concept can include effects of geocosmic fields on human health and behavior: for example, solar storms that significantly perturb the geomagnetic field correlate with increased rates and mortality from myocardial infarction.[31,32]

HISTORY OF BIOFIELD SCIENTIFIC STUDIES

Early biofield studies were motivated in part by the many CAM modalities that appear to involve energy and/or informational fields and are broadly known as "energy medicine." These include energy healing, homeopathy, acupuncture, magnet therapy, bioelectromagnetic therapies, electrodermal therapy, and applied kinesiology, among others. Some of these modalities involve novel ways of obtaining useful information from the body's energy field as well as applying energy fields therapeutically.

"Laying on of hands" is one of the oldest, most ubiquitous forms of healing known to humankind, apparently having emerged independently among ancient cultures worldwide. The father of modern Western medicine, Hippocrates, referred to it as "the force which flows from many people's hands."[33] There are a growing number of studies on this and other related biofield healing modalities (as indicated in other articles in this journal issue) demonstrating a spectrum of beneficial results from the psychological and behavioral levels down to clinically relevant biomarkers.[26,34-36] Another area is bioelectromagnetic medicine, where it has now been demonstrated that nonthermal EMFs, often with interaction energies substantially below that of thermal noise, produce a wide variety of clinically significant effects, including enhancement of growth, wound repair, regeneration, and the reduction of pain and inflammation.[3,16-18,37,38]

In addition, the underlying principles of biological organization, including embryonic development and the coordinated maintenance of biological structure and function, are beginning to be better understood, with evidence suggesting that field-like phenomena underlie many of these processes as described earlier.

Field effects have also been invoked as explanations of a large body of research on human intention effects and nonlocality.[39] Recent reports with relevance to CAM practices include effects on cultured cells,[40] seed germination,[41] and distant healing of surgical wounds.[42] Further, several studies have reported EEG correlations between isolated human subjects[43-47] with in vitro corroboration using neurons adhering to printed circuit boards.[48] Experiments performed with shielding suggest that some of these results are not mediated by EMFs,[43,48] perhaps suggesting a role for quantum entanglement or another nonlocal process.[29] Such phenomena, which clearly call for scientific explanations at levels of organization beyond the molecular realm, may be explained by a common model of biofield effects.

Concepts of sentience, mind, and consciousness have also evolved from the mechanistic approach of biochemical neuroscience to a field-oriented approach. The application of quantum theory to these concepts has led to several proposals of the body-mind as a macroscopic quantum system.[49-52] While the predictive power of these models is as yet unclear, there is increasing experimental evidence showing quantum signaling, communication, and conductivity in the cytoskeletal network of microtubules,[53,54] and the electric fields generated by synchronized oscillations of microtubules have been demonstrated to play key roles in the regulation of cell division and chromosome folding and transcription.[55,56] Similarly, it has been proposed that the acupuncture system and the patterning of cell resting potentials described above[19,21] act through the continuum of liquid crystalline collagen fibers that make up the bulk of the connective tissues.[57] In this model, supported by evidence from biochemistry, cell biology, biophysics, and neurophysiology, the collagen matrix provides pathways for rapid intercommunication throughout the body, enabling the organism's mind-body to function as a coherent whole.[57,58] Together, these results describe the mind-body as an interconnected system in which electromagnetic and quantum interactions act through field-coherent oscillatory activity to regulate biological processes and mediate interactions correlated with sentience and mental activity.[57,59,60]

BIOFIELD AS A CONVEYOR OF INFORMATION

As a regulator and mediator of biological interactions, the biofield appears intimately connected with information delivery within the organism. The biofield thus holds and conveys information that is vital for biocommunication and bioregulation. Here it must be said that the concept of information in biology is nothing new; it is already used successfully to explain

numerous molecular mechanisms in molecular biology, such as information encoded in DNA, hormone-receptor interactions, enzyme-substrate interactions, and many other forms of molecular recognition, as well as in ECG and EEG data. Further, many of these well-understood mechanisms may also be thought of as biofield interactions because information itself is often an emergent property of dynamical interactions that cannot be meaningfully understood from a reductionist viewpoint. At the cellular and subcellular levels, oscillatory behaviors emerge from negative feedback loops and coupled positive and negative feedback loops[61] and result from stochastic, nonlinear biological mechanisms interacting with the fluctuating environment.[62] For example, the emergence of phase-synchrony across large numbers of cells in circadian cooperative systems is the result of nonlinear coupling of oscillators across the cellular and multicellular levels.[63,64] Similarly, electrically phase-coupled systems in neuronal networks give rise to cooperative behaviors across large numbers of neurons.[65]

The concept of biofield regulation offers a shift from a mechanical, chemistry-based view of biology to an information-based view. Unlike machines, living organisms have an immense network of internal and external interconnections across which information flows to modulate life functions. The continuous exchange of information in living systems to maintain their integrity is astounding. Furthermore, new relationships along with new information exchanges emerge at higher levels of organization in life, forming new wholes. The biofield may be considered one such multilevel organizational concept in which information flows within and between the various levels of the organism. A wealth of information exchange, much like a "conversation" between the elements of these various levels of order—the "whispering" between cells and other units of life—is critical to sustaining life and promoting healing. The biofield may be considered to be the language of life.

Biofield information can manifest beyond mechanistic concepts; bioelectromagnetic medicine presents another example of the informational aspect of biofield interactions. The concept of "electromagnetic bioinformation" was advanced by Fritz-Albert Popp[49,66] to describe findings that biophotons and other extremely low-level energy transactions in bioelectromagnetics below the thermal noise limit could induce biological effects. In addition to the above-mentioned weak EMF effects, a large body of literature has demonstrated the existence of nonthermal EMF resonance interactions.[16,67-69] Bioeffects often occur only for particular frequencies, amplitudes, or waveforms, and the precise location of resonances is in general determined by the characteristics of the EMF/biological target system, which can vary with changes in state of health, disease, or injury.[70] Entrainment of physiological functions such as EEG and ECG with external fields[25] may be also seen as induced synchronization, which constitutes a flow of information from an external field to the body. Furthermore, other elements of the biofield may carry information important for medical diagnostics, beyond the EEG and ECG, that provide useful medical information and suggest new modes of treatment via informational medicine. Indeed, information offers a unifying concept in the *modus operandi* of CAM and integrative medical modalities.[71,72]

While information is exchanged across multiple levels of order in living systems, perhaps the most definitive information flow in humans is from the "top down," from intention to the material body, to affect health and promote healing with conscious intention, purpose, context, and meaning. Information may thus be seen to mediate or serve as a bridge between mind and body: for example, in mind-body modalities, intent to heal, etc.

Typically, information is thought to be carried by either energy or matter. However, Bell's Theorem (quantum nonlocality) supports observations of instantaneous interaction between entangled states.[73-75] The quantum potential function conveys active information everywhere,[76-78] as does the morphogenetic field,[79] with no diminution over distance. Information may thus be everywhere instantaneously, but it is active only where it is specifically directed—for example, by conscious intent—and may be considered intelligent information, producing a very specific response only where it is intended. Thus, information itself may be considered causal even though it does not always have a physical carrier.[80]

TOWARD AN EVOLVING DEFINITION OF BIOFIELD

As described above, the biofield has evolved into a multiscale concept that offers a broader context for understanding biological regulation and information flow than does the currently dominant molecular paradigm of biological systems. As such, a biofield, whether at the level of biophotons, patterns of cell membrane resting potentials, EEG of brain, ECG of heart, or the synchronous movements of birds in flight, can succinctly be described as an organizing influence distributed over space and time. While biofields have most often been described as electromagnetic in nature,[81,82] there have been several proposals of biofields involving quantum information flow.[5,29,83] In their organizing capacity, it seems more useful to speak of biofields in terms of their homeodynamic activities than as individual entities: ie, to describe what they do rather than what they are. As presented earlier, the concept of a field from physics refers to a nonmaterial element that interacts with an object and a field cannot be detected directly but only through its action upon a probe. Thus, biofield interactions can influence and be influenced by a variety of biological pathways including biochemical, cellular, and neurological processes as they modulate activity and information flow across multiple levels of living systems. At this stage, the biofield may be considered as a

"massless" or information-based organizing principle in accordance with the original definition proposed by the 1992 NIH advisory committee.[6]

Finally, it is of interest to reflect again on the relation of the biofield concept to *energy medicine*, a term especially in vogue in the latter part of the 20th century. While biofields play a substantive role in guiding health processes, here they are conceived as playing a broader regulatory and informational role in biology than solely as a form of medical intervention as implied by energy medicine. The term *biofield therapy*, which involves healer-based interactions with biofields both within and around living systems,[84,85] best captures this aspect of healing beyond limited implication of medicine as a treatment for illness.

CONCLUSIONS AND FUTURE PROSPECTS

The biofield concept, emerging initially from vitalist perspectives, offers an increasingly useful approach to explain a variety of physiological phenomena. Its applicability continues to evolve in terms of empirical inquiry. Endogenous biofield interactions with environmental, geocosmic, and other exogenous fields provide the rudiments of a scientific foundation for a holistic view of life and a *modus operandi* for numerous CAM modalities. The family of energy healing practices that have been widely practiced since antiquity, now called biofield therapies, may involve biocommunication and/or energy transfer through the biofield. While the biofield concept is a useful construct to guide new research on energy healing and other CAM modalities, it is also a requisite for a better understanding of contemporary developments in biophysics and biology. Moreover, information connected with the biofield may serve as a bridge between mind and body, which is fundamental to understanding mind-body interactions.

The biofield is also an important metaphor to guide further research. There are numerous examples from the history of science where metaphor and analogy have been key elements in the construction of successful theories. The use of metaphor in science is especially appropriate and critical for success in the exploratory phase of investigation when detailed descriptions and theories are unavailable. Metaphors provide foundational material for forming hypotheses, conducting studies, and eventually elucidating testable theories. Scientific metaphors can be key elements for posing truly novel questions, which upon experimental testing, advance our knowledge and understanding. The concept of the biofield, while still in its nascent stages, may well serve this purpose as biology moves from a local, chemistry-based model to an interconnected, information-based viewpoint. Further investigations in biofield science and healing, especially those involving multidisciplinary collaborations—including clinical and preclinical trials, physiology, biophysics, device technology, and theoretical and philosophical models—will guide the way to a new paradigm in biology and medicine.

REFERENCES

1. Maizes V, Rakel D, Niemiec C. Integrative medicine and patient-centered care. Explore (NY). 2009;5(5):277-89.
2. Cassidy CM. What does it mean to practice an energy medicine? J Altern Complement Med. 2004;10(1):79-81.
3. Funk RH, Monsees T, Ozkucur N. Electromagnetic effects—from cell biology to medicine. Prog Histochem Cytochem. 2009;43(4):177-264.
4. Movaffaghi Z, Farsi M. Biofield therapies: biophysical basis and biological regulations? Complement Ther Clin Pr. 2009;15(1):35-7.
5. Bischof M, Del Giudice E. Communication and the emergence of collective behavior in living organisms: a quantum approach. Mol Biol Int. 2013;2013:987549.
6. Rubik B, Pavek R, Greene E, Laurence D, Ward R, Al E. Manual healing methods. In: Rubik B, et al, eds. Alternative medicine: expanding medical horizons: a report to the National Institutes of Health on alternative medical systems and practices in the United States (NIH Publication). Washington, DC: US Government Printing Office; 1995:113-57.
7. Bischof M. Vitalistic and mechanistic concepts in the history of bioelectromagnetics. In: Beloussov L, Popp F, eds. Biophotonic: non-equilibrium and coherent systems in biophysics, biology, and biotechnology. Proceedings of International Alexander Gurwitch Conference, Sept 28-Oct 2, 1994. Moscow: Bioinform Services; 1995:3-14.
8. Senzon SA. Chiropractic and energy medicine: a shared history. J Chiropr Humanit. 2008:27-54.
9. Hahnemann S. Organon of medicine. 6th ed. Germany: WF Wakeman; 1833.
10. Northrup GW. Osteopathic medicine: an american reformation. Chicago: American Osteopathic Association; 1966.
11. Beloussov L V, Opitz JM, Gilbert SF. Life of Alexander G. Gurwitsch and his relevant contribution to the theory of morphogenetic fields. Int J Dev Biol. 1997;41(6):771-7; comment 778-9.
12. Jerman I, Krasovec R, Leskovar RT. Deep significance of the field concept in contemporary biomedical sciences. Electromagn Biol Med. 2009;28(1):61-70.
13. Van Wijk R. Bio-photons and bio-communication. J Sci Explor. 2001;15(2):183-97.
14. Popp FA, Chang JJ. The physical background and the informational character of biophoton emission. In: Chang JJ, Popp FA, eds. Biophotons. Dordrecht, The Netherlands: Kluwer; 1998:238-50.
15. Ives J, van Wijk E, Bat N, et al. Ultraweak photon emission as a non-invasive health assessment: a systematic review. PLoS One. 2014;9(2):e87401.
16. Brain interactions with weak electric and magnetic fields. Neurosci Res Prog Bull. 1977;15(1):1-129.
17. Shupak N. Therapeutic uses of pulsed magnetic-field exposure: A review. Radio Sci Bull. 2003 Dec;307:9-32.
18. Funk RH, Monsees TK. Effects of electromagnetic fields on cells: physiological and therapeutical approaches and molecular mechanisms of interaction. A review. Cells Tissues Organs. 2006;182(2):59-78.
19. Becker RO. The bioelectric factors in amphibian-limb regeneration. J Bone Joint Surg Am. 1961;43-A:643-56.
20. Becker RO. Stimulation of partial limb regeneration in rats. Nature. 1972 Jan 14;235(5333):109-11.
21. Levin M. Endogenous bioelectrical networks store non-genetic patterning information during development and regeneration. J Physiol. 2014;592(Pt 11):2295-305.
22. Adams DS, Tseng AS, Levin M. Light-activation of the Archaerhodopsin H(+)-pump reverses age-dependent loss of vertebrate regeneration: sparking system-level controls in vivo. Biol Open. 2013;2(3):306-13.
23. Steinhoff U, Schnabel A, Burghoff M, et al. Spatial distribution of cardiac magnetic vector fields acquired from 3120 SQUID positions. Neurol Clin Neurophysiol. 2004 Nov 30; 2004:59.
24. McCraty R, Atkinson M, Tomasino D, Bradley RT. The coherent heart, heart–brain interactions, psychophysiological coherence, and the emergence of system-wide order. Integr Rev. 2009;5(2):10-115.
25. McCraty R. The energetic heart: Bioelectromagnetic communication within and between people. In: Rosch PJ, Markov MS, eds. Bioelectromagnetic Medicine. New York: Marcel Dekker; 2005:511-30.
26. Jain S, Mills PJP. Biofield therapies: helpful or full of hype? A best evidence synthesis. Int J Behav Med. 2010;17(1):1-16.
27. Hammerschlag R, Marx BLB, Aickin M, Marx A. Nontouch biofield therapy: a systematic review of human randomized controlled trials reporting use of only nonphysical contact treatment. J Altern Complement Med. 2014;20(12):881-92.
28. Roe CA, Sonnex C, Roxburgh EC. Two meta-analyses of noncontact healing studies. Explore (NY). 2015;11(1):11-23.
29. Thaheld FH. An interdisciplinary approach to certain fundamental issues in the fields of physics and biology: towards a unified theory. Biosystems. 2005;80(1):41-56.
30. Cosic I, Pirogova E, Vojisavljevic V, Fang Q. Electro-magnetic properties of biomolecules. FME Transanct. 2006;34(2):71-80.
31. Halberg F, Cornélissen G, Otsuka K, et al; the International BIOCOS Study

Group. Cross-spectrally coherent ~10.5- and 21-year biological and physical cycles, magnetic storms and myocardial infarctions. Neuro Endocrinol Lett. 2000;21(3):233-58.

32. Stoupel E. The effect of geomagnetic activity on cardiovascular parameters. Biomed Pharmacother. 2002;56 Suppl 2:247s-56s.
33. Schiegl H. Healing magnetism. Freiburg, Germany: Herman Verlag KG; 1983.
34. Lutgendorf SK, Mullen-Houser E, Russell D, et al. Preservation of immune function in cervical cancer patients during chemoradiation using a novel integrative approach. Brain Behav Immun. 2010;24(8):1231-40.
35. Friedman RS, Burg MM, Miles P, Lee F, Lampert R. Effects of Reiki on autonomic activity early after acute coronary syndrome. J Am Coll Cardiol. 2010;56(12):995-6.
36. Jain S, Pavlik D, Distefan J, et al. Complementary medicine for fatigue and cortisol variability in breast cancer survivors. Cancer. 2012;118(3):777-87.
37. Rubik B, Walleczek J, Liboff A, Hazelwood C, Becker R. Bioelectromagnetics Applications in Medicine. In: Rubik B, Al. E (11-member editorial review board), eds. Alternative Medicine: Expanding Medical Horizons: A Report to the National Institutes of Health on Alternative Medical Systems and Practices in the United States. Washington, DC: US Government Printing Office; 1995:45-65.
38. Muehsam D, Ventura C. Life rhythm as a symphony of oscillatory patterns: electromagnetic energy and sound vibration modulates gene expression for biological signaling and healing. Glob Adv Heal Med. 2014;3(2):40-56.
39. Radin D, Nelson R. Meta-analysis of mind-matter interaction experiments: 1959-2000, I.a.E.M. In: Healing, ed. London: Harcourt Health Sciences; 2003:39-48.
40. Radin D, Yount G. Effects of healing intention on cultured cells and truly random events. J Altern Complement Med. 2004;10(1):103-12.
41. Creath K, Schwartz GE. Measuring effects of music, noise, and healing energy using a seed germination bioassay. J Altern Complement Med. 2004;10(1):113-22.
42. Schlitz M, Hopf HW, Eskenazi L, Vieten C, Radin D. Distant healing of surgical wounds: an exploratory study. Explore (NY). 2012;8(4):223-30.
43. Wackermann J, Seiter C, Keibel H, Walach H. Correlations between brain electrical activities of two spatially separated human subjects. Neurosci Lett. 2003;336(1):60-4.
44. Radin DI. Event-related electroencephalographic correlations between isolated human subjects. J Altern Complement Med. 2004;10(2):315-23.
45. Richards TL, Kozak L, Johnson LC, Standish LJ. Replicable functional magnetic resonance imaging evidence of correlated brain signals between physically and sensory isolated subjects. J Altern Complement Med. 2005;11(6):955-63.
46. Standish LJ, Johnson LC, Kozak L, Richards T. Evidence of correlated functional magnetic resonance imaging signals between distant human brains. Altern Ther Health Med. 2003;9(1):128, 122-5.
47. Standish LJ, Kozak L, Johnson LC, Richards T. Electroencephalographic evidence of correlated event-related signals between the brains of spatially and sensory isolated human subjects. J Altern Complement Med. 2004;10(2):307-14.
48. Pizzi R, Fantasia A, Gelain F, Rossetti D, Vescovi A. Non-local correlations between separated neuronal networks. Proc SPIE. 2004;5436:107-17.
49. Popp F. Electromagnetic Bio-Information. Baltimore, MD: Urban und Schwarzenberg; 1989.
50. Hameroff SR. Quantum coherence in microtubules: A neural basis for emergent consciousness? J Conscious Stud. 1994;1(1):91-118.
51. Ho MW, Popp FA, Warnke U, eds. Bioelectrodynamics and Biocommunication. London: World Scientific; 1994.
52. Stapp HP. Mind, Matter and Quantum Mechanics. Berlin, Heidelberg: Springer Verlag; 2009.
53. Hameroff S, Nip A, Porter M, Tuszynski J. Conduction pathways in microtubules, biological quantum computation, and consciousness. Biosystems. 2002;64(1-3):149-68.
54. Havelka D, Cifra M, Kučera O, Pokorný J, Vrba J. High-frequency electric field and radiation characteristics of cellular microtubule network. J Theor Biol. 2011;286(1):31-40.
55. Zhao Y, Zhan Q. Electric fields generated by synchronized oscillations of microtubules, centrosomes and chromosomes regulate the dynamics of mitosis and meiosis. Theor Biol Med Model. 2012 Jul 2;9:26.
56. Zhao Y, Zhan Q. Electric oscillation and coupling of chromatin regulate chromosome packaging and transcription in eukaryotic cells. Theor Biol Med Model. 2012 Jul 3;9:27.
57. Ho MW, Knight DP. The acupuncture system and the liquid crystalline collagen fibers of the connective tissues. Am J Chin Med. 1998;26(3-4):251-63.
58. Langevin HM. Connective tissue: a body-wide signaling network? Med Hypotheses. 2006;66(6):1074-77.
59. Plankar M, Brežan S, Jerman I. The principle of coherence in multi-level brain information processing. Prog Biophys Mol Biol. 2013;111(1):8-29.
60. Ho M-W. Illuminating water and life. Entropy. 2014;16(9):4874-91.
61. Ferrell JE, Tsai TY-C, Yang Q. Modeling the cell cycle: why do certain circuits oscillate? Cell. 2011;144(6):874-85.
62. Glass L. Synchronization and rhythmic processes in physiology. Nature. 2001;410(6825):277-84.
63. Bordyugov, G, Westermark P, Korenčič A, Bernard S, Herzel H. Mathematical modeling in chronobiology. Handb Exp Pharmacol. 2013;(217):335-57.
64. Lara-Aparicio M, Barriga-Montoya C, Padilla-Longoria P, Fuentes-Pardo B. Modeling some properties of circadian rhythms. Math Biosci Eng. 2014;11(2):317-30.
65. Dodla R, Wilson CJ. Interaction function of oscillating coupled neurons. Phys Rev E Stat Nonlin Soft Matter Phys. 2013;88(4):042704.
66. Popp FA, Becker G, Konig H, Peschka W, eds. Elektromagnetic Bioinformation. Munich: Urban und Schwarzenberg; 1979.
67. Zhadin MN. Review of Russian literature on biological action of DC and low-frequency AC magnetic fields. Bioelectromagnetics. 2001;22(1):27-45.
68. Binhi VN, Rubin AB. Magnetobiology: the kT paradox and possible solutions. Electromagn Biol Med. 2007;26(1):45-62.
69. Muehsam DJ, Pilla AA. A Lorentz model for weak magnetic field bioeffects: part II—secondary transduction mechanisms and measures of reactivity. Bioelectromagnetics. 2009;30(6):476-88.
70. Muehsam DJ, Pilla AA. The sensitivity of cells and tissues to exogenous fields: effects of target system initial state. Bioelectrochem Bioenerg. 1999;48(1):35-42.
71. Rubik B. Energy medicine and the unifying concept of information. Altern Ther Health Med. 1995;1(1):34-9.
72. Rubik B. Information, energy, and the unpredictable whole. Adv J Mind-Body Heal. 1997;13(2):67-70.
73. Einstein A, Podalsky B, Rosen N. Can quantum-mechanical description of physical reality be considered complete? Phys Rev. 1935 May 15;47:777-80.
74. Bell JS. On the Einstein Podolsky Rosen paradox. Physics (College Park Md). 1964;1(3):195-200.
75. Aspect A, Grangier P, Roger G. Experimental realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: A new violation of Bell's inequalities. Phys Rev Lett. 1982;49(2):91-4.
76. Aharonov Y, Bohm D. Significance of electromagnetic potentials in the quantum theory. Phys Rev. 1959;115(3):485-91.
77. Bohm D. Wholeness and the Implicate Order. London: Routledge and Kegan Paul; 1980.
78. Noguchi A, Shikano Y, Toyoda K, Urabe S. Aharonov-Bohm effect in the tunnelling of a quantum rotor in a linear Paul trap. Nat Commun. 2014;5:3868.
79. Sheldrake R. A New Science of life: the hypothesis of formative causation. London: Blond and Briggs; 1981.
80. Walker SI, Davies PC. The algorithmic origins of life. J R Soc Interface. 2012 Dec 12;10(79):20120869.
81. Rubik B. The biofield hypothesis: its biophysical basis and role in medicine. J Altern Complement Med. 2002;8(6):703-17.
82. Hintz KJ, Yount GL, Kadar I, Schwartz G, Hammerschlag R, Lin S. Bioenergy definitions and research guidelines. Altern Ther Heal Med. 2003;9(3 Suppl):A13-A30.
83. Rein G. Bioinformation within the biofield: beyond bioelectromagnetics. J Altern Complement Med. 2004;10(1):59-68.
84. Warber SL, Cornelio D, Straughn J, Kile G. Biofield energy healing from the inside. J Altern Complement Med. 2004;10(6):1107-13.
85. Levin M. The wisdom of the body: future techniques and approaches to morphogenetic fields in regenerative medicine, developmental biology and cancer. Regen Med. 2011;6(6):667-73.

ORIGINAL ARTICLE

Biofield Science: Current Physics Perspectives

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ABSTRACT

This article briefly reviews the biofield hypothesis and its scientific literature. Evidence for the existence of the biofield now exists, and current theoretical foundations are now being developed. A review of the biofield and related topics from the perspective of physical science is needed to identify a common body of knowledge and evaluate possible underlying principles of origin of the biofield. The properties of such a field could be based on electromagnetic fields, coherent states, biophotons, quantum and quantum-like processes, and ultimately the quantum vacuum. Given this evidence, we intend to inquire and discuss how the existence of the biofield challenges reductionist approaches and presents its own challenges regarding the origin and source of the biofield, the specific evidence for its existence, its relation to biology, and last but not least, how it may inform an integrated understanding of consciousness and the living universe.

INTRODUCTION

Conventional biology is based on molecular processes—ie, biochemical interactions that ultimately reduce to macromolecules such as DNA and RNA. Even organismal biology, which concerns itself with addressing organisms as wholes, still relies on the reductionist approach of understanding the whole by analyzing how the parts fit together. These approaches, although very successful in specific scientific and medical applications, fail to address phenomena that by their nature are holistic—ie, they may need to be explained from a whole organism context, crossing boundaries of scale, and thereby including quantum and conventional fields, mind, and relationship to environment. It seems that biology, despite the great successes it has achieved and the multitude of applications in theory as well as in practice, has still not undergone the types of revolutions that shook physics over the last 100 years.

Evidence for the existence of the biofield now exists, and current theoretical foundations are now being developed.[1,2] The term *biofield* describes "a field of energy and information, both putative and subtle, that regulates the homeodynamic function of living organisms and may play a substantial role in understanding and guiding health processes."[3] Another definition describes it as

> *an organizing principle for the dynamic information flow that regulates biological function and homeostasis. Biofield interactions can organize spatiotemporal biological processes across hierarchical levels: from the subatomic, atomic, molecular, cellular, organismic, to the interpersonal and cosmic levels. As such, biofield interactions can influence a variety of biological pathways, including biochemical, neurological and cellular processes related to electromagnetism, correlated quantum information flow, and perhaps other means for modulating activity and information flow across hierarchical levels of biology.*[4]

Unified and coherent characteristics of the biofield imply a strong and perhaps unique role for quantum models. A review from the viewpoint of physical science is needed in order to identify a common body of knowledge and evaluate possible underlying principles of origin of the biofield. To that end, the review presented here surveys current models including electromagnetic processes and quantum models. We go on to speculate on processes that are not currently well understood. Central to the possible role of quantum theory, for example, we discuss quantum biology and its manifestations in such processes such as photosynthesis, avian navigation, olfactory reception, regeneration, microtubule interactions, brain dynamics, and cognition.

It has been hypothesized that biology could ultimately be built from more fundamental underlying quantum physics. This assumption is implicit in many approaches to molecular biology, genetics, and various applications in medicine and health but is often more honored in the breach. If biology truly derives from physics, then biology should be an extension of quantum physics, the most accurate and fundamental physical theory at our disposal. While quantum biology is an emerging branch of science, most practicing biologists don't take it into account. Conventional biology and biophysics derive predominately from a biochemical and Newtonian physics standard, but biological effects

that cannot be understood without reference to quantum phenomena are accumulating, as in avian magnetoreception, olfaction, and plant photosynthesis.

However, very recent work[1] describes a theoretical foundation for biology, suggesting that biology can be put on an equal footing with physics and not simply reduced to biochemical processes. Living matter would then be seen as following basic principles and laws that are not reducible to conventional physics, though would be smoothly interwoven with quantum physical processes. In this view, we would assert that the generic science of biology is complementary to the generic science of physics (ie, the 2 are closely related but not identical). Possibly both are anchored to mutual processes through the underlying quantum vacuum.

In this regard, the evidence for the existence of the biofield holds the promise of significant growth in scientific understanding and for developing applications in medicine, health, and healing. This line of research and application of quantum physics perspective approaches living organisms through "an emergent and potentially all-encompassing biofield"[2] that entails the existence of long-range interactions, most likely of a coherent nature. Even as experimental evidence is accumulating for the existence of precisely such a long-range, coherent biofield, theoretical understanding is still lacking. Various hurdles exist: The concept of the biofield has many aspects, the concept often means different things to different workers, and a clear language for the description of biofield interactions hasn't been agreed upon. Further complicating the situation is that a host of relevant terms and concepts (eg, bioplasma, bioelectromagnetics, quantum vacuum) are being widely used in a variety of different contexts.

Does the theoretical understanding of biofield involve a few dominant theories? Do they depend on specific phenomena? Can such understanding be part of existing field theories (such as electromagnetism) or is new physics a necessary outcome of studies of the biofield? From the viewpoint of classical physics, another possibility that has been suggested is that the biofield consists of electromagnetic emanations from molecular transitions in living matter. This possibility is not viable due to associated short timescales. From this perspective, electromagnetic field (EMF) coherence might be an essential requirement for biofield interactions to organize biological processes.[5] Because quantum physics underlies all electromagnetic theories and thus biochemistry and neurobiology, quantum mechanical processes, the role of the vacuum, and interpretations concerning the role of the mind itself[6] are important aspects to consider. Also we shall discuss in greater detail below how other "quantum-like" properties of the biofield may play a key role in biofield interactions (by *quantum-like*, we intend macroscopic and biological correlates of quantum phenomena such as nonlocality, superposition, complementarity,[7,8] etc). If the workings of generalized, mesoscopic (molecules to mm in size) and macroscopic quantum-like processes that span both physics and biology can be demonstrated, then we will discuss in this article how the biofield itself may be an important—and perhaps to-date, crucial but ignored—missing link. In other words, if *quantum-like* is defined as the more general framework embracing biology and physics, then macroscopic quantum processes such as entanglement (where multiple objects exist in the same quantum state and so are linked together) and coherence (ordering of the phase angles between the components of a system in a quantum superposition) across a single organism and beyond would be crucial signposts marking what lies ahead, coherence as such being a bridge between micro- and macroscales.[9,10] The recent discovery of macroscopic entanglement in 2 diamond crystals could also be pointing to the likelihood that quantum-like phenomena may, in some cases, literally be propagation of quantum level phenomena into the macroscopic scale.[11] These recent issues will be briefly addressed in the current work.

Ultimately, for any quantum discussion, the problem of observation *à la* von Neumann arises.[6] The so-called "von Neumann cut," or the point of separation between the observer and the observed system, suggests an essential role for the observer with clear relevance to how biofield interactions may be connected to brain structure and processes. Where is the observer situated, in the brain? What is the role of mind and consciousness itself in biofield interactions? One can speculate on the many possibilities that exist with regard to the interaction of an observer with observed systems, where the cut may be (if anywhere) in biological systems, serving as a connection to the activity of the biofield. We must consider consciousness as an integral part of biofield theory and experimentation, as any discussion of quantum biology directly implicates the question of the observer and the observer requires consciousness.

The review presented here is meant as a comprehensive introduction to many aspects already known while also highlighting issues remaining and speculating upon conceptual developments that are needed to develop a theoretical framework for the copious body of data on biofield phenomena. We also refer the reader to the extensive discussion presented in the excellent compendium of relevant works in Popp and Beloussov.[12] This book discusses in detailed chapters the idea of biophysics as being quantum biological, developmental biology and morphology and field theory, biophotonic emission studies, mitogenetic radiation as a biofield phenomena, and life and consciousness as relevant aspects to biophysics and integrative biophysics as being inclusive of this.

HISTORICAL AND THEORETICAL CONCEPTIONS FOR THE BIOFIELD

The concept of a biofield has been emerging steadily, with the work of several groups indicating that part of a living organism's energy is "integrated into a sort of an all-inclusive, long range and to a certain degree *coherent field*."[2] This suggests that fundamental properties

like coherence, integrative function, and various long-range influences on the organism are all potentially associated with the biofield. A number of scientists have historically proposed that a biological field exists in a holistic or global organizing form.[13-15] The details are different, but in general, such propositions involve coherence in electromagnetic waves,[15] biophotons,[16] or going beyond electromagnetism, human intention.[17] In some suppositions, an "electromagnetic body" or "subtle body" is invoked, as related to acupuncture meridians in traditional Chinese medicine[18] and chakras, the subtle energy centers in the Indian esoteric tradition.[17] As Liboff notes, "Once the organism is described as an electromagnetic entity, this strongly suggests the reason for the efficacy of the various electromagnetic therapies, namely as the most direct means of restoring the body's impacted electromagnetic field to its normal state."[19]

From a recent perspective, the term *biofield* was coined in 1994 by a panel on manual medicine modalities convened at the National Institutes of Health (NIH) to discuss complementary and alternative medicine (CAM).[20] As result, the NIH, through the National Center for Complementary and Alternative Medicine, issued a request for applications for grant proposals to study a variety of biofield therapies, including Reiki, healing touch, qigong, and other subtle energy healing interactions.[15] As a result of this research focus, much of the physiological evidence for the biofield has come through the application of various CAM techniques of healing.

To get at its nature in terms of fields explored in classical physics, the biofield has been defined as "the endogenous, complex dynamic EMF resulting from the superposition of component EMFs of the organism that is proposed to be involved in self-organization and bioregulation of the organisms."[15] A classical electromagnetic-based definition such as this one can serve as an important starting point, insofar as it involves the concept of bioinformation.[15] However, as we will see below, any electromagnetic-based definition is limiting, since it does not encompass quantum and holistic effects. EMF theories are also themselves special cases of quantum field theories, the latter being more natural and general, and therefore able to account for the properties of coherence, nonlocality, and entanglement,[21,22] which are strikingly relevant to living organisms.

METHODOLOGICAL ISSUES: "INTEGRATIVE BIOPHYSICS"

Before turning our attention to the specifics of the biofield and the underlying physics, we will examine the general role of "integrative biophysics," a term coined by Popp and Beloussov that refers to different aspects of nonconventional biophysics and biology.[12] Specifically, the term indicates a departure from equilibrium thermodynamics, the foundation of classical physics and chemistry[23] on which most of biology is based. Instead, a central aspect of integrative biophysics is modeling of the organism built completely upon the field concept—this forms a common thread throughout integrative biophysics and phenomena associated with biophotons.

> *Quantum mechanics has established the primacy of the unseparable whole. For this reason, the basis of the new biophysics must be the insight into the fundamental interconnectedness within the organism as well as between organisms, and that of the organism with the environment. This will be an integral biophysics. . . . The existence of a prephysical, unobservable domain of potentiality in quantum theory, which forms the basis of the fundamental interconnectedness and wholeness of reality and from which arise the patterns of the material world, may provide a new model for understanding the holistic features of organisms, such as morphogenesis and regeneration, and thus provide a foundation for integral biophysics.*[12]

As a starting point, evidence of bioelectromagnetic fields and the biological effects of external EMFs have historically lagged behind the successes of biochemistry, resulting in a delayed start in understanding the ubiquitous nature of biofields in living organisms. The historical emphasis on reductionist molecular biological explanations has been practical and allowed for the gains of current biomedicine. Organismal and biofield biology and their multifaceted mechanisms and forms may also offer a host of useful approaches for investigating and unlocking the mysteries of life that have been neglected.

The need for general principles in biology has been pointed out by Bizzarri, Palombo, and Cucina[24] and by Grandpierre, Chopra, and Kafatos.[1] Instead of looking on a more integrated approach like systems biology as merely an extension of molecular biology, these investigators strongly suggest that integrated biology and biophysics operate beyond the reductionist approach. For example, these authors are challenging genetics as being the sole discipline for explaining evolution. We hope that integrative biophysics and associated field processes, including EMFs, biophotons, and possible quantum interactions, will soon be seen as necessary, fundamental, and complementary aspects of molecular biology and biochemistry. New vistas for understanding evolution will emerge when these complementary approaches are accepted.

ELECTROMAGNETIC FIELDS

We now turn our attention to specific aspects of biofield, beginning with EMFs. An EMF is a physical field produced by electrically charged particles in motion. We refer to the work of Jerman, Leskovar, and Krašovec[2] for many of the details. A widely applicable notion of the biofield is associated with endogenous EMFs of organisms.[5,2] Every living cell membrane "has

an electric field of very high intensity (around 10^7 V/m) though of a rather low voltage . . . one of the basic features of life."[2] Biomedical researchers and clinicians routinely gather meaningful data from the manifestations of endogenous EMFs through the use of skin surface measurements like electroencephalograms (EEGs) and electrocardiograms (ECGs).[25] The human body also includes classical acoustic energy fields due, for example, to muscular contraction.[26] Coherence is often observed in EEG, which would indicate self-organizing systems.[27] Such coherence has been shown to increase during meditative states of settled awareness.[28,29]

Applying very–low power coherent EMFs at specific frequencies in the mm range to biological systems results in a resonance-like behavior that supports the theoretical prediction of polar coherent modes in a manner comparable to Bose condensation.[30] Polar coherent modes are predicted to result from the high-intensity field across cell membranes, that when driven by metabolism, create coherent microwave oscillation. A Bose-Einstein condensate is a state of matter of a dilute gas of bosons cooled to temperatures very close to absolute zero. Under such conditions, macroscopic quantum phenomena become apparent. Such macroscopic quantum phenomena are hypothesized as qualities of the biofield. Moreover, according to Fröhlich,[27] these polar coherent modes represent the basis for electromagnetic oscillations at cellular levels in the organism. The existence of endogenous EMFs at the predicted Fröhlich frequencies has not yet been proven experimentally, and their coherent nature in the body is only inferred.[2] However, the discovery of an endogenous EMF at much lower MHz frequencies in microtubules is significant because it suggests a form of coherent electromagnetic activity that may play a role in biofield signaling, thus lending some support to the theory coherent modes of Fröhlich but at much lower frequencies than predicted theoretically.[31]

Other indirect indications of endogenous EMFs come from biophotonics,[2] with foundations in the pioneering work of Popp and collaborators on coherent ultraweak light emissions from cells.[12,32-34] Bischof describes the biophoton field,[35] summarizing 90 years of peer-reviewed published research, as follows: "All living organisms, including humans, emit a low-intensity glow that cannot be seen by the naked eye, but can be measured by photomultipliers that amplify the weak signals several million times and enable the researchers to register it in the form of a diagram. As long as they live, cells and whole organisms give off a pulsating glow with a mean intensity of several up to a few ten thousand photons per second and square centimeter," also known as "cellular glow" or "ultraweak bioluminescence."[34] These biophotonic phenomena could point to long-range interactions between biological organisms. This possibility is supported by observations of intercellular signaling mediated by biophotons.[36-39] via a field containing coherent states[32-34,40] in agreement with the pioneering conjectures of Fröhlich.

In summary, the electromagnetic basis includes the presence of at least 2 field sources: "one (static electric-transmembrane potential) that has been known for long, and the other, a high frequency oscillating and more or less coherent EMF."[2] The latter can be considered to have 2 further aspects manifesting in different energy or frequency ranges: (1) a microwave to MHz and lower frequency range coherence, which we can simply refer to as the Frölich field, and (2) a visible/infrared/near ultraviolet diffuse field, which we can refer to as the Popp photon field. The former has been observed but at lower frequencies than predicted; the latter is supported empirically by observations of the statistical coherence of biophotons, which produce emission spectra that are distinctly different from byproducts of biochemical reactions.[40] This appears to be related to quantum mechanical squeezed states.[40,41] Squeezed states of light belong to the class of nonclassical states of light and indicate quantum coherent states. As such, quantum mechanical effects are clearly indicated through coherence and squeezed states in both the Fröhlich and Popp fields; therefore, they constitute nonclassical fields with their own particular properties (see next section). Recently it has been suggested that the Fröhlich field and the Popp field are interconnected through strong mode coupling in living systems.[2] An experimental and theoretical basis for defining the existence of a macroscopic coherent quantum system in living things is being developed here and extended subsequently. This has profound implications for biology and medicine.

Coherent EMFs may indeed be the organizing agent of cellular processes, which would indicate that the biophoton source is nonbiochemical.[42] It is of course possible that these ultraweak photon fields are somehow related to biochemical processes, although concensus[42] is that they may be guiding the entire cellular physiology. Biofield interactions could also be responsible for the organization of cellular microtubular networks[43] and biological regulation processes that have been shown to occur via endogenous EMFs within microtubular cytoskeleton such as the following: the regulation of the dynamics of mitosis and meiosis[44,45]; chromosome packing during the mitotic phase of the cell-cycle[44]; and interactions between ion channel activity and the phosphorylation status of binding molecules such as MAP2 and CaMKII, which act modulate cytoskeletal structure and connectivity.[46] These experimental data are supported by theoretical prediction of classical and quantum information processing in microtubules.[47,48] The coherent photon field, on the other hand, could be the dominant factor in cellular physiology,[49] a conclusion supported by experimental observations of cell-to-cell signaling via coherent biophoton activity.[36-39]

It is of course important to also consider that neither biophotons nor biomolecular physiology are primarily causative but are instead tightly coupled processes arising codependently within biological systems.

In this vein, it should be recognized that individual cellular or multicellular organisms, while temporally and spatially separate from each other when regarded from customary investigative points of view, actually have no strict and definable boundaries between themselves.[50] In complex ways, living organisms form colonies and populations, merge with influences from the environment as they eat and breathe, behave according to shared genetic inheritance, and are inhabited by innumerable microorganisms known collectively as the microbiome, which makes even a marked visual boundary like the skin quite tenuous. It is just as important to consider the entire biosphere as a single evolving living structure comprising all seemingly separate "beings."[50]

BEYOND BIOELECTROMAGNETICS

Moving beyond classical EMF descriptions, the general CAM approach aims to modulate the endogenous fields. It has been suggested that this aim must include modulation of nonclassical and quantum forms of energy.[25] Indeed, it is a logical necessity to consider that the collective biofield consists of (at least) electromagnetic, optical, acoustic, and nonclassical energy fields associated with biological entities: cells, bodies, perhaps ecosystems, and even Gaia as a whole.[25] As stated above, the coherence of endogenous EMFs suggest, specifically that nonclassical fields are existing in biological entities.[40,41] It has been proposed that the biofield may be applicable in complementary medical therapies and healing.[51]

Potentially such therapies could be directed noninvasively at enhancing or stimulating the body's healing process, reducing pain and anxiety, and a variety of other conditions. Many of these applications reflect the influence of mind/body interactions, suggesting that the role of the observer in quantum mechanics (QM) may be of central importance to understanding mind/body therapies and the role of mind and emotions in health and wellbeing. To what extent "mind" may also be related to the biofield lies outside the scope of this review, but we have been describing some of the basic physical biofield processes that could explain the efficacy of complementary medical therapies.

All physics, including electromagnetic theory, rests upon a nonclassical foundation. For example, the electromagnetic potential field (comprising the vector potential, A, and scalar potential, ϕ, which are the sources of EMFs) mediates the classical EMFs described by Maxwell's equations and quantum levels described by the Schrödinger equation.[22] The electromagnetic potential acts by modulating the phase of charged particle wave functions; field interactions can occur in regions of zero electric and magnetic fields, yet nonzero A and ϕ.[21] Thus the electromagnetic potential is itself a nonclassical field functioning through a modulation of quantum phase rather than via a classical field of force. The case for other nonclassical fields has been summarized by Rein,[25] and such fields, while not yet directly observed, are a direct consequence of both classical, relativistic, and quantum theories.

For example, because the wave equations derived from Maxwell's equations (ie, classical electromagnetic theory) are symmetric in time, solutions exist for both the "advanced" and "retarded" electromagnetic potentials, propagating backwards and forwards in time, respectively.[52] Other field quantities that propagate at faster-than-light speeds, such as pilot waves, follow directly from calculations in both classical and relativistic electrodynamics.[53] In relativistic quantum theory, solutions to the Dirac equation successfully predicted the (now experimentally confirmed) existence of the positron, requiring a formulation in which the arrow of time is reversed.[54] "Longitudinal" or "scalar" waves have also been suggested to be primary aspects of the biofield.[24] In contrast to the transverse vector waves of classical EMF theory, such scalar waves are hypothesized to result from superposition of electromagnetic waves—eg, when 2 waves cancel each other, a transformation of energy into vacuum potentiality is thought to occur.[25] Such scalar fields, which are not mediated by electric dipoles or electron transitions, propagate far from equilibrium[25] and clearly don't constitute known electromagnetic-based structures.

These connections with nonclassical fields have led several scientists to consider the body as functioning as a macroscopic quantum system.[9,25,55-58] The existence of macroscopic biological processes linked to QM leads to quantum biology and as we will see below, to a biofield conception beyond both quanta and biological entities to the underlying vacuum and even further. In an integrated quantum description of the body, bioinformation must play a fundamental role. The implications for biomedicine are profound. Such a system would create a model for the origin and cause of broad physiological regulatory behavior that we currently lack, primary to molecular biology. Practical control of this system would lead to deep insights for healing, regeneration, morphology, disease elimination, growth, and mind/body interaction, as well as insights into the fundamental questions of what is life, what is consciousness, and what the full mechanisms underlying evolution are. It may describe a new, unique, quantum mechanical and electrically based physiological system that interfaces with both the quantum world, quantum vacuum, and biochemical world. It may be the key to integrating the science of consciousness and biology. It would certainly be an epochal paradigm shift for science.

QUANTUM PHYSICS AND QUANTUM BIOLOGY

Quantum physics provides a theoretical entry to attempt to explain the existence of the biofield and how it interacts with the body. There are qualifications to this assumption, however. Bischof indicates the fundamental sense that quantum physics has implicitly replaced the old reductionist and molecular view of science with a holistic one in which materiality forms an unbroken

whole.[23] Likewise, the most persistent paradigm in neuroscience considers the mind as an emergent property of a large and complex physical brain that mediates awareness and remembrance.[58,59] In this orthodox view, "mind" appeared in the evolutionary chain because of the development of nervous systems in general, central nervous systems in particular, or only in primates and perhaps just *homo sapiens*.[60]

In contrast, a view closely linked to the role of observation in quantum measurements assigns a role to subjectivity in keeping with the Copenhagen Interpretation (CI) and particularly its revision by John von Neumann, known as the orthodox quantum view.[6] It holds that consciousness provides the individual observer with agency and freedom.[61-63] As such, quantum measurement theory has yielded to what Wheeler refers to as the "participatory universe." The conundrum of whether or not the falling tree would make a noise in the forest is irrelevant if no conscious observers were around to hear it. From this participatory viewpoint, properties of quanta and quantum systems in general are "contextual": They don't exist by themselves but are intrinsically tied to acts of observation.

In von Neumann's view, nature exhibits free choice of response to an act of observation by an observer. The time evolution of a quantum system is described by the wave function, which fully characterizes such systems through the deterministically evolving Schrödinger equation.[6] However, what value will result following an actual experimental choice is not known. Once an experiment is conducted, a single value in the probability space described by the wave function results, and this is the famous "collapse of the wave function."[64] Quantum theory presents us with a world following a completely different order from the world of everyday experience.[63] In what constitutes the underlying reality, quanta are entangled in both space and time, and nonlocality is implied in quantum measurements.[64]

By extension, a number of quantum physicists take participation to be an absolute requirement, holding that the world is primarily mental, since mental decisions implicitly play the primary role in the collapse of the wave function.[6,57,64-66] In the CI of quantum theory, the wave function is not considered to be real. Rather, it is only a prescription of determining probabilistic potential outcomes, which are described by the square of the absolute value of the wave function, as proposed by Born.[67,68] However, the variables measured must conform to macroscale classical analogues, since any apparatus in the lab would be a classical system. Thus the CI has a duality built into it. Not all physical variables of a quantum system can be simultaneously known (according to the Heisenberg Uncertainty Principle). In the CI, quantum systems behave in a complementary manner, either as particles or waves (Bohr's Principle of Complementarity). This complementary relationship manifests in the act of observation itself. For example, the more precisely a particle's position (particle-like aspect) is measured, the less precisely can its momentum be known (ie, wavelength or wave-like aspect). Thus the type of measurement chosen by the observer determines the outcome of experiments, suggesting a participatory role for the observer.

In von Neumann's view, there is a universal wave function.[6] However, as in the CI, there is also collapse through conscious observation. For von Neumann, the state transformation due to measurement (process 1) is distinct from that due to time evolution (process 2) as described by the Schrödinger time-dependent equation: Time evolution is deterministic and unitary whereas measurement is nondeterministic and nonunitary.[6,58] Von Neumann's interpretation is the gold standard against which all other interpretations must be compared.[63] Von Neumann's nondeterministic interpretation of measurement gives a psychological component to reality itself, casting the observer in the role of an active participant in the creation of events.

This viewpoint, that the observer's participation plays an essential role in the outcome of events, has fundamental implications for biofield science and mind/body therapies. It has the potential for understanding how many such therapies operate. In the same breath, the issue of efficacy arises. There is a wide range of response to all medical interventions, whether in complementary or conventional scientific medicine. No 2 patients respond alike, and uncertainty is always present. Mind and body are fundamentally connected. Thus, the primary connection of the observer and the observed system, as understood in QM, has profound implications for the nature of the biofield: We cannot take the living body as an entity existing independent of the biofield to which it belongs and independent of the practitioner and the receiving subject in CAM treatments.

The primary shortcoming of molecular biology is that the "holistic" character of the physical world now recognized in quantum theory is either not acknowledged by the bioengineers or rejected as irrelevant.[23,69] The world view of QM is much richer and more holistic than molecular biology would have. It is no surprise that many of the founders of QM understood the implications of wholeness in both physics and biology. For example, Planck held that wholeness must be introduced into physics as in biology.[70] Bohr understood the significance of complementarity beyond QM and how it was paramount to biology.[67,68] Schrödinger wrote an important work with the title "What is Life?" in which he approached the holistic view for both QM and life as similar.[71] For example, primary colors are not a fundamental property of light but are related to the physiological response of the eye to light. Moreover, Heisenberg also held that mind plays a fundamental role in the universe.[72]

Today, the evidence of macroscopic quantum effects in biology has yielded a plethora of phenomena that can be understood through the application of quantum physics. They include understandings of the role of

coherence in photosynthesis,[73,74] the avian compass through which birds navigate,[74] the sense of smell,[75] quantum coherence in microtubules,[56,76] regeneration,[77] and quantum processes in brain dynamics.[78-80]

QUANTUM-LIKE PROCESSES

The application of quantum microphysics to macroscopic scales is natural and yet at the same time surprising. The naturalness is because QM is the most complete theory of physical reality that we have where classical physics is incomplete. The surprise is because most QM effects occurring in the microcosm, such as entanglement and nonlocality, don't readily apply to everyday experience. In what follows, we refer to Kafatos[63] as it applies to bridging the microscopic and macroscopic domains.

By quantum-like effects are meant (1) phenomena that are clearly related to QM but apply at macroscopic scales where normally they would not be expected and (2) phenomena that should be seen as extensions beyond current orthodox QM, in particular those involving life processes that cannot be accounted for by standard biochemistry, biology, or quantum theory. The Hilbert space formalism of QM, Schrödinger's wave mechanics, and Heisenberg's matrix mechanics don't directly address life processes. Quantum-like processes have been theoretically invoked in a host of life processes and macroscopic physics (such as brain dynamics).[7,8] "Quantum-like" indicates that the principles of QM apply at all scales, not just the microscopic, and as such, they provide fundamental insights to phenomena in fields outside physics, such as those already touched upon—biology, neuroscience, and medicine—and potentially extending to other areas like psychology and even anomalous psi phenomena, where one might apply QM phenomena such as entanglement and nonlocality.[81]

Reflecting on these concepts from the perspective of complexity theory, it becomes clear that many of the "peculiar" effects observed at the quantum level have biological forms: for example, biological complementarity[50] and uncertainty.[82,83] Extending QM concepts in this way leads to biological scale, quantum-like nonlocality, recursion, and entanglement. These extensions are more than analogies or metaphors. Beyond a scope usually considered as peculiar to the quantum world and not occurring in the "real world" of classical physics, we suggest that if the observable universe at its foundation is quantum mechanical, as held in standard orthodox QM,[6,58,84,85] then nonlocality could indeed be one of the signature aspects of an underlying mental world. This has been referred to as the "conscious universe."[64,85-88] Such a universe, where consciousness is primary, would entail *qualia* of experience, where the qualities of the experienced world describe reality with the validity of conventional science and yet go much further by including every aspect of mind.[89,90] Quantum-like can thus be understood as the (future) extension of both QM and quantum biology[91] to account for the physical, mental, and biological realms,[92] with the biological domain characterized by huge complexity and different levels of information rates.[1]

THE QUANTUM VACUUM

In interpersonal field phenomena,[23] the presence of nonelectromagnetic fields is indicated. These may be electromagnetic potential fields, which Aharonov and Bohm[21] showed are very real. Tiller has suggested that these potential fields mediate between EMFs, the macroscopic quantum states of matter, and the physical vacuum.[22] We agree with Bischof that "all the features of unbroken wholeness of reality implicit in quantum theory—non-separability, non-locality, fundamental connectedness—which are so fundamental for biological understanding, are an expression of the properties of the vacuum."[23] According to this view, the vacuum organizes the structure of space-time through macroscopic EMFs, and the phase-controlling property of the electromagnetic potentials plays a central role.[23] The importance of phase-relations for complex biosystems, consisting of many oscillating fields coupled nonlinearly by their phase-relations, points to the importance of the vacuum for the biofield itself.

Relatedly, the coherence of biophoton emission has been suggested to arise from "potential information" in the organism that is virtual and nonmeasurable[23] and a "superfluid vacuum model" has been proposed for biophoton emission of seeds and its connection to their vitality.[93] This model characterizes the vacuum as a superfluid Bose-condensate of photons in which virtual fields in the vacuum state are involved in the manner posited by Grandpierre and Kafatos.[94] Zeiger and Bischof make clear "that there is significantly more to the quantum vacuum than just the electromagnetic vacuum (the zero-point fluctuations)," and

> *the need for assuming a pre-physical dimension of potentiality for the understanding of organisms, and for the creation of the new discipline of vacuum biophysics as a basis of biophysical understanding, is postulated . . . The fundamental quantum mechanical nature of biological phenomena will only be fully understood if the vacuum is taken into full and explicit consideration as the essence and ground of these phenomena. The quantum vacuum may serve as a framework for a unification program in biology aimed at incorporating all relevant aspects of life into a physical picture of the organism.*[93]

In agreement with views presented above, Zeiger and Bischof also recognize the role of the observer and of consciousness itself in QM.[92] In addition, Grandpierre and Kafatos and Grandpierre, Chopra, and Kafatos have provided arguments for the fundamental role of the quantum vacuum in biology, in the autonomy or free choice of organisms and as the driver of biological evolution.[94]

PRELIMINARY RESULTS FOR "PHANTOM LEAF EFFECT": A MODEL SYSTEM FOR BIOFIELD RESEARCH?

An intriguing experimental result, known as "the phantom leaf effect," if fully verified, may be an example of some or even all of these biofield processes. In these experiments, coronal discharge[95] or the Kirlian photographic effect reveals a field effect in the morphological form of an intact living leaf even after part of the leaf is severed.[96] This suggests an analogy to the subjective experience of a phantom limb reported by patients after the limb has been amputated. There might be a persisting biofield that represents the amputated limb. First described by Adamenko and reported by Tiller[96] and by Ostrander and Schroeder,[97] more recent validating experiments have been performed with detection methods of greater precision; these are summarized in Hubacher.[98] In his most recent publication, Hubacher performed the experiment with highest definition photographic samples using the largest number of samples to date.[98] Of 137 leaves severed and imaged, 96 (70%) demonstrated clear phantoms (example in the Figure).[98]

In these experiments the phantom structure (1) appears as an integral and coherent whole, (2) is independent spatially of the organism, (3) interacts with both magnetic and electric fields and conducts current, and (4) represents the precise anatomy of the original physical leaf.[98] Hubacher concludes that the phantom leaf, being electroconductive, may carry both information and energy and therefore possibly represents a true biofield manifestation that regulates physiological processes.

An early explanation of this effect questioned whether the phantom leaf effect might result from moisture emission from the cut portion driven into the space from which the cut section had been removed by the power of the field emission process. However, the most recent data do not support this explanation, as the precise and complex anatomical replication of the original leaf is present in minute detail.

On the other hand, it is also unclear why the effect is not seen 100% of the time (though it is more reproducible in this current cohort than it has been before). Hubacher suggests that

> *some parameter or group of parameters is probably needed beyond what is understood, to reliably reproduce these results. These include such things as frequency, waveform, dielectric spacing, pulse widths, and types of grounding. Other variables can include film types, gases in the electrode mechanism, humidity, power sources, times of year, plant species, [and] chemically influenced specimens, eg, perfusion with chloroform prior to photography.*[98]

Further work is clearly needed to determine the impact of these variables, but the fact remains that phantom leaves have been demonstrated using a variety of techniques. The remarkable results strongly suggest a robust effect that can arise from a very broad array of interwoven field phenomena.

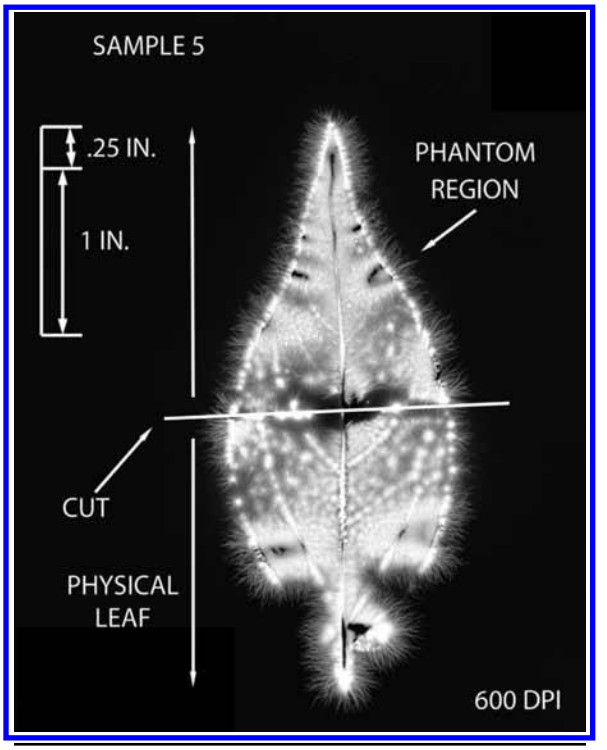

Figure Example of the phantom leaf effect from Hubacher (2015).

In the images obtained, it is electron flux that creates the image. These data point to the existence of an intact, integral, and conductive system permeating the original leaf. Given the absence of any conductive physical structures in the severed area, the coronal discharge appears to be under the influence of a quantum-level, nonphysical field functioning below the level of EMFs, in order to support and structure those EMFs. Vacuum phantom effects have also been proposed at the molecular level for DNA.[99,100] We note also that the quantum vacuum produces real measurable effects such as the Lamb shift,[100] the Casimir effect (which occurs when charged parallel electrodes are closely adjacent[101]), and the Bose condensation mentioned above.[30]

The mechanisms are as yet unknown, but the various findings point to aspects that would be expected from the postulated biofield. It can be asked, then, whether a phantom structure functions like a true physiological system, as has been suggested for the biofield. A functioning system of this nature has been postulated to deliver energy and/or information systemically throughout an organism using electromagnetic signals and forces.[9]

In this regard, it appears that the phantom leaf effect may provide an excellent model through which to explore the manifestations of a truly observable biofield (or of overlapping, interactive biofields). At the very least, the opportunity to explore biofield mechanisms at the level of EMF or below, into subtler quantum realms, is intriguing. The fact that the phantom leaf effect is highly robust in recent trials[97] suggests that further

work will identify confounding variables, which will likely uncover some of the underlying principles.

DISCUSSION AND CONCLUSIONS

Our examination of the evidence for the biofield indicates the need for explanations to go beyond conventional classical physics and biology. In particular, one needs the consideration of holistic approaches and coherent processes. Biofields may be carried by EMFs, quantum and quantum-like processes, and other fundamental coherent states. Further research must be done on the physical origins of the biofield and how it relates to an integrated understanding of consciousness and the "living universe." Our recommendations include new investigations that address the comprehensive issues listed below, some of which are currently speculative.

- What is the role of observation in the structure of the biofield? Does the state of the practitioner affect the structure of the biofield in medical applications, for example? Even for the same subject receiving different CAMs at different times, would the biofield depend on the person administering the treatment?
- Is the coherence seen in biofield, and particularly in biophoton emissions, indicative of the basic quantum(like) nature of life? Similarly, do nonlocality and entanglement and other quantum properties apply among different interacting organisms?
- In CAM, how is the endogenous and all-encompassing nature of the biofield in an individual tied to the biofield of the practitioner and to all biofields of living entities? For example, do biofields linking every living entity exist at all scales? How would we show this experimentally and what would the consequences be?
- If entanglements across "different" biofields are real, how might CAM modalities be developed to deliver the maximum beneficial effects to the patient?
- Can the use of CAM take advantage of the nonlocal nature of the biofield (eg, along with hands-on healing, distant healing, as in Reiki, could be equally effective)?
- Can the biofield be understood as ultimately emanating from the quantum vacuum? Would this open up new vistas for energetic healing transmission? For example, would the persistence of biofield be utilized for health benefits across space-time?
- Can we devise scientific experiments to study specific quantum-like properties of the biofield that would be useful in CAM?
- The phantom leaf effect may represent an easily performed and reproducible model system for exploring not only the primary nature of the biofield but also how CAM interventions might interact with it or even change it.
- Finally, what makes biofield research so fascinating is its immediate impact on human beings. We are living entities imbedded in the fields described by classical and quantum physics. Nature's forces invisibly affect us every day, and science has long searched for a bridge between the quantum and classical world. If these worlds turn out to be united in a very practical way through the phenomenon of life itself, the biofield will be far more than theoretical. It will redefine what human life constitutes, where we belong in the panoply of life on the planet, and ultimately how we should live in a wider, even cosmic, context.

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REFERENCES

1. Grandpierre A, Chopra D, Kafatos MC. The universal principle of biology: determinism, quantum physics and spontaneity. NeuroQuantology. 2014;12(3):364-373.
2. Jerman I, Leskovar RT, Krašovec R. Evidence for biofield. In: Zerovnik E, Markic O, Ule A, editors. Philosophical insights about modern science. Hauppauge, NY: Nova Science Publishers; 2009:199-216.
3. Jain S, Rapgay L, Daubenmier, J, Muehsam, D, Rapgay, L, Chopra, D. Indo-Tibetan philosophical and medical systems: perspectives on the biofield. Global Adv Health Med. 2015;4(suppl):16-24.
4. Muehsam D, Chevalier G, Barsotti T, Gurfein BT. An overview of biofield devices. Global Adv Health Med. 2015;4(suppl):42-51.
5. Fröhlich H. Long-range coherence and energy storage in biological systems. Int J Quant Chem. 1968; 2(5):641-9.
6. von Neumann J. Mathematical foundations of quantum mechanics. Princeton, NJ: Princeton University Press; 1955.
7. Roy S, Kafatos M. Complementarity principle and cognition process. Physics Essays. 1999;12(4):662-8.
8. Roy S, Kafatos M. Quantum processes and functional geometry: new perspectives in brain dynamics. Forma. 2004;19:69-84.
9. Ho MW, Popp FA, Warnke U, editors. Bioelectrodynamics and biocommunication. London: World Scientific; 1994.
10. Li HK. Coherence–A bridge between micro- and macro-systems. In: Belusov LV, Popp FA, editors. Biophotonics–non-equilibrium and coherent systems in biology, biophysics and biotechnology. Moscow: Bioinform Services; 1995:99-114.
11. Lee KC, Sprague MR, Sussman BJ, et al. Entangling macroscopic diamonds at room temperature. Science. 2011;334(6060):1253-6.
12. Popp FA, Beloussov L, editors. Integrative biophysics: biophotonics. Dordrecht, the Netherlands: Kluwer Academic; 2003.
13. Burr HS, Northrop FS. The electro-dynamic theory of life. Q Rev Biol. 1935;10(3):322-3.
14. Burr HS. Blueprint for immortality: the electric patterns of life. Trowbridge, England: The C.W. Daniel Company Limited; 1988.
15. Rubik B. The biofield hypothesis: its biophysical basis and role in medicine. J Altern Complement Med. 2002;8(6):703-17.
16. Popp FA. Evolution as the expansion of coherent states. In: Zhang L, Popp FA, Bischof M, editors. Current development of biophysics: the stage from an ugly duckling to a beautiful swan. Hangzhou, China: Hangzhou University Press; 1996:252-64.
17. Savva S. Toward a cybernetic model of the organism. Adv Mind-body Med. 1998;14:292-301.
18. Zhang CL. Standing wave, meridians and collaterals, coherent electromagnetic field and wholistic thinking in Chinese traditional medicine. J Yunnan Coll Trad Med. 1996;19:27-30. Chinese.
19. Liboff AR. Toward an electromagnetic paradigm for biology and medicine. J Altern Complement Med. 2004;10(1):41-7.
20. Rubik B, Pavek R, Ward R, et al. Manual healing methods. Alternative medicine: expanding medical horizons. Washington, DC: US Government Printing Office; 1994:45-65.
21. Aharonov Y, Bohm D. Significance of electromagnetic potentials in the quantum theory. Phys Rev. 1959;115(3):485-491.
22. Tiller WA. What are subtle energies? J Sci Explor. 1993;7(3):293-304.
23. Bischof M. Introduction to integrative biophysics. In: Popp FA, Beloussov L, editors. Integrative biophysics: biophotonics. Dordrecht: Kluwer Academic; 2003:1-115.
24. Bizzarri M, Palombo A, Cucina A. Theoretical aspects of systems biology. Progr Biophys Mol Biol. 2013;112(1-2):33-43.
25. Rein G. Bioinformation within the biofield: beyond bioelectromagnetics. J Altern Complement Med. 2004;10(1):59-68.

26. Barry DT. Muscle sounds from evoked twitches in the hand. Arch Phys Med Rehabil. 1991;72(8):573-81.
27. Frölich H. Theoretical physics and biology. In: Frölich H, editor. Biological coherence and response to external stimuli. Berlin: Springer-Verlag; 1988:1-24.
28. Tiller WA, McCraty R, Atkinson M. Cardiac coherence: a new, noninvasive measure of autonomic nervous system order. Altern Ther Health Med. 1996;2(1):52-65.
29. Travis F, Tecce J, Arenander A, Wallace AK. Patterns of EEG coherence, power and contingent negative variation characterize the integration of transcendental and waking states. Biol Psychol. 2002;61(3):293-319.
30. Frölich H. Evidence for Bose condensation-like excitation of coherent modes in biological systems. Physics Lett A. 1975;51(1):21-2.
31. Pokorny J. Excitations of vibrations in microtubules in living cells. Bioelectrochemistry. 2004;63(1-2):321-6.
32. Popp FA, Nagl W, Li KH, Scholz W, Weingärtner O, Wolf R. Biophoton emission. New evidence for coherence and DNA as a source. Cell Biophys. 1984;6(1):33-52.
33. Popp FA, Nagl W. Concerning the question of coherence in biological systems. Cell Biophys. 1988;13(3):218-20.
34. Popp FA, Li KH. Hyperbolic relaxation as a sufficient condition of a fully coherent ergodic field. Int J Theoret Phys. 1993;32(9):1573-83.
35. Bischof M. Biophotons: The lights in our cells. http://www.international-light-association.eu/PDF/Biophotons.pdf. Accessed September 8, 2015.
36. van Wijk R. Bio-photons and bio-communication. J Sci Explor. 2001;15(2):183-97.
37. Fels D. Cellular communication through light. PLoS One. 2009;4(4):e5086.
38. Fels D. Analogy between quantum and cell relations. Axiomathes. 2012;22(4):509-20.
39. Scholkmann F, Fels D, Cifra M. Non-chemical and non-contact cell-to-cell communication: a short review. Am J Transl Res. 2013;5(6):586-93.
40. Popp FA, Chang JJ, Herzog A, et al. Evidence of non-classical (squeezed) light in biological systems. Phys Lett A. 2002;293(1-2):98-102.
41. Bajpai RP. Squeezed state description of spectral decompositions of a biophoton signal. Physics Letters A. 2005;337(4-6):265-73.
42. Cohen S, Popp FA. Biophoton emission of the human body. J Photochem Photobiol B Biol. 1997;40(2):187-9.
43. Hameroff S, Penrose R. Orchestrated reduction of quantum coherence in brain microtubules: a model of consciousness. Math Comp Sim. 1996;40(3-4):453-80.
44. Zhao Y, Zhan Q. Electric fields generated by synchronized oscillations of microtubules, centrosomes and chromosomes regulate the dynamics of mitosis and meiosis. Theor Biol Med Model. 2012 Jul 2;9:26.
45. Plankar M, Brezan S, Jerman I. The principle of coherence in multi-level brain information processing. Prog Biophys Mol Biol. 2013;111(1):8-29.
46. Glass L. Synchronization and rhythmic processes in physiology. Nature. 2001;410(6825):277-84.
47. Hameroff S, Nip A, Porter M, Tuszynski J. Conduction pathways in microtubules, biological quantum computation, and consciousness. Biosystems. 2002;64(1-3):149-68.
48. Havelka D, Cifra M, Kucera O, Pokorny J, Vrba J. High-frequency electric field and radiation characteristics of cellular microtubule network. J Theor Biol. 2011;286(1):31-40.
49. van Wijk R, van Wijk E. Human biophoton emission. Rec Res Devel Photochem Photobiol. 2004;7:139-173.
50. Theise ND, Kafatos MC. Complementarity in biological systems: a complexity view. Complexity. 2013;18(6):11-20.
51. Hammerschlag R, Jain S, Baldwin AL, et al. Biofield research: a roundtable discussion of scientific and methodological issues. J Altern Complement Med. 2012;18(12):1081-6.
52. Wheeler JA, Feynman RP. Interaction with the absorber as the mechanism of radiation. Rev Mod Phys. 1945;17:157-81.
53. Eisberg RM. Fundamentals of modern physics. New York, NY: John Wiley and Sons; 1961.
54. Feynman RP. The theory of positrons. Phys Rev. 1949;76(6):749-59.
55. Popp FA, Warnke U, Konig, HL, editors. Electromagnetic bio-information. Munich: Urban & Schwarzenberg; 1979.
56. Hameroff SR. Quantum coherence in microtubules: a neural basis for emergent consciousness? J Conscious Stud. 1994;1(1):91-118.
57. Rauscher EA, Rubik BA. Human volitional effects on a model bacterial system. PSI Res. 1983;2:38-47.
58. Stapp HP. Mind, matter and quantum mechanics. Berlin: Springer Verlag; 2009.
59. Kafatos M, Kak S. Veiled Nonlocality and cosmic censorship. Physics Essays. 2015;28:182-187. And arXiv. 2014;1401.2180.
60. Theise ND, Kafatos MC. Sentience everywhere: Complexity theory, panpsychism & the role of sentience in self-organization of the universe. J Conscious Explor Res. 2013;4(4):378-90.
61. Kak S. The universe, quantum physics, and consciousness. Cosmology. 2009;3:500-10.
62. Kak S, Chopra D, Kafatos MC. Perceived reality, quantum mechanics, and consciousness. Cosmology. 2014;18:231-45.
63. Kafatos MC. Physics and consciousness: quantum measurement, observation and experience. White paper in the workshop Frontiers of Consciousness Research, March 4th and 5th, 2014, National Academy of Science's Beckman Center at the University of California, Irvine (UCI), 2014.
64. Kafatos M, Nadeau R. The conscious universe. New York: Springer Verlag; 1991, 2000.
65. Kafatos MC. The conscious universe. In: Chopra D, editor. Brain, mind, cosmos: the nature of our existence and the universe. Ebook: Amazon; 2013.
66. Goswami A. The self-aware universe. New York: Jeremy P. Tarcher/Putnam; 1993.
67. Bohr N. Atomic theory and the description of nature. Cambridge: Cambridge University Press; 1934.
68. Bohr N. Atomic physics and human knowledge. New York: Wiley; 1958.
69. Primas H. Chemistry, quantum mechanics, and reductionism. Lecture notes in chemistry. Vol. 24. Berlin: Springer; 1981.
70. Planck M. Where is science going? London: G. Allen and Unwins; 1933.
71. Schrödinger E. What is life? The physical aspect of the living cell. Cambridge: Cambridge University Press; 1944.
72. Heisenberg W. Physics and philosophy. New York: Harper; 1958.
73. Engel GS, Calhoun TR, Read EL, et al. Evidence for wavelike energy transfer through quantum coherence in photosynthetic systems. Nature. 2007;446(7137):782-6.
74. Ishizaki A, Fleming GR. Theoretical examination of quantum coherence in a photosynthetic system at physiological temperature. Proc Natl Acad Sci U S A. 2009;106(41):17255-60.
75. Lloyd S. Quantum coherence in biological systems. J Phys Conf Ser. 2011;302(012037):1-5.
76. Jibu M, Hagan S, Hameroff SR, Pribram KH, Yasue K. Quantum optical coherence in cytoskeletal microtubules: implications for brain function. Biosystems. 1994;32(3):195-209.
77. Levin M. Bioelectric mechanisms in regeneration: Unique aspects and future perspectives. Semin Cell Dev Biol. 2009;20(5):543-56.
78. Eccles JC. Do mental events cause neural events analogously to the probability fields of quantum mechanics? Proc R Soc Lond. 1986; 227(1249):411-28.
79. Rein G. Modulation of neurotransmitter function by quantum fields. In: Pribram KH, editor. Behavioral neurodynamics. Washington DC: International Neural Network Society; 1993.
80. Freeman WJ, Vitiello G. Dissipation and spontaneous symmetry breaking in brain dynamics. J Physics A Math Theoret. 2008;41(30):304042.
81. Tressoldi PE, Storm L, Radin D. Extrasensory perception and quantum models of cognition. Neuroquantology. 2010;8(4 Suppl 1):581-7.
82. Theise ND. Now you see it, now you don't. Nature. 2005;435(7046):1165.
83. Theise ND. Implications of "post-modern biology" for pathology: the Cell Doctrine. Lab Invest. 2006;86(4):335-44.
84. Stapp HP. Retrocausal effects as a consequence of orthodox quantum mechanics refined to accommodate the principle of sufficient reason. In: Sheehan DP, editor. Quantum retrocausation: Theory and experiment. 2011;1408:31-44.
85. Stapp HP. Benevolent universe? eBook ISBN: 978-1-105-56456-7; 2012.
86. Nadeau R, Kafatos M. The non-local universe: The new physics and matters of the mind. Oxford: Oxford University Press; 1999.
87. Radin D. The conscious universe: the scientific truth of psychic Phenomena . New York: Harper One;1997.
88. Radin D. Entangled minds: extrasensory experiences in a quantum reality. New York: Simon & Schuster; 2006.
89. Kafatos M, Tanzi RE, Chopra D. How consciousness becomes the physical universe. J Cosmol. 2011;14:3-14.
90. Chopra D, Kafatos MC, Tanzi RE. A consciousness-based science: From quanta to qualia. In: Chopra D, editor. Brain, mind, cosmos: The nature of our existence and the universe. eBook: Amazon; 2013.
91. Lambert N, Chen YN, Cheng YC, Li CM, Chen GY, Nori F. Quantum biology. Nat Phys. 2013;9(1):10-8.
92. Theise ND, Kafatos MD. Non-dual conscious realism: fundamental principles of the non-material, self-organizing universe. Science and Non-Duality Conference; 2014.
93. Zeiger BF, Bischof M. The quantum vacuum in biology. Paper presented at: 3rd International Hombroich Symposium on Biophysics, International Institute of Biophysics, (IIB); August 21, 1998; Neuss, Germany.
94. Grandpierre A, Kafatos M. Biological autonomy. Philos Stud. 2012;2(9):631-49.
95. Loeb LB. Electrical coronas, their basic physical mechanisms. Berkeley: California Press; 1965.
96. Tiller WA. Some energy field observations of man and nature. In: Krippner S, Rubin D, editors. Galaxies of life: The human aura in acupuncture and kirlian photography. New York: Gordon and Breach; 1973:71-112.
97. Ostrander S, Schroeder L. Psychic discoveries behind the iron curtain. Englewood Cliffs: Prentice-Hall; 1970.
98. Hubacher J. The phantom leaf effect: a replication, part 1 J Altern Complement Med. 2015;21(2):83-90.
99. Gariaev P, Poponin V. Anomalous phenomena in DNA interaction with electromagnetic radiation: Vacuum DNA phantom effect and it possible rational explanation. Bull Lebedev Phys Instit. 1992;12:24-30.
100. Glab WL, Ng K, Yao D, Nayfeh NH. Spectroscopy between parabolic states in hydrogen: Enhancement of the Stark-induced resonances in its photoionization. Phys Rev A. 1985;31(6):3677-84.
101. Jaffe RL. Casimir effect and the quantum vacuum. Phys Rev D. 2005;72:021301(R).

REVIEW ARTICLE

Biofield Physiology: A Framework for an Emerging Discipline

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ABSTRACT

Biofield physiology is proposed as an overarching descriptor for the electromagnetic, biophotonic, and other types of spatially-distributed fields that living systems generate and respond to as integral aspects of cellular, tissue, and whole organism self-regulation and organization. Medical physiology, cell biology, and biophysics provide the framework within which evidence for biofields, their proposed receptors, and functions is presented. As such, biofields can be viewed as affecting physiological regulatory systems in a manner that complements the more familiar molecular-based mechanisms. Examples of clinically relevant biofields are the electrical and magnetic fields generated by arrays of heart cells and neurons that are detected, respectively, as electrocardiograms (ECGs) or magnetocardiograms (MCGs) and electroencephalograms (EEGs) or magnetoencephalograms (MEGs). At a basic physiology level, electromagnetic activity of neural assemblies appears to modulate neuronal synchronization and circadian rhythmicity. Numerous nonneural electrical fields have been detected and analyzed, including those arising from patterns of resting membrane potentials that guide development and regeneration, and from slowly-varying transepithelial direct current fields that initiate cellular responses to tissue damage. Another biofield phenomenon is the coherent, ultraweak photon emissions (UPE), detected from cell cultures and from the body surface. A physiological role for biophotons is consistent with observations that fluctuations in UPE correlate with cerebral blood flow, cerebral energy metabolism, and EEG activity. Biofield receptors are reviewed in 3 categories: molecular-level receptors, charge flux sites, and endogenously generated electric or electromagnetic fields. In summary, sufficient evidence has accrued to consider biofield physiology as a viable scientific discipline. Directions for future research are proposed.

INTRODUCTION AND OVERVIEW

The impetus to frame a new area of physiology often arises at the interface of existing fields of inquiry. As prime examples, neuroendocrinology emerged when nerve endings in the hypothalamus, near the base of the brain, were observed to release hormones that cue the anterior pituitary to regulate an array of endocrine tissues[1]; psychoneuroimmunology emerged when the phenomenon of conditioned immunosuppression was observed and when nerve endings were discovered adjacent to lymphocytes in secondary lymphoid tissue[2]; cognitive neuroscience came into its own when correlates of mental processes began to be identified by means of increasingly sensitive brain imaging techniques.[3] We suggest that biofield physiology, with its initial focus on the characterization of endogenous electrical and magnetic fields as indices of health and illness—eg, via electroencephalography or magnetoencephalography (EEG and MEG) or electrocardiography and magnetocardiography (ECG and MCG)—represents another such confluence of disciplines, integrating concepts and information from cell biology, biophysics, and medical physiology.

Biologically-generated fields (biofields) are a spatially distributed set of forces and physical properties that have the capacity to encode information and exert instructive influences on cells and tissues capable of perceiving and being modified by them.[4,5] As such, biofields complement molecular processes as key contributors to what biophysicist Mae-Wan Ho, PhD, describes as global coherence—the multilevel integration of diverse biological activities across time and scale.[6] In her view, global coherence—the defining quality of living organisms—accounts for their most salient properties such as long-range order and coordination, rapid and efficient energy transfer, and extreme sensitivity to specific signals.

Although we focus in this paper on fields generated by living systems, there is substantive scientific literature demonstrating that physiological regulatory systems in humans and animals are also affected by and even synchronized to environmentally generated fields, eg, of geomagnetic and solar origin.[7-11] Of additional interest, disruptions in these fields have been observed to create adverse effects on health and behavior.[12] A

companion paper in this supplement reviews evidence for the therapeutic use of externally applied electrical and magnetic fields (see Muehsam, et al, this issue). For example, a recent Cochrane review concludes that pulsing electromagnetic field therapy "may offer some benefit in the treatment of delayed union and nonunion of long bone fractures,"[13] a finding supportive of the US Food and Drug Administration approval of such therapeutic usage.[14]

Given that electrical and magnetic fields,[15] as well as biophotons in the full range from ultraviolet to infrared,[16,17] are detected during normal physiological activity, the question often arises whether such endogenous phenomena are merely epiphenomena of metabolic events or are incompletely understood biological signaling systems. The present paper explores the evidence for the latter view. We suggest physiological regulatory systems are affected by biofields in a manner that complements the more familiar molecular-based mechanisms, by which regulatory systems respond to endogenous biochemical signals and exogenous pharmacological agents.

We begin our article by describing known and postulated biofields, including how they are generated and which physiological systems may be affected. Next, we consider receptor systems that may detect, integrate, and trigger responses to both biofields and environmental fields. We conclude by identifying areas for future research aimed at clarifying form and function of biofields. Overall, a case will be made that sufficient evidence has accrued to consider biofield physiology as a viable, if nascent-stage, scientific discipline that is likely to expand the current biomedical model of health and disease.

BIOFIELDS: FORM AND FUNCTION

Every region of the body, however superficial or deep, is crisscrossed with well-studied communication and regulatory systems, including neural pathways, blood-borne hormones and exosomes (cell-derived vesicles), and immune surveillance. Yet the existence of fluctuating endogenously generated electromagnetic and other fields, which also suffuse all our cells and comprise an additional rich source of biological information and regulation, remains an underappreciated aspect of physiology.[18,19]

Electrical activity, in the form of charge separation, is a fundamental feature of every living cell. As single cell and multicellular organisms evolved in a primordial sea, the ability to maintain a low-sodium/high-potassium intracellular milieu, in the face of the high-sodium/low-potassium concentrations in sea water, served as a source of energy to enable uptake of metabolites and discharge of waste products across the cell surface. Proteins, evolved to serve as specific ion channels and pumps, maintain this ionic gradient (the "resting potential") between inside and outside of each cell.

But evolution found greater promise for the resting potential than merely as an energy source for ion pumps and crossmembrane transport of molecules. As multicellular organisms evolved, patterns of resting potentials of cells throughout the body became designated as instructive scaffolding to guide pattern formation and stem cell behavior during embryogenesis and organ regeneration.[20-23] For example, endogenous arrays of bioelectric potentials are now known to instruct left-right patterning,[24-26] eye induction,[27] size regulation,[28,29] and patterning during complex organ regeneration.[30-33] New tools allow these bioelectric gradients to be directly observed noninvasively in vivo[34,35] and to be specifically altered to assess effects on intercellular communication and tissue-level or organ-level outcomes.[36,37] Importantly, the molecular mechanisms that couple changes in bioelectric gradient distribution to downstream transcriptional and epigenetic targets are also being characterized.[27,34,36,38,39]

Further, as the advent of multicellular organisms led to increased cellular specialization, muscle and nervous tissue developed mechanisms to turn their resting potentials into high-speed action potentials, propagating along the cell surface with frequencies and other characteristics that encode information.[40] Passage of this information from cell to cell via chemical and electrical synapses expanded the effective area of these electrical fields. Transmembrane currents in neurons also produce local electric fields that induce "ephaptic coupling" (nonsynaptic electrical coupling) between adjacent axons, which influences the synchronization and timing of action potential firing in neurons.[41] As further examples, various types of electrical fields—created by either mechanical stress (piezoelectricity) or streaming potentials—in bone, tendons, skin, and fascia are thought to regulate the functioning of osteocytes and fibroblasts to adjust the density of supporting tissues in response to loads.[42] Also, electric fields generated by the intracellular network of microtubules, centrosomes, and chromosomes appear to play fundamental roles in regulating the dynamics of mitosis, meiosis, and a variety of other cellular activities.[43]

In addition to the high-speed electrical signals conducted along nerve axons, a second communication network, based in ubiquitous epithelial cells, conducts information as slowly varying direct currents.[44,45] The DC fields generated by this system, which spread across considerable distances, play key roles in recognizing damage and guiding cell migration necessary for wound healing (especially in skin, heart, and cornea) as well as in regulating the migration of neuronal path-finding.[46-51] Recent research has identified numerous molecular signaling pathways that mediate the interactions of these bioelectric fields, first described decades ago,[52,53] with the plasma membrane and cytoskeletal mechanisms to facilitate tissue repair.[55-59]

Although the transepithelial DC fields and the gradients of resting membrane potentials (V_{mem}) share functional similarities, the DC fields are produced only by epithelial layers in a relatively standardized form,[60] while V_{mem} are generated by all cells in a wide variety

of patterns.[23,36] A further difference lies in the transduction mechanisms of these systems. The V_{mem} patterns are sensed by a different set of membrane proteins from those that respond to the DC fields.[39,61] Cells use both systems during morphogenesis: the DC fields set directionality of growth and positional information[62-64] and the V_{mem} gradients control differentiation and proliferation and establish anatomical identity of whole regions.[23,28,65]

Since electric charge in motion, whether along a wire or a nerve axon, produces a magnetic field in the surrounding space, this phenomenon represents a further type of biofield. Magnetic fields emanating from the body, although extremely weak relative to the geomagnetic field of the earth, are readily detected by superconducting quantum interference device (SQUID)–based magnetometers.[66] Evidence has recently been summarized that nonthermal electromagnetic fields of amplitude similar to the cardiac field can affect a wide variety of biological functions, including gene expression, particularly in stem cells.[54]

The strongest rhythmic electrical and magnetic fields in the body are produced by synchronous activity of heart muscle cells. While the ECG is readily detected via surface electrodes, the heart's magnetic field can be recorded up to several feet from the body surface as an MCG.[67] Magnetic fields produced by the heart appear to carry information that can also be detected by other persons or animals.[68] An example of the informational potential (bioeffectiveness) of these heart fields is cardiac-induced entrainment, or frequency locking, detected when the R-waves of one subject's ECG become precisely synchronized with the onset of EEG alpha waves of another subject at a distance of up to 5 feet.[69] Heart fields may also encode psychoemotional information, as indicated by the 75% accuracy rate in detecting discrete emotional states from patterns of heart rate variability.[70]

The electrical and magnetic fields generated by the composite activity of thousands of brain cells are detected as an EEG and MEG, respectively. At a functional level, the electromagnetic activity of neural assemblies has been proposed to modulate neuron synchronization[71] and circadian rhythmicity[72] and to underlie the computational and cognitive processes of the brain.[73,74] More specifically, weak sinusoidal electric fields appear to enhance and entrain physiological neocortical network activity.[75] Thus, in a feedback loop, the local fields help to synchronize the neural network that generates them.

Another type of biofield phenomenon is the coherent, ultraweak photon emissions (UPE), detected from cell cultures and from the body surface.[16,76,77] Since the initial observations of UPE or biophotons were detected from inflammation-producing reactive oxygen species, the level of these emissions has been explored as a noninvasive marker of "metabolic stress" and a measure of overall health.[17] More broadly, such UPE, instead of being considered as metabolic epiphenomena, may serve important physiological roles.

A role for ultraweak light signaling in normal physiological regulation is suggested by evidence of intercellular communication under chemically separated but optically coupled in vitro conditions, eg, through a thin glass film.[78-80] These studies have identified infrared as a primitive source of "cellular vision" to guide migration and other behaviors.[78,81] More recently, a role for biophotons in neural activity was based on observations that fluctuations in UPE correlate with cerebral blood flow and cerebral energy metabolism[82] as well as with EEG activity.[83] Moreover, photonic stimulation at one end of a nerve appears to elicit increased UPE at the other end.[84] As a means of information transfer, biophotons have the advantages of extremely high speed and the ability to penetrate into and through cell membranes and organs that present barriers to the diffusion of molecular signals. Nonconventional means of UPE-mediated biosignaling include wave propagation within longitudinally-oriented neuronal microtubules[85] and passage through membrane-spanning regions of proteins that may serve as "light pipes."[86]

Considerations of physiological activity of biofields also include resonance signaling, ie, the modulation of cell function by specific electromagnetic frequencies.[87] Involvement of nonclassical and quantum forms of energy[5,88] (eg, A-fields and scalar waves[89]) has not been explored to the same level of rigorous detail as the bioelectric gradients and fields discussed above, and physiological roles for such phenomena have not yet been demonstrated. (See the article "Biofield Science: Current Physics Perspectives" in this Supplement for a more extensive discussion of nonclassical and quantum forms of energy.)

BIOFIELD RECEPTOR SYSTEMS

A further challenge for framing a physiology of biofields is to identify endogenous receptor systems that detect electromagnetic or other types of fields and trigger responses to these nonmolecular stimuli. While the concept of receptor brings to mind the conformational matching invoked to characterize receptor-mediated responses to hormones and drugs, biofield reception may be better described by phenomena from physics, such as resonance and impedance matching, based on tuning to signal frequencies. As previously proposed, 3 overlapping categories of biofield receptors can be considered: molecular-level receptors, charge flux sites, and endogenously generated electric or electromagnetic fields.[90,91]

An important series of studies on cultured cells identified 2 examples of the first type of receptor sites—deoxyribonucleic acid (DNA) and the cell membrane—at which exogenous electromagnetic signals exert specific biological effects.[92,93] Just as steroid hormones upregulate transcription of particular genes by binding to hormone response elements of DNA, so do low-frequency (<300 Hz) electromagnetic fields appear

to increase transcription of select genes by acting at upstream regions of DNA designated as electromagnetic response elements (EMRE).[94] Deletion of the EMRE eliminates the ability of the applied electromagnetic field to regulate the target genes, while other genes can be converted from electromagnetic nonresponders to responders by inserting the EMRE at upstream regions. Similar electromagnetic fields, as demonstrated by the same researchers, appear to increase the activity of several membrane-bound enzymes.[93]

Charge flux sites, the second type of receptor as exemplified by the perturbation of transmembrane calcium fluxes, have been proposed as a generic mechanism by which weak electromagnetic fields affect biological systems.[95,96] If voltage sensitivity of calcium ion (Ca^{2+}) channels facilitates the targeting of these sites by electromagnetic fields, voltage-modulated channels for other ions should also be tested as potential target sites. Low-frequency electromagnetic fields have also been proposed to interact with DNA by accelerating the movement of electrons within the helical arrays of base pairs.[97] Changes in charge separation in small DNA regions occur during aggregation, so that interactions may be more pronounced in specific active segments of DNA.[93]

While ion channels and ion pumps have major roles in establishing the resting potential of an individual cell, it is gap junctions, the specialized electrical connections between adjacent cells, that allow voltage and current-mediated signals to be propagated across groups of cells.[98] In this manner, spatiotemporal patterns of resting potentials arise to provide bioelectrical guidance during tissue development, regeneration, and cancer suppression.[20,23,99] Although it is not yet apparent that applied weak electromagnetic fields can alter resting potentials, let alone affect multicellular patterns of membrane voltage, applied weak electrical currents do appear to induce regeneration of adult frog limbs. These exogenously applied currents are comparable in direction and density to the outward electrical currents detected from regenerating amphibian limbs, and it is possible that some of the reported effects of applied electromagnetic fields are due to modification of endogenous bioelectric gradients.[15,100]

A final candidate for a receptor system for endogenous and exogenous biofields is a body-wide network that appears to exhibit all 3 types of potential receptor sites: molecular, charge flux, and endogenous field. Unspecialized "loose" connective tissue, often referred to as fascia, forms a continuous head to toe network surrounding and permeating all tissues and organs.[101] As an extracellular matrix, structured mainly by collagen fibers, fascia provides a supportive and regulatory framework for all organs of the body as it coordinates cellular perception and interpretation of mechanical forces. This extracellular system reaches into the interior of cells via transmembrane bridging molecules known as integrins, which allow information from the fascia to modify cell metabolism and genetic activity.[102] Speculation on the nature of such collagen-signaling focuses on water molecules hydrogen-bonded along the outer shell of the collagen triple helix, oriented in a manner that supports the rapid jump conduction of protons along the length of the collagen fibers.[103,104] Since collagen structures both conduct and modify photon pulses emitted from biological sources,[104] it is conceivable that signaling along collagen fibers serves as a surveillance system of endogenous biofield emission to complement the immune and nervous systems in monitoring tissue health.

Further speculation based on the water-protein relationship along collagen fibers invokes quantum coherence, a state that can occur when all water molecules in a particular domain or region are spinning synchronously, emitting spin or torsion waves. Such spin coherence and quantum coherence enable the collagen matrix to be ultrasensitive to electromagnetic fields in a manner that can be frequency selective due to a quantum phenomenon known as the Larmor Precession.[105,106] This effect, resulting from the torque of an external magnetic field exerted on the spin of subatomic particles, is the basis of magnetic resonance imaging (MRI).[107]

Known sensitivities of organisms to extremely small environmental cues, including visible light and electromagnetic fields, merit consideration in this overview of biofield receptors.[108] These sensitivities—which evolved, for example, to locate prey, avoid predators, navigate, and sense changing weather patterns—often operate at or near limits set by physics. An exemplar is the ability of the retina to detect a single photon of light,[109] which occurs via calcium channel–mediated signal amplification and allows thousands of calcium ions enter a retinal rod in response to an individual photon.[110] The public health debate concerning potentially harmful effects of electromagnetic fields was influenced for decades by the conventional physics doctrine that living systems could only be affected by energy strong enough to cause ionization or heating of tissues. In contrast, evidence that very weak, nonionizing electromagnetic fields exert biological effects is well documented,[96,111] and the history of the shift away from the thermal model has been chronicled.[112] Finally, German researchers have demonstrated that individual molecules can act as transmitting and receiving antennae in the mediation of efficient intermolecular communication via single photons.[113]

CONCLUSIONS

Sufficient evidence has accrued to consider biofield physiology as a viable scientific discipline, based on nonlocal, integrated, information-conveying phenomena as well as on emerging molecular details of localized biophysical interactions. Endogenously generated pulses of ultraweak photons, electromagnetic fields directly related to cardiac activity, and patterns of distributed membrane voltage are varied forms of physiological activity designated as biofields, each with established properties and proposed biological

functions. Several receptor systems have been identified that mediate responses to these biofields. By analogy with the hormones, receptors, and regulatory functions that comprise endocrinology, components of the biofield physiology framework are in place.

In seeking to define biofield physiology as an area of research, it is helpful to distinguish it from the existing discipline of bioelectromagnetics and to consider the 2 approaches as different phases of a continuum. If bioelectromagnetics is more about defining mechanisms of local interactions, then biofield physiology is more about understanding the integrated, longer-range functions within the whole organism: the former more reductive, the latter more integrative.

Biofield physiology is still at an early stage of formation. While it is incontrovertible that biological systems emit and react to a wide range of energetic influences, we have not achieved a detailed understanding or mathematical modeling of the essential field aspect of such interactions (a prerequisite for exploiting their long-range organizing properties). Moreover, many of the experimental findings are preliminary, while the biofields studied are varied in form and cannot yet be considered as interrelated representatives of a clearly defined system of biological self-regulation. Further, much of the research appears guided by existing paradigms of biochemistry and physiology. As one example, evidence of DNA response elements that respond to specific electromagnetic frequencies, analogous to DNA regions responsive to specific hormones, is an important finding. However, biofields may also act in a more dispersive, nonspecific manner to activate self-regulatory systems that, in turn, stimulate surveillance to detect the source of tissue imbalance or disease. As future research is likely to reveal, such imbalances may be understood via models based on either molecular-level or biofield-level dysfunction, a perspective that will further expand diagnostics, treatment options, and our concepts of physiology.

DIRECTIONS FOR FUTURE RESEARCH

Interrelation of Endogenous Biofields With Major Physiological Systems

While there is broad acceptance that the nervous, endocrine, immune, and cardiovascular systems are in continuous intercommunication via electrical and molecular signals,[114] the possibility must also be considered that endogenous biofields act as carriers of information between these systems. An exemplar is heart-brain interaction, where several types of cardiac-initiated signals appear to exert sequential effects on brain activity. Electromagnetic signals from the heart reach the brain in a relatively instantaneous manner, followed first by a range of neural signals arriving in millisecond timeframes and subsequently by pressure waves and hormonal signals arriving with delays of seconds.[68] In general, different types of signals mediate rapid/short-acting vs slower/longer-lasting responses, eg, neurally-released adrenaline and hormonally released corticosteroids, respectively, coordinate the stress response. Physiological requirements for ultrarapid responses may be met by biofields. As research continues to identify physiological roles of endogenous biofields, a wider lens should be used to examine whether and how biofields may have intersystem integrative roles in physiological regulation.

Relation of Biofield-mediated Physiological Changes to Health and Healing

In regard to human health, biofield research has taken 2 broad directions aimed at establishing salutary and detrimental effects of biofields and biofield therapies. Caution is recommended regarding attempts to draw correlations between biofields and health based on present data. For example, a recent review of biophoton detection as a potential noninvasive means of health assessment stresses the need for standardization of devices and conditions used to monitor this UPE.[17] Epidemiological assessments of adverse effects of ambient electromagnetic fields face critiques common to such long-term correlational studies. Future research on biofields and health needs to include state-of-the-science physiological endpoints that best reflect clinical conditions. Such research will benefit from advances in "calibrating" biofield therapy practitioners and biofield devices as well as from improved methodology for designing and implementing appropriate controls.

At the Frontier

Many of the hypotheses gathered for this paper are, at present, at the leading edge of speculation, but they are offered with confidence that emerging technologies will eventually be able to either validate or refute them. As an instructive example, Pienta and Coffey stated in 1991 that "Cells and intracellular elements are capable of vibrating in a dynamic manner with complex harmonics, the frequency of which can now be measured and analyzed in a quantitative manner by Fourier analysis."[115] In the decades since that statement, other technologies have been developed to characterize ultrafast activities in the molecular fabric of the fascia or living matrix and/or ground regulation systems[102,116] and "wetware."[117]

As a final thought, new insights into the properties of water[118] and applications of quantum field theory[119] will undoubtedly contribute to a deeper understanding of the relationships between biofields and molecular dynamics. Raman and infrared spectroscopic techniques are now enabling rapid and sensitive chemical characterization of samples based strictly on the vibrational signatures of the molecules present in a sampling volume. When applied to biological systems, the techniques provide highly complex spectra that document changes taking place in the entire genome, proteome, and metabolome; real time in-vivo applications are possible. The January 2013 issue of the *Journal of Photonics* was devoted to the most recent developments, with commentary on possible future directions.

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REFERENCES

1. Reichlin S. Neuroendocrinology. N Engl J Med. 1963;269:1182-91, 1246-50, 1296-1303.
2. Ader R. Psychoneuroimmunology. 1st ed. New York: Elsevier Academic Press; 1981.
3. Gazzaniga M. The cognitive neurosciences. Cambridge, MA: Massachusetts Institute of Technology Press; 2000.
4. Rubik B. The biofield hypothesis: its biophysical basis and role in medicine. J Altern Complement Med. 2002 Dec;8(6):703-17.
5. Rein G. Bioinformation within the biofield: beyond bioelectromagnetics. J Altern Complement Med. 2004 Feb;10(1):59-68.
6. Ho MW. The rainbow and the worm: The physics of organisms. 3rd ed. Singapore: World Scientific Publishing; 2008.
7. Burch J, Reif J, Yost M. Geomagnetic activity and human melatonin metabolite excretion. Neurosci Lett. 2008;438(1):76-9.
8. Liboff AR. A role for the geomagnetic field in cell regulation. Electromagn Biol Med. 2010;29(3):105-12.
9. Blackman CF, Blanchard JP, Benane SG, House DE, Elder JA. Double blind test of magnetic field effects on neurite outgrowth. Bioelectromagnetics. 1998;19(4):204-9.
10. Eder SH, Cadiou H, Muhamad A, McNaughton PA, Kirschvink JL, Winklhofer M. Magnetic characterization of isolated candidate vertebrate magnetoreceptor cells. Proc Natl Acad Sci U S A. 2012;109(30):12022-7.
11. Wiltschko R, Wiltschko W. Sensing magnetic directions in birds: radical pair processes involving cryptochrome. Biosensors. 2014;4(3):221-42..
12. Shibib K, Brock M, Gosztonyi G, Erne S, Hahlbohm H, Schoknecht G. The geomagnetic field: a factor in cellular interactions? I. Magnetism and Schwann cell-axon interaction in the peripheral nerves of the newborn rat. Neurol Res. 1987;9(4):225-35.
13. Griffin XL, Costa ML, Parsons N, Smith N. Electromagnetic field stimulation for treating delayed union or non-union of long bone fractures in adults. Cochrane Database Syst Rev. 2011;(4):CD008471.
14. Markov MS. Expanding use of pulsed electromagnetic field therapies. Electromagn Biol Med. 2007;26(3):257-74.
15. Funk R, Monsees T, Ozkucur N. Electromagnetic effects—From cell biology to medicine. Prog Histochem Cytochem. 2009;43(4):177-264.
16. Van Wijk R, Schamhart D. Regulatory aspects of low intensity photon emission. Experientia. 1988;44(7):586-93.
17. Ives J, van Wijk E, Bat N, et al. Ultraweak photon emission as a non-invasive health assessment: a systematic review. PLoS One. 2014;9(2):e87401. doi:10.1371/journal.pone.0087401.
18. Cifra M, Fields J, Farhadi A. Electromagnetic cellular interactions. Prog Biophys Mol Biol. 2011;105(3):223-46.
19. Rossi C, Foletti A, Magnani A, Lamponi S. New perspectives in cell communication: Bioelectromagnetic interactions. Semin Cancer Biol. 2011;21(3):207-14.
20. Levin M. Endogenous bioelectrical networks store non-genetic patterning information during development and regeneration. J Physiol. 2014;592(Pt 11):2295-305.
21. Lan J, Williams C, Levin M, Black L 3rd. Depolarization of cellular resting membrane potential promotes neonatal cardiomyocyte proliferation in vitro. Cell Mol Bioeng. 2014;7(3):432-45.
22. Sundelacruz S, Levin M, Kaplan D. Depolarization alters phenotype, maintains plasticity of predifferentiated mesenchymal stem cells. Tissue Eng Part A. 2013;19(17-18):1889-908.
23. Tseng A, Levin M. Cracking the bioelectric code: Probing endogenous ionic controls of pattern formation. Commun Integr Biol. 2013;6(1):e22595.
24. Adams D, Robinson K, Fukumoto T, et al. Early, H+-V-ATPase-dependent proton flux is necessary for consistent left-right patterning of non-mammalian vertebrates. Development. 2006;133(9):1657-71.
25. Levin M, Thorlin T, Robinson K, Nogi T, Mercola M. Asymmetries in H+/K+-ATPase and cell membrane potentials comprise a very early step in left-right patterning. Cell. 2002;111(1):77-89.
26. Morokuma J, Blackiston D, Levin M. KCNQ1 and KCNE1 K+ channel components are involved in early left-right patterning in *Xenopus laevis* embryos. Cell Physiol Biochem. 2008;21(5-6):357-72.
27. Pai V, Aw S, Shomrat T, Lemire J, Levin M. Transmembrane voltage potential controls embryonic eye patterning in *Xenopus laevis*. Development. 2012;139(2):313-23.
28. Beane W, Morokuma J, Lemire J, Levin M. Bioelectric signaling regulates head and organ size during planarian regeneration. Development. 2013;140(2):313-22.
29. Perathoner S, Daane J, Henrion U, et al. Bioelectric signaling regulates size in zebrafish fins. PLoS Genet. 2014;10(1):e1004080.
30. Adams D, Masi A, Levin M. H+ pump-dependent changes in membrane voltage are an early mechanism necessary and sufficient to induce Xenopus tail regeneration. Development. 2007;134(7):1323-35.
31. Adams D, Tseng A, Levin M. Light-activation of the Archaerhodopsin H(+)-pump reverses age-dependent loss of vertebrate regeneration: sparking system-level controls in vivo. Biol Open. 2013;2(3):306-13.
32. Monteiro J, Aires R, Becker J, Jacinto A, Certal A, Rodríguez-León J. V-ATPase proton pumping activity is required for adult zebrafish appendage regeneration. PLoS One. 2014;9(3):e92594.
33. Tseng A, Beane W, Lemire J, Masi A, Levin M. Induction of vertebrate regeneration by a transient sodium current. J Neurosci. 2010;30(39):13192-200.
34. Adams D, Levin M. Measuring resting membrane potential using the fluorescent voltage reporters DiBAC4(3) and CC2-DMPE. Cold Spring Harb Protoc. 2012(4):459-64.
35. Adams D, Levin M. General principles for measuring resting membrane potential and ion concentration using fluorescent bioelectricity reporters. Cold Spring Harb Protoc. 2012(4):385-37.
36. Adams D, Levin M. Endogenous voltage gradients as mediators of cell-cell communication: strategies for investigating bioelectrical signals during pattern formation. Cell Tissue Res. 2013;352(1):95-122.
37. Levin M, Stevenson C. Regulation of cell behavior and tissue patterning by bioelectrical signals: challenges and opportunities for biomedical engineering. Annu Rev Biomed Eng. 2012;14:295-323.
38. Chernet B, Levin M. Transmembrane voltage potential is an essential cellular parameter for the detection and control of tumor development in a Xenopus model. Dis Model Mech. 2013;6(3):595-607.
39. Tseng A, Levin M. Transducing bioelectric signals into epigenetic pathways during tadpole tail regeneration. Anat Rec (Hoboken). 2012;295(10):1541-51.
40. Gerstner W, Kreiter A, Markram H, Herz A. Neural codes: firing rates and beyond. Proc Natl Acad Sci U S A. 1997;94(24):12740-1.
41. Jefferys J. Nonsynaptic modulation of neuronal activity in the brain: electric currents and extracellular ions. Physiol Rev. 1995;75(4):689-723.
42. Ahn A, Grodzinsky A. Relevance of collagen piezoelectricity to "Wolff's Law": a critical review. Med Eng Phys. 2009;31(7):733-41.
43. Zhao Y, Zhan Q. Electric fields generated by synchronized oscillations of microtubules, centrosomes and chromosomes regulate the dynamics of mitosis and meiosis. Theor Biol Med Model. 2012 Jul 2;9:26.
44. Nuccitelli R. Endogenous ionic currents and DC electric fields in multicellular animal tissues. Bioelectromagnetics. 1992;Suppl 1:147-57.
45. Robinson K, Messerli M. Electric embryos: the embryonic epithelium as a generator of developmental information. In: McCaig C, ed. Nerve growth and guidance. Portland: Portland Press; 1996:131-41.
46. McCaig C, Song B, Rajnicek A. Electrical dimensions in cell science. J Cell Sci. 2009;122(Pt 23):4267-76.
47. Reid B, Song B, McCaig C, Zhao M. Wound healing in rat cornea: the role of electric currents. FASEB J. 2005;19(3):379-86.
48. Wang E, Zhao M. Regulation of tissue repair and regeneration by electric fields. Chin J Traumatol. 2010;13(1):55-61.
49. Yao L, Shanley L, McCaig C, Zhao M. Small applied electric fields guide migration of hippocampal neurons. J Cell Physiol. 2008;216(2):527-35.
50. Zhao M, Forrester J, McCaig C. A small, physiological electric field orients cell division. Proc Natl Acad Sci. 1999;96(9):4942-6.
51. Guo A, Song B, Reid B, et al. Effects of physiological electric fields on migration of human dermal fibroblasts. J Invest Dermatol. 2010;130(9):2320-7.
52. Burr HS. An electro-dynamic theory of development suggested by studies of proliferation rates in the brain of Amblystoma. J Comp Neurol. 1932;56:347-71.
53. Nordenström B. Impact of biologically closed electric circuits (BCEC) on structure and function. Integr Physiol Behav Sci. 1992;27(4):285-303.
54. Muehsam D, Ventura C. Life rhythm as a symphony of oscillatory patterns: electromagnetic energy and sound vibration modulates gene expression for biological signaling and healing. Global Adv Health Med. 2014;3(2):40-55.
55. Cao L, Graue-Hernandez E, Tran V, et al. Downregulation of PTEN at corneal wound sites accelerates wound healing through increased cell migration. Invest Ophthalmol Vis Sci. 2011;52(5):2272-8.
56. Cao L, McCaig C, Scott R, et al. Polarizing intestinal epithelial cells electrically through Ror2. J Cell Sci. 2014;127(Pt 15):3233-9.
57. Cao L, Pu J, Zhao M, Cao L, Pu J ZM. GSK-3β is essential for physiological electric field-directed Golgi polarization and optimal electrotaxis. Cell Mol Life Sci. 2011;68(18):3081-93.
58. Pullar C, Zhao M, Song B, et al. Beta-adrenergic receptor agonists delay while antagonists accelerate epithelial wound healing: evidence of an endogenous adrenergic network within the corneal epithelium. J Cell Physiol. 2007;211(1):261-72.
59. Zhao M, Song B, Pu J, et al. Electrical signals control wound healing through phosphatidylinositol-3-OH kinase-gamma and PTEN. Nature. 2006;442(7101):457-60.
60. McCaig C, Rajnicek A, Song B, Zhao M. Controlling cell behavior electrically: current views and future potential. Physiol Rev. 2005;85(3):943-78.
61. Levin M. Molecular bioelectricity in developmental biology: new tools and

recent discoveries: control of cell behavior and pattern formation by transmembrane potential gradients. Bioessays. 2012;34(3):205-17.
62. Yao L, Pandit A, Yao S, McCaig C. Electric field-guided neuron migration: a novel approach in neurogenesis. Tissue Eng Part B Rev. 2011;17(3):143-53.
63. Zhao M. Electrical fields in wound healing—An overriding signal that directs cell migration. Semin Cell Dev Biol. 2009;20(6):674-82.
64. Chifflet S, Hernández J, Grasso S. A possible role for membrane depolarization in epithelial wound healing. Am J Physiol Cell Physiol. 2005;288(6):C1420-30.
65. Sundelacruz S, Li C, Choi Y, Levin M, Kaplan D. Bioelectric modulation of wound healing in a 3D in vitro model of tissue-engineered bone. Biomaterials. 2013;34(28):6695-705.
66. Lewis M. Biomagnetism: a new tool in sport and exercise science. J Sport Sci. 2003;21(10):793-802.
67. Steinhoff U, Schnabel A, Burghoff M, et al. Spatial distribution of cardiac magnetic vector fields acquired from 3120 SQUID positions. Neurol Clin Neurophysiol. 2004 Nov 30;2004:59.
68. McCraty R, Atkinson M, Tomasino D, Bradley R. The coherent heart, heart–brain interactions, psychophysiological coherence, and the emergence of system-wide order. Integr Rev. 2009;5(2):10-115.
69. McCraty R. The energetic heart: Bioelectromagnetic communication within and between people. In: Rosch P, Markov M, eds. Bioelectromagnetic Medicine. New York: Marcel Dekker; 2004:541-62.
70. Leon E, Clarke G, Callaghan V, Doctor F. Affect-aware behaviour modelling and control inside an intelligent environment. Pervas Mobile Comput. 2010;6(5):559-74.
71. Lestienne R. Spike timing, synchronization and information processing on the sensory side of the central nervous system. Prog Neurobiol. 2001;65(6):545-91.
72. Cajochen C, Wyatt J, Czeisler C, Dijk D. Separation of circadian and wake duration-dependent modulation of EEG activation during wakefulness. Neuroscience. 2002;114:1047-60.
73. Aur D. A comparative analysis of integrating visual information in local neuronal ensembles. J Neurosci Methods. 2012;207(1):23-30.
74. Aur D, Jog M, Poznanski R. Computing by physical interaction in neurons. J Integr Neurosci. 2011;10(4):413-22.
75. Fröhlich F, McCormick D. Endogenous electric fields may guide neocortical network activity. Neuron. 2010;67(1):129-43.
76. Popp F, Nagl W, Li K, Scholz W, Weingartner O, Wolf R. Biophoton emission. New evidence for coherence and DNA as source. Cell Biphys. 1984;6(1):33-52.
77. Rubik B. Natural light from organisms: What, if anything, can it tell us? Noetic Sci Rev. 1993 Summer;26:10.
78. Albrecht-Buehler G. Rudimentary form of cellular "vision." Proc Natl Acad Sci U S A. 1992;89(17):8288-92.
79. Shen X, Mei W, Xu X. Activation of neutrophils by a chemically separated but optically coupled neutrophil population undergoing respiratory burst. Experientia. 1994;50(10):963-8.
80. Scholkmann F, Fels D, Cifra M. Non-chemical and non-contact cell-to-cell communication: a short review. Am J Transl Res. 2013;5(6):586-93.
81. Albrecht-Buehler G. A long-range attraction between aggregating 3T3 cells mediated by near-infrared light scattering. Proc Natl Acad Sci U S A. 2005;102(14):5050-5.
82. Kobayashi M, Takeda M, Sato T, et al. In vivo imaging of spontaneous ultraweak photon emission from a rat's brain correlated with cerebral energy metabolism and oxidative stress. Neurosci Res. 1999;34(2):103-13.
83. Van Wijk R, Bosman S, Ackerman J, Van Wijk E. Correlation between fluctuations in human ultra-weak photon emission and EEG alpha rhythm. Neuroquantology. 2008;6(4):452-63.
84. Sun Y, Wang C, Dai J. Biophotons as neural communication signals demonstrated by in situ biophoton autography. Photochem Photobiol Sci. 2010;9(3):315-22. doi:10.1039/b9pp00125e.
85. Rahnama M, Tuszynski JA, Bókkon I, Cifra M, Sardar P, Salari V. Emission of mitochondrial biophotons and their effect on electrical activity of membrane via microtubules. J Integr Neurosci. 2011;10(1):65-88.
86. Oschman J, Oschman N. Vortical structure of light and space: biological implications. J Vortex Sci Technol. 2015;2:1-3.
87. Foletti A, Grimaldi S, Lisi A, Ledda M, Liboff AR. Bioelectromagnetic medicine: the role of resonance signaling. Electromagn Biol Med. 2013;32(4):484-99.
88. Tiller W. What are subtle energies? J Sci Explor. 1993;7(3):293-304.
89. Swanson C. The torsion field and the aura. Subtle Ener Ener Med. 2008;19(3):43-89.
90. Hintz KJ, Yount GL, Kadar I, Schwartz G, Hammerschlag R, Lin S. Bioenergy definitions and research guidelines. Altern Ther Health Med. 2003;9(3 Suppl):A13-30.
91. Movaffaghi Z, Farsi M. Biofield therapies: biophysical basis and biological regulations? Complement Ther Clin Pract. 2009;15(1):35-7.
92. Blank M, Goodman R. Initial interactions in electromagnetic field-induced biosynthesis. J Cell Physiol. 2004;199(3):359-63.
93. Blank M. Protein and DNA reactions stimulated by electromagnetic fields. Electromagn Biol Med. 2008;27(1):3-23.
94. Lin H, Blank M, Rossol-Haseroth K, Goodman R. Regulating genes with electromagnetic response elements. J Cell Biochem. 2001;81(1):143-8.
95. McLeod K. The role of cell and tissue calcium in transducing the effects of exposure to low-frequency electromagnetic fields. In: Blank M, ed. Electromagnetic fields: Biological interactions and mechanisms. Washington, DC: American Chemical Society; 1995:349-65.
96. Pall M. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. J Cell Mol Med. 2013;17(8):958-65.
97. Meyl K. DNA and cell resonance: magnetic waves enable cell communication. DNA Cell Biol. 2012;31(4):422-4.
98. Jamora C, Fuchs E. Intercellular adhesion, signalling and the cytoskeleton. Nat Cell Biol. 2002;4(4):E101-8.
99. Yang M, Brackenbury W. Membrane potential and cancer progression. Front Physiol. 2013 Jul 17;4:185.
100. Shupak NM. Therapeutic uses of pulsed magnetic-field exposure: A review. Radio Sci Bull. 2003 Dec;307:9-32.
101. Langevin HM. Connective tissue: a body-wide signaling network? Med Hypotheses. 2006;66(6):1074-7.
102. Oschman JL. Energy medicine in therapeutics and human performance. Edinburgh: Elsevier; 2003.
103. Ho MW, Knight D. The acupuncture system and the liquid crystalline collagen fibers of the connective tissues. Am J Chin Med. 1998;26(3-4):251-63.
104. Van Wijk R, van der Greef J, van Wijk E. Human ultraweak photon emission and the yin yang concept of Chinese medicine. J Acupunct Meridian Stud. 2010;3(4):221-31.
105. Oschman JL. Functional role of quantum coherence in interfacial water. Paper presented at: Water Conference 2013; Sofia, Bulgaria, October 22-25, 2013.
106. Muehsam DJ, Pilla AA. A Lorentz model for weak magnetic field bioeffects. Bioelectromagnetics. 2009;30(6):462-88.
107. Akber SF. The physics of NMR tomography. Nuklearmedizin. 1986;25(1):33-8.
108. Bialek W. Physical limits to sensation and perception. Annu Rev Biophys Biophys Chem. 1987;16:455-78.
109. Baylor DA, Lamb TD, Yau KW. Response of retinal rods to single photons. J Physiol. 1979 Mar;288:613-34.
110. Stryer L. Molecular design of an amplification cascade in vision. Biopolymers. 1985;24(1):29-47.
111. Sage C, Carpenter D. Public health implications of wireless technologies. Pathophysiology. 2009;16(2-3):233-46.
112. Oschman JL. Energy and the healing response. J Bodyw Mov Ther. 2005;9(1):3-15.
113. Lee KG, Chen XW, Eghlidi H, et al. A planar dielectric antenna for directional single-photon emission and near unity collection efficiency. Nat Photon. 2011;5:166-69.
114. Irwin MR. Human psychoneuroimmunology: 20 years of discovery. Brain Behav Immun. 2008;22(2):129-39.
115. Pienta KJ, Coffey DS. Cellular harmonic information transfer through a tissue tensegrity-matrix system. Med Hypotheses. 1991;34(1):88-95.
116. Pischinger A. The extracellular matrix and ground regulation: basis for a holistic biological medicine. Berkeley, CA: North Atlantic Books; 2007.
117. Bray D. Wetware: a computer in every cell. New Haven, CT: Yale University Press; 2009.
118. Pollack GH. The fourth phase of water: beyond solid, liquid, and vapor. Seattle, WA: Ebner & Sons; 2013.
119. Bischof M, Del Giudice E. Communication and the emergence of collective behavior in living organisms: a quantum approach. Mol Biol Int. 2013;2013:987549.

ORIGINAL ARTICLE

An Overview of Biofield Devices

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ABSTRACT

Advances in biophysics, biology, functional genomics, neuroscience, psychology, psychoneuroimmunology, and other fields suggest the existence of a subtle system of "biofield" interactions that organize biological processes from the subatomic, atomic, molecular, cellular, and organismic to the interpersonal and cosmic levels. Biofield interactions may bring about regulation of biochemical, cellular, and neurological processes through means related to electromagnetism, quantum fields, and perhaps other means of modulating biological activity and information flow. The biofield paradigm, in contrast to a reductionist, chemistry-centered viewpoint, emphasizes the informational content of biological processes; biofield interactions are thought to operate in part via low-energy or "subtle" processes such as weak, nonthermal electromagnetic fields (EMFs) or processes potentially related to consciousness and nonlocality. Biofield interactions may also operate through or be reflected in more well-understood informational processes found in electroencephalographic (EEG) and electrocardiographic (ECG) data. Recent advances have led to the development of a wide variety of therapeutic and diagnostic biofield devices, defined as physical instruments best understood from the viewpoint of a biofield paradigm. Here, we provide a broad overview of biofield devices, with emphasis on those devices for which solid, peer-reviewed evidence exists. A subset of these devices, such as those based upon EEG- and ECG-based heart rate variability, function via mechanisms that are well understood and are widely employed in clinical settings. Other device modalities, such a gas discharge visualization and biophoton emission, appear to operate through incompletely understood mechanisms and have unclear clinical significance. Device modes of operation include EMF-light, EMF-heat, EMF-nonthermal, electrical current, vibration and sound, physical and mechanical, intentionality and nonlocality, gas and plasma, and other (mode of operation not well-understood). Methodological issues in device development and interfaces for future interdisciplinary research are discussed. Devices play prominent cultural and scientific roles in our society, and it is likely that device technologies will be one of the most influential access points for the furthering of biofield research and the dissemination of biofield concepts. This developing field of study presents new areas of research that have many important implications for both basic science and clinical medicine.

INTRODUCTION

Developments in several fields of research, including biophysics, biology, functional genomics, metabolomics, neuroscience, psychology, and psychoneuroimmunology have advanced our understanding of the interrelatedness of these disciplines from the level of basic biological processes to a dynamic systems or "biofield" level. These recent advances have also shown that emotional states, intention, stress, and other psychosocial factors can significantly affect biological function and health outcomes.[1-7] Molecular, cellular, and organismic function and regulation are thus interwoven with and can be influenced by emotion, cognition, and psychosocial factors, suggesting the existence of a "subtle"—ie, low-energy system of biofield—interactions connecting these activities.

Here, we define the term *biofield* as "an organizing principle for the dynamic information flow that regulates biological function and homeostasis." Biofield interactions can organize spatiotemporal biological processes across hierarchical subtle and gross levels: from the subatomic, atomic, molecular, cellular, and organismic to the interpersonal and cosmic levels. As such, biofield interactions can influence and be influenced by a variety of biological pathways, including biochemical, cellular, and neurological processes related to electromagnetism, correlated quantum information flow, and perhaps other means for modulating activity and information flow across multiple levels of biology.

Biofield devices comprise physical instruments that may be most clearly understood from the viewpoint of a biofield paradigm, and a large and diverse number of devices have been developed to measure or manipulate biofield interactions. These include both diagnostic devices (to measure biofield properties) and therapeutic devices (to manipulate biofield interactions). The study of biofield devices is at a nascent stage of development, and much further research is needed to determine clinical efficacy and elucidate the underlying mechanisms of action for many of the devices mentioned here. Thus the purpose of this work is to provide an overview of those

devices that we judge to be promising enough to warrant further investigation rather than to provide a critical review. We believe a critical review is warranted but out of the scope of this paper.

The biofield devices summarized here operate through a variety of modalities rather than a single mechanism. Some biofield devices function through well-understood mechanisms and are already widely used in clinical settings: for example, electroencephalography (EEG)- and electrocardiography (ECG)-based heart rate variability (HRV). Other devices appear to operate through mechanisms that are novel or incompletely understood. However, all of these devices share a common property: rather than functioning primarily in a reductionist, chemistry-centered manner, biofield devices function via the informational content of biological processes and can interact via low-energy or "subtle" processes, including those potentially related to consciousness and nonlocality.[8,9]

BIOFIELD DEVICES

Here we provide a brief overview of the broad categories of biofield devices, with the goal being to stimulate further discussion and research. It is out of the scope of this overview to assess the efficacy of particular devices. Rather, we describe those devices for which we deemed that sufficient evidence exists to warrant mention. In order to manage this task in a manuscript of reasonable length, we chose to focus upon devices for which peer-reviewed scientific reports suggesting efficacy are available rather than conference proceedings or manufacturers' white papers. However, in the few cases that specific devices with sufficient promise and relevance lacked a peer-reviewed basis, we have presented whatever evidence was available. Here, devices are organized according to mode of operation and these modalities include electromagnetic field (EMF)-light, EMF-heat, EMF-nonthermal, electrical current, vibration and sound, physical and mechanical, intentionality and nonlocality, gas and plasma, and other (mode of operation not well understood).

Modalities Using Electromagnetic Fields: Light

One line of research that has yielded a large amount of information on biofield activity is the study of biophoton emission (BE), also called ultraweak photon emission. BE is the spontaneous emission of light which emanates from all living organisms, including humans.[10] Several studies have reported intercellular BE signaling,[11] and it has been suggested that such signaling by coherent biophotons could explain many regulatory functions,[12] including cellular orientation detection,[13] biophoton-regulation of neurotransmitter release,[14] leukocyte respiratory activity,[15] and enhanced seed germination.[16] A systematic review has suggested that detection of BE may be useful as a medical diagnostic approach and as a research tool.[17]

The body also exhibits sensitivity to exogenous light exposure, and numerous phototherapies use visible light to treat seasonal affective disorder,[18] vitamin D deficiency,[19] and a variety of skin conditions.[20-24] Infrared light has been used therapeutically for wound[25] and bone[26] repair. Laser therapy (LT) is another form of phototherapy that is now employed for a wide variety of clinical applications.[27] Low-level laser therapy (LLLT), which acts without ablating tissue, has been extensively studied, producing a growing body of systematic reviews supporting efficacy of LLLT for several pathologies[27] including skeletal muscle repair,[28] tendinopathy,[29] rheumatoid arthritis,[30] osteoarthritis,[31] neck pain,[32] chronic joint disorders,[33] and traumatic brain injury.[34] Nonthermal LLLT appears to involve cytochrome c oxidase as the photoacceptor,[35] further elucidating one instance in which the informational content of subtle low-energy light-signaling may be more important than the physical energy of the input signal.

Modalities Using Electromagnetic Fields: Heat

Devices using infrared thermography (IRT), also called infrared thermal imaging, can detect small changes in temperature due to muscular and metabolic activity, subcutaneous blood flow, and patterns of perspiration in specific parts of the body.[36] Because of its high sensitivity, IRT can be used for a broad range of applications,[37] including assessment of fever, complex regional pain syndrome, Raynaud's phenomenon, and cardiovascular disease. Although there is controversy regarding efficacy and clinical use, IRT has also been studied for the detection of temperature changes due to inflammatory diseases and a variety of other syndromes,[38] including breast cancer[39,40] and vascular dysfunction.[41] IRT can provide real-time clinical data on functional metabolism without the use of radioactive dyes to identify lymphatic congestion and lymph involvement in angiogenesis related to malignancies.[42] Other applications of IRT have been useful in relation to angiology, allergology, rheumatology, plastic surgery,[43] dermatology, orthopedics, diagnosis of circulatory abnormalities,[44] and veterinary medicine.[37] With respect to biofield and mind-body studies, IRT can be used as a tool to assess psychophysiological activity,[45] affective states in social situations,[36,45] and diagnostic techniques related to traditional Chinese medicine (TCM).[46] IRT may be viewed as both a subtle and gross measuring device.

Modalities Using Electromagnetic Fields: Nonthermal

EMF interactions and electric currents, primarily created by ions within the body, are essential for a variety of critical biological functions, including regulation of ion transport, maintenance of membrane electrical potential, nervous system activity, cytoskeletal transport, coordination of cell migration, embryonic development, and wound healing.[47,48] Recent studies have also shown that processes regulating the dynamics of mitosis, meiosis, and a variety of other processes are governed by electric fields generated within the intracellular network of microtubules, centrosomes, chromosomes,[48-50] and nuclear chromatin.[51] Also, EMF

signaling in neuronal microtubules has been suggested as a substrate for cognition[50] and as a source of observed EEG correlates of consciousness,[52] suggesting the existence of a system of subtle signaling that relies on rhythm, resonance, and synchronization.[53,54]

In addition to these endogenous EMF interactions, biological systems appear to exhibit sensitivity to exogenous EMF exposures for most of the frequencies, field strengths, and amplitudes occurring in natural and man-made environments.[46,47] These observations have led to the development of a large number of therapeutic applications and clearance from the US Food and Drug Administration (FDA) and regulatory bodies worldwide for EMF treatment of pathologies such as bone repair, pain, and edema.[55]

Of particular relevance to biofield science, a large and rapidly growing body of data has demonstrated the existence of nonthermal EMF bioeffects, for which the molecular interaction energies are less than the average thermal energy of the target.[56] The existence of these extremely weak EMF effects suggests the possibility of bioinformation flow at extremely low energies and could foreshadow a paradigm shift away from the biochemical paradigm and towards an information-oriented model, wherein weak signaling (via EMF, light, or vibration) plays an essential role in biological regulation.

Pulsed electromagnetic field (PEMF) devices are the most common types of EMF therapy devices.[57] PEMF devices employ pulsed—ie, time-varying—waveforms that are generally transmitted to the body via antennae near the target tissue. Because of the extremely large body of literature on PEMF therapies, here we shall consider only those pathologies for which sufficient numbers of clinical studies have permitted literature reviews.

Treatment of nonunion bone fractures is one of the most widely adopted PEMF therapies cleared by the FDA.[58] Other PEMF devices have been cleared by the FDA for pain and inflammation.[59] PEMF treatment for osteoarthritis has been extensively studied, producing statistically significant results, but recent reviews have suggested that further research is needed to assess the clinical relevance of these findings.[60-65] PEMF "resonance" or "bioresonance" devices are designed to function via resonances at frequencies characteristic of EEG, ECG, or other endogenous EMF processes. Although the conceptual basis for bioresonance is unclear and efficacy has not been definitively demonstrated, bioeffects have been reported for some PEMF resonance devices.[66-68]

Transcranial magnetic stimulation (TMS) is a form of pulsed magnetic field therapy that uses a rapidly changing magnetic field to induce electric fields strong enough to stimulate cortical neurons and alter neuronal activity.[69] While TMS was initially used as an investigative tool in cognitive neuroscience,[70] further inquiry has led to its clinical use as an FDA-cleared treatment for treatment-resistant depression.[71-74] Now widely accepted as a noninvasive, low-cost method for brain stimulation, TMS has been reported to produce benefits for a wide variety of psychiatric conditions such as depression, acute mania, bipolar disorders, panic, hallucinations, obsessions/compulsions, schizophrenia, catatonia, posttraumatic stress disorder, and drug craving.[75] TMS has also been studied as a treatment for neurological conditions such as Parkinson's disease, dystonia, tics, stuttering, tinnitus, spasticity, epilepsy, stroke-related aphasia, and motor dysfunction and pain syndromes such as neuropathic pain, visceral pain, or migraine.[75] Several clinical studies are underway to evaluate the clinical utility of TMS for these indications,[69,75-77] and a recent review has set forth evidence-based guidelines for TMS therapy and listed specific conditions for which current evidence is sufficient or insufficient to recommend treatment.[78]

Static Magnetic Field Therapies

A wide variety of health claims have been made for static magnetic field (SMF) therapies, and a large number of manufacturers currently sell magnets intended for therapeutic purposes.[79,80] Most SMF therapies use ceramic or neodymium permanent magnets placed on the skin surface or very near to the body. Although the quality of published research varies greatly, blinded in vivo studies have reported a variety of clinical benefits for SMF exposures, including improvements related to postsuction lipectomy edema and pain[81]; fibromyalgia pain and sleep disorders[82,83]; chronic pelvic pain[84]; pain, numbness, and tingling due to diabetic peripheral neuropathy[85]; postpolio pain[86]; and musculoskeletal pain.[87] Other trials reported both positive short-term and negative long-term results on osteoarthritis knee pain[88] and no effect on foot[89,90] and chronic back pain[91] (although the latter 2 trials employed magnets in bipolar configuration, resulting in lower amplitude inside the target as compared to unipolar configuration). Reviews have produced ambivalent conclusions for analgesia[92] and microcirculation[93] and have reported that more research is needed to determine clinical efficacy for bone, tendon, and skin healing.[94]

Modalities Using Electric Currents, Voltages, or Potentials

All living organisms produce electric currents and potentials. This endogenous bioelectricity is a crucial component of biology, as it serves as a substrate for membrane potential, all nervous system activity, and many other vital biological processes.[47,48] Pivotal advances in medicine have resulted from the ability to measure and manipulate bioelectricity,[95] and here we provide examples of devices that measure or manipulate bioelectricity and have been employed for research in biofield science. Even though their underlying mechanisms are understood well, EEG and ECG are included as biofield devices. These approaches are sensitive measures of distributed information flow required for cellular regulation and function, which although well understood in terms of biophysical substrates, also represent important examples of biofield

interactions according to the above definition.

EEG is a noninvasive technique that uses electrodes on the scalp to produce quantitative information about the functional state of the brain. The frequencies present in EEG data are indicative of particular brain states and brain function on a cellular level. EEG is used to identify epileptic seizure activity and has been employed as a research tool to measure changes in brain state related to biofield therapies.[96]

ECG, using skin surface electrodes in a manner similar in principle to EEG, is a diagnostic tool for detecting the electrical activity of the heart. ECG is sometimes used for the diagnosis of heart-related conditions, including myocardial infarction, syncope, and pulmonary embolism.[97] ECG data can also be used to measure changes in HRV[98-102] that have been linked to a variety of biofield practices, though further studies are needed.[103-105]

Electrodermal activity measured by skin conductance and galvanic skin response (GSR) reflects autonomic sympathetic arousal associated with emotional and cognitive states.[106] GSR measurements are also employed by several devices claiming diagnostic abilities, but the veracity of these claims has not been clearly demonstrated. Also, the use of GSR for diagnosis is controversial: while the FDA classifies GSR measurement as a Class II medical device to be used only for the measurement of skin conductance and permitted for use in biofeedback,[107] a number of manufacturers of devices intended for a broader range of diagnoses via GSR have obtained FDA labeling under this more narrow designation. Another device employing electrodermal measurement is the apparatus for meridian identification (AMI), which measures electrical characteristics of the skin at acupuncture points located at the base of fingers and toes called Jing-Well points.[108] Based on the theory that the "energy" or "strength" of the acupuncture meridians (or energy channels) is reflected by electrodermal characteristics, conductance, capacitance, and polarization, measurements from Jing-Well points are analyzed in order to diagnose a variety of pathologies, as well as to assess overall wellbeing.[109] In a controlled study of claustrophobia therapy, increase in AMI-measured prepolarization current at Jing-Well points correlated with a significant reduction in anxiety.[110] Similarly, statistically significant differences between electric potential measurements obtained on and off acupoints and between external focus and healing states have been reported in "energy healing" practitioners.[111]

In addition to these diagnostic uses of bioelectricity, electrical stimulation is rapidly emerging as an important new domain in medicine. Stimulation technologies, such as vagus nerve stimulation (VNS), deep brain stimulation (DBS), and transcranial direct current stimulation (tDCS), are currently practiced clinically and are under investigation for several new indications, in particular for diseases and conditions that are unresponsive to pharmacological therapy.

VNS, which entails the use of implanted electrodes to stimulate the vagus nerve, is currently approved in the United States for treatment of epilepsy and depression and is being actively studied as treatment for osteoarthritis, tinnitus, anxiety, Alzheimer's disease, migraine, fibromyalgia, obesity, autism, sepsis, and inflammatory pathologies.[112,113] DBS involves the use of implanted electrodes to stimulate targeted regions of the brain.[114] DBS has been studied as a treatment for chronic pain, major depression, and Tourette syndrome[115] and is currently FDA-cleared for the treatment of tremor, Parkinson's disease, dystonia, and obsessive-compulsive disorder. It is also under consideration as a diagnostic/research tool.[115] During tDCS, electrodes are placed upon the scalp to noninvasively transmit electrical current across the brain. Research on tDCS is emerging and preliminary results suggest it may enhance cognitive performance.[116]

Earthing, also known as grounding, is a practice whereby individuals connect themselves electrostatically to the earth by walking barefoot outdoors or by using grounded conductive mats, bedsheets, or body bands when indoors. Based upon the notion that the earth's negative surface charge is a virtually limitless reservoir of free electrons constantly replenished by the global atmospheric electric circuit,[117,118] when earthed, the body uses these electrons as antioxidants for neutralizing excessive oxidative stress in the body.[119,120] Research published over the last decade reports a broad array of health-related results, including improved sleep, decreased pain, normalizing effect on cortisol, reduction and/or normalization of stress, diminished damage to muscles caused by delayed onset muscle soreness, reduction of primary indicators of osteoporosis, improved glucose regulation, and enhanced immune function.[121] While this simple technique holds promise as a therapy and method for enhancing overall wellbeing, more research is needed to determine the mechanisms and clinical significance of earthing.

Taken as a whole, these electric current technologies, which alleviate symptoms by delivering electrical current into a system that is experiencing dysfunction, produce systems-level effects and could be viewed as cutting-edge examples of biofield diagnostic and therapeutic devices. While still in the nascent stages of refinement and elucidation of mechanisms of action, the potential positive clinical impact of this class of devices is significant and likely to shed light upon several interrelated areas of biofield science.

Modalities Using Vibration/Sound

A number of devices use sound, both within and outside of the audible range for humans. Infrasound is low-frequency sound with frequencies below 20 Hz, which is the limit of "normal" human hearing. Infrasound has been reported to be effective for increasing vitality, accelerating healing, and strengthening immune function.[122]

Transcranial ultrasound (TUS) is a noninvasive neuromodulatory technique that may be useful for the

treatment of mental health and neurological disorders.[123,124] While further work is needed to demonstrate the range of clinical applications,[125,126] recent clinical studies have reported improvement in mood in chronic pain patients, suggesting promise for TUS as a noninvasive treatment for pain management and perhaps depression.[127]

Several therapies using audible sound have been developed that could be considered biofield devices. Music therapy, the clinical and evidence-based use of musical sounds to meet therapeutic goals, has been shown to promote wellness, manage stress, alleviate pain, enhance emotional expression and memory, improve communication, and promote physical rehabilitation.[128] Neuroacoustic therapies use sound to modulate brain activity and are reported to affect sympathetic-parasympathetic balance and synchronize the activity of the right and left brain hemispheres.[129] Binaural beat neuroacoustic therapies employ combined tones of slightly differing frequencies and left–right channels, which are reported to induce altered states of consciousness,[130] modulate EEG activity and hypnotic susceptibility,[131] and affect vigilance and mood.[132]

Modalities Based Upon Mechanical/Physical Interactions

TCM uses acupuncture as a technique for balancing the flow of a vital energy called *qi*, believed to move through the body's meridians.[133] TCM posits that disruption of energy flow is a root cause of many types of disease[134] and that one means to harmonize the flow of *qi* is to insert thin metal needles into particular acupuncture points on the skin, often followed by stimulation of the needles mechanically or electrically.[135] Acupuncture is commonly used to treat many symptoms and diseases, including chronic pain, osteoarthritis, side effects of chemotherapy, and fibromyalgia.[136-139] Although the anatomical nature of these meridians is unclear, it has been suggested that threadlike, nonlymphatic subcellular structures sometimes called Bonghan ducts or primo vascular structures may play a role[140,141]; several theories for mechanisms of action have been put forth, including local inflammatory responses, cytoskeletal remodeling, release of adenosine (antinociceptive effects), neuromodulation, endogenous opioid production, and alteration of autonomic nervous system tone.[142-145]

Modalities Based Upon Human Intention

A large and growing research literature has considered the role of human consciousness and intention in biology, psychology, and the physical sciences.[8,9] These human intentionality effects have been reported in a variety of living systems—for example EEG[146] and galvanic skin response[147]—suggesting that human intention may play a key role in biofield interactions.

Two large-scale projects are currently collecting data on human interactions with global events: (1) the Global Consciousness Project is collecting data on correlations between statistics of continuously operating random event generators around the world and brief episodes of widespread mental and emotional reaction to major world events,[148] and (2) the Global Coherence Initiative is seeking to examine interactions of humans with EMFs of terrestrial, solar, and cosmic origin by installing a global network of 12 to 14 ultrasensitive magnetic field detectors around the planet and correlating EMF data with variables such as HRV.[149] While these global projects involve large numbers of participants around the world, the intention host device (IHD) is another type of device methodology based upon human intention focused more individually.[150] The IHD has been reported to broadcast imprinted human intention to condition a laboratory environment and to produce alterations in time-series measurements of temperature, pH, drosophila fitness and energy metabolism, in vitro enzyme activity, and molecular concentration variability.[150,151]

Modalities Using Gas or Plasma

Gas discharge visualization (GDV) is an important example of the use of plasma in biofield science. Based on the Kirlian effect, a high-frequency, high-voltage field is used to stimulate weak photon emission, followed by the application of modern optics, electronics, and computer processing to form images of the weak photon emission. Dating back to the 1930s,[152] this technique has been called electrography,[153] electrophotography,[154] corona discharge photography,[155] bioelectrography,[152] GDV,[156] electrophotonic imaging (EPI),[157] and Kirlianography.[152] GDV/EPI techniques are currently used diagnostically based upon the characteristics of images of the fingertips[158] and often with proprietary means of correlating these data with acupuncture systems or other means of assessing the biological state.[159] Nearly 1000 papers have been published (mostly in Russian) on GDV research and a few hundred more in the West. A recent review of GDV research applied to medicine and psychology can be found in the book *Electrophotonic Applications in Medicine: GDV Bioelectrography*.[160] One study reported significant differences in cancer patient GDV scans when compared with healthy particpants, and after 6 weeks of treatment including surgery, chemotherapy, and radiation, a change trending toward healthy subject GDV profiles.[161] These intriguing data suggest that informatics based upon biofield measurement devices such as the GDV may be useful for gaining deeper understanding of disease states and guiding practitioners and their patients towards states of greater wellness.

Other Device Modalities

In light of observations of nonlocal effects,[8,9] which suggest that biofield interactions may involve means of information transfer that cannot be easily described via well-understood substrates (eg, EMFs), here we describe devices that do not fit easily into the categories listed above. Although a vast number of

other devices fall into this category, here we list 3 of the more well-known modalities: torsion fields, orgone energy, and scalar waves. These 3 modalities were chosen because of their prominent positions amongst devices purported to act upon the biofield. However, it should be noted that the biophysical substrates are either poorly understood or not generally accepted by the scientific community. Claims of effects and efficacy for these modalities have not been verified, and further research is needed to establish not only the veracity of the claims but also to fully confirm the existence of the specific effects reported.

Torsion Fields

The notion of a torsion field is generally credited to the Russian professor N.P. Myshkin[162] and is based upon the theory that particles with spin are coupled via torsion fields.[162] A collection of relevant experiments is reviewed in a volume by Swanson.[163] Torsion fields are of interest to biofield science in that they could provide a theoretical framework for explaining non-EMF interactions and how these might interact with biological systems.

Orgone Energy

Orgone energy is a purported universal life force originally described in the 1930s by the Austrian psychoanalyst Wilhelm Reich.[164-166] Reich believed orgone energy to be a massless, omnipresent substance, closely associated with living energy but also present in inert matter. Orgone energy was thought to create organization on all scales using orgone particles called "bions," from the microscopic to macroscopic levels within organisms, clouds, or even galaxies.[165] Reich designed and built special "orgone energy accumulators" to collect and store orgone energy from the environment and claimed these devices could be used for improvement of general health.[164]

Scalar Waves

Scalar waves are said to be produced when 2 electromagnetic waves of the same frequency are exactly out of phase and cancel with each other.[167] Rather than the waves completely disappearing in the destructive interference, it is hypothesized that a transformation of energy into a scalar wave occurs, with the resulting scalar field "reverting back" to a vacuum state of potentiality.[167] Scalar waves are purported to explain homeopathy and lymphatic detoxification; treat diabetes, nearsightedness, kidney stones, Parkinson's disease, strokes, arthritis, and cancer; and reverse the aging process.[168]

DISCUSSION

Although the biofield devices described here operate through a great diversity of mechanisms, these devices all share the common quality of being most clearly understood within a biofield framework, wherein information flow or the capacity to create organization acts across hierarchical levels to coordinate biological activity. Elements of this framework are already well accepted by the biomedical community and have been applied through several device modalities, including ECG, EEG, other electrophysiological techniques, some EMF therapies, ultrasound, thermal imaging, and techniques using light like LT. Extraordinary medical and scientific progress has occurred as a result of these modalities and the elucidation of their underlying principles. Further progress is likely to be informed by the recent demonstration of endogenous EMF regulation of a variety of biological processes and indications of quantum information processing in the cytoskeleton.[48-52,54,169] These recent results suggest a biophysical basis for biofield coordination of activities across the molecular, cellular, and organismic levels[53] and may provide testable hypotheses regarding biofield regulation of homeodynamics and mind-body interactions.

In contrast to this growing knowledge of biofield mechanisms, several biofield modalities appear to operate according to principles that are not currently well understood or accepted by mainstream medical science. Further study of those modalities for which there is strong experimental evidence—eg, BE, consciousness and nonlocal interactions, GDV, TCM—may substantially advance our understanding of biofield interactions and their biological and health implications.[57] The growing basic science data and existence of devices operating via consciousness or intention,[8,9] which may act through nonlocal quantum correlations, must be taken seriously. Despite long-lasting taboos proscribing study of these phenomena, researchers must have the courage and self-awareness necessary to assess the veracity, specific properties, and general significance of the large and important body of research in this area.

The large diversity of biofield device modalities presents several significant methodological issues not limited to the fact that biofield interactions appear to involve exceedingly complex systems. Attempts to reduce biofield interactions to reductionist substrates may be inadequate, underscoring the need for a more holistic "systems biology" approach.[170] Significantly, several of the modalities described here, such as BEs and extremely weak EMFs, operate at extremely low interaction energies, often below the apparent thermal threshold of Brownian motion.[56] Such low energies suggest the existence of weak-field information transfer or subtle signaling, for which the biological mechanisms are only now becoming elucidated. While the existence of extremely weak EMF effects is now beyond dispute,[56] understanding of the clinical relevance of specific nonthermal waveforms is still in its infancy, and a more comprehensive model of the resonant response of the body to particular weak EMF signaling is still needed. Furthermore, the significance of these EMF effects is unclear when juxtaposed with the variety of EMFs that many individuals are exposed to in the course of everyday life.

In order to determine which biological processes exhibit functional sensitivities to these subtle factors, researchers will have to carefully control for the influence of very weak EMFs and other low-energy subtle influences. Therein, specialized equipment and laboratories will be required, including the use of Faraday cages, μ-metal enclosures, completely dark rooms, noise-proofing, and the development of instruments sensitive enough to measure biofield interactions or subtle low-energy nonthermal influences. Nearly all cell culture incubators produce a nonuniform EMF of bioactive strength, which must be taken into consideration.[56] Controlling for picotesla-nanotesla range sensitivities[57] presents further challenges, as shielding at these extremely low field strengths may be difficult or impossible in some situations. In the absence of a means to control for all potential subtle effectors, it may, in some instances, be necessary to adopt a new paradigm of research wherein naturally occurring EMF fluctuations due to solar/geomagnetic and other sources are an integral part of the experimental environment and are therein measured and accounted for in analyses. Similarly, circadian and other naturally occurring biological rhythms may influence very sensitive systems. These factors may be precursors of a shift towards an information-based model of low-energy interactions, wherein the informational content of a process may be much more relevant than the apparent energy of interaction.

Interfaces for Future Research

Biofield studies are now evolving toward being an accepted discipline within mainstream science, and the existence of a community or several related groups focused on biofield research will greatly enhance the visibility and credibility of the field as a whole. To further the development of knowledge in the next decade, we propose the creation of an organization or community of researchers dedicated to furthering biofield studies and device development. Regular opportunities for interaction and critical assessment of progress and results will enhance the growth of knowledge related to this emerging field. A collaborative community will also enable the independent replication of key findings. This will be critical for achieving acceptance by the scientific community at large.

Another important goal will be to acquire funding for independent replications or concurrent experimental protocols in separate laboratories. Private sources of funding are necessary to perform research today, and this often results in conflicts of interest. For example, device manufacturers provide a substantial portion of the funding for research in EMF therapeutics. Research in this emerging and sometimes controversial field, which is moving toward advances in science, illustrates how such conflicts of interest could significantly hinder acceptance by the mainstream scientific community. Efforts could be made to form collaborations amongst device manufacturers to replicate findings and make distinctions between similar devices. Although this may appear to run contrary to the short-term goals of individual companies, the long-term benefits may be substantial.

In order to further the progress of biofield research and device development, research must be coordinated across several levels. Further developments of diagnostic and therapeutic biofield device technologies will require interdisciplinary research joining clinical and preclinical studies with basic science efforts in physiology, biophysics, and the development of a theory of mind and nonlocal consciousness in the following areas.

Basic Science Foundations: Physiology, Biophysics, and Theory of Mind/Consciousness

Interfaces among these 3 fields are crucial for the development and refinement of biofield device technologies. A better understanding of the physiology of biofield interactions (ie, biofield reception, generation, and function) will require interfaces with biophysics and new models for subtle biological influences such as extremely weak EMF effects or biophotonics. A more comprehensive theory of mind is required to understand nonlocal interactions and to further understand the biophysical bases for these effects. At this stage, models based upon quantum correlations appear promising,[54,169] but testable hypotheses are needed in order to develop a more detailed functional framework. Development of the interfaces between physiology, biophysics, and a testable nonlocal theory of the role of the mind will elucidate the specific ways in which devices can be developed for detection and manipulation of biofield interactions.

Preclinical Research

Cell culture and animal models provide an essential interface for testing and implementation phases of device development. A large body of previous data has already been valuable for steering the device research described here.

Clinical Research

Many of the devices reviewed here hold significant promise as low-cost, personalized diagnostic and therapeutic approaches. As such, rigorously designed clinical studies are a high priority for moving biofield device research and development forward. This will require interfaces among clinical, preclinical, and basic science researchers in order to assess the unique translational and methodological questions discussed above.

Cross-platform Validation

An immediate goal will be to support the creation of laboratories that can design and carry out studies to test across multiple devices using gold-standard diagnostic and therapeutic medical approaches as comparators. The outcomes of these crossplatform validation studies could lead to the further development and implementation of noninvasive diagnostic medical assessments and therapeutic devices that are related to biofield science.

CONCLUSIONS

The current existence of biofield devices is a demonstration of the clear, specific, and tangible knowledge that has been gained thus far in biofield science. Devices play prominent cultural and scientific roles in our society, and it is likely that device technologies will be one of the most influential access points for the furthering of biofield research and the dissemination of biofield concepts. Comprehensive study of biofield devices will require a concerted research effort, interdisciplinary collaborations, and sufficient funding. Systematic studies are needed to deepen our understanding of the nature of biofield interactions and to move biofield device development and experimentation forward. This developing field of study presents new areas of research that have many important implications for basic science, clinical medicine, and potentially, the forward progress and evolution of our species. The ever-growing understanding of biofield science holds promise to foster a more humane and personalized form of medicine and an expansion of our scientific viewpoint to include the importance of each individual's interconnectedness with communities, the immediate environment, the earth, and the cosmos.

REFERENCES

1. Rossi EL. Psychosocial genomics: gene expression, neurogenesis, and human experience in mind-body medicine. Adv Mind Body Med. 2002;18(2):22-30.
2. McCraty R, Atkinson M, Tomasino D, Bradley RT. The coherent heart: heart–brain interactions, psychophysiological coherence, and the emergence of system-wide order. Integr Rev. 2009;5(2):10-114.
3. Jonas WB, Eisenberg D, Hufford D, Crawford C. The evolution of complementary and alternative medicine (CAM) in the USA over the last 20 years. Forsch Komplementmed. 2013;20(1):65-72.
4. Morgan N, Irwin MR, Chung M, Wang C. The effects of mind-body therapies on the immune system: meta-analysis. PLoS One. 2014;9(7):e100903.
5. Simkin DR, Black NB. Meditation and mindfulness in clinical practice. Child Adolesc Psychiatr Clin N Am. 2014;23(3):487-534.
6. Innes KE, Selfe TK. Meditation as a therapeutic intervention for adults at risk for Alzheimer's disease—potential benefits and underlying mechanisms. Front Psychiatry. 2014 Apr 23;5:40.
7. Lee C, Crawford C, Teo L, et al. An analysis of the various chronic pain conditions captured in a systematic review of active self-care complementary and integrative medicine therapies for the management of chronic pain symptoms. Pain Med. 2014;15 Suppl 1:S96-103.
8. Hankey A. The influence of psychic phenomena: a new light on health. J Altern Complement Med. 2007;13(8):787-8.
9. Radin D, Nelson R. Meta-analysis of mind-matter interaction experiments: 1959-2000. IaEM healing. London: Harcourt Health Sciences; 2003:39-48.
10. Popp FA, Nagl W, Li KH, Scholz W, Weingärtner O, Wolf R. Biophoton emission. New evidence for coherence and DNA as source. Cell Biophys. 1984;6(1):33-52.
11. Vanwijk R. Bio-photons and bio-communication. J Sci Explor. 2001;15(2):183-97.
12. Popp FA, Chang JJ. The physical background and the informational character of biophoton emission, In: Chang JJ, Fisch J, Popp FA, Editors. Biophotons. Dordrecht, The Netherlands: Kluwer; 1998:238-50.
13. Albrecht-Buehler G. Rudimentary form of cellular "vision". Proc Natl Acad Sci U S A. 1992;89(17):8288-92.
14. Galantsev VP, Kovalenko SG, Moltchanov AA, Prutskov VI. Lipid peroxidation, low-level chemiluminescence and regulation of secretion in the mammary gland. Experientia. 1993;49(10):870-5.
15. Shen X, Bei L, Hu TH, Aryal B. The possible role played by biophotons in the long-range interaction between neutrophil leukocytes. In: Beloussov LV, Voeikov VL, VanWijk R, Editors. Biophotonics and coherent systems in biology. Moscow: Moscow University Press; 2000:336-46.
16. Kuzin AM, Surkenova GM. Secondary biogenic irradiation of plant structures after gamma-irradiation at low dose. In: Beloussov LV, Editor. Biophotonics. Moscow: Bioinform Services; 1995:257-65.
17. Ives JA, van Wijk EP, Bat N, et al. Ultraweak photon emission as a non-invasive health assessment: a systematic review. PLoS One. 2014;9(2):e87401.
18. Terman JS, Terman M, Lo ES, Cooper TB. Circadian time of morning light administration and therapeutic response in winter depression. Arch Gen Psychiatry. 2001;58(1):69-75.
19. Wacker M, Holick MF. Vitamin D—effects on skeletal and extraskeletal health and the need for supplementation. Nutrients. 2013;5(1):111-48.
20. Diffey BL. Ultraviolet radiation physics and the skin. Phys Med Biol. 1980;25(3):405-26.
21. Hamilton FL, Car J, Lyons C, Car M, Layton A, Majeed A. Laser and other light therapies for the treatment of acne vulgaris: systematic review. Br J Dermatol. 2009;160(6):1273-85.
22. American Cancer Society. Light therapy. 2011; http://www.cancer.org/treatment/treatmentsandsideeffects/complementaryandalternativemedicine/manualhealingandphysicaltouch/light-therapy%5D. Accessed September 9, 2015.
23. Adauwiyah J, Suraiya HH. A retrospective study of narrowband-UVB phototherapy for treatment of vitiligo in Malaysian patients. Med J Malaysia. 2010;65(4):297-9.
24. Titus S, Hodge J. Diagnosis and treatment of acne. Am Fam Physician. 2012;86(8):734-40.
25. Toyokawa H, Matsui Y, Uhara J, et al. Promotive effects of far-infrared ray on full-thickness skin wound healing in rats. Exp Biol Med (Maywood). 2003;228(6):724-9.
26. Azril MA, Shaifuzain AR, Halim AY, Iskandar MA, Shukrimi A, Imran Y. Effect of far infrared radiation on bone healing—study in rabbits. Malaysian J Med Sci. 2006;13(Suppl):87.
27. Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516-33.
28. Alves AN, Fernandes KP, Deana AM, Bussadori SK, Mesquita-Ferrari RA. Effects of low-level Laser therapy on skeletal muscle repair: a systematic review. Am J Phys Med Rehabil. 2014;93(12):1073-85.
29. Tumilty S, Munn J, McDonough S, Hurley DA, Basford JR, Baxter GD. Low level laser treatment of tendinopathy: a systematic review with meta-analysis. Photomed Laser Surg. 2010;28(1):3-16.
30. Brosseau L, Robinson V, Wells G, et al. Low level laser therapy (Classes I, II and III) for treating rheumatoid arthritis. Cochrane Database Syst Rev. 2005(4):Cd002049.
31. Jamtvedt G, Dahm KT, Christie A, et al. Physical therapy interventions for patients with osteoarthritis of the knee: an overview of systematic reviews. Phys Ther. 2008;88(1):123-36.
32. Chow RT, Johnson MI, Lopes-Martins RA, Bjordal JM. Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis of randomised placebo or active-treatment controlled trials. Lancet. 2009;374(9705):1897-908.
33. Bjordal JM, Couppé C, Chow RT, Tunér J, Ljunggren EA. A systematic review of low level laser therapy with location-specific doses for pain from chronic joint disorders. Aust J Physiother. 2003;49(2):107-16.
34. Naeser MA, Zafonte R, Krengel MH, et al. Significant improvements in cognitive performance post-transcranial, red/near-infrared light-emitting diode treatments in chronic, mild traumatic brain injury: open-protocol study. J Neurotrauma. 2014;31(11):1008-17.
35. Prindeze NJ, Moffatt LT, Shupp JW. Mechanisms of action for light therapy: a review of molecular interactions. Exp Biol Med (Maywood). 2012;237(11):1241-8.
36. Ioannou S, Gallese V, Merla A. Thermal infrared imaging in psychophysiology: Potentialities and limits. Psychophysiology. 2014;51(10):951-63.
37. Redaelli V, Tanzi B, Luzi F, et al. Use of thermographic imaging in clinical diagnosis of small animal: preliminary notes. Ann Ist Super Sanita. 2014;50(2):140-6.
38. Ring EF, Ammer K. Infrared thermal imaging in medicine. Physiol Meas. 2012;33(3):R33-46.
39. Kennedy DA, Lee T, Seely D. A comparative review of thermography as a breast cancer screening technique. Integr Cancer Ther. 2009;8(1):9-16.
40. Ng EY. A review of thermography as promising non-invasive detection modality for breast tumor Int J Therm Sci. 2009;48(5):849-59.
41. Thiruvengadam J, Anburajan M, Menaka M, Venkatraman B3 Potential of thermal imaging as a tool for prediction of cardiovascular disease. J Med Phys. 2014;39(2):98-105.
42. Zore Z, Boras I, Stanec M, Oresić T, Zore IF. Influence of hormonal status on thermography findings in breast cancer. Acta Clin Croat. 2013;52(1):35-42.
43. Mikulska D. Contemporary applications of infrared imaging in medical diagnostics. Ann Acad Med Stetin. 2006;52(1):35-9; discussion 39-40. Polish.
44. Jiang LJ, Ng EY, Yeo AC, et al. A perspective on medical infrared imaging. J Med Eng Technol. 2005;29(6):257-67.
45. Merla A. Thermal expression of intersubjectivity offers new possibilities to human-machine and technologically mediated interactions. Front Psychol. 2014 Jul 23;5:802.
46. Ni JX, Gao SH, Li YH, et al. Clinical trial on the characteristics of zheng classification of pulmonary diseases based on infrared thermal imaging technology. Evid Based Complement Alternat Med. 2013;2013:218909.
47. Funk RH, Monsees TK. Effects of electromagnetic fields on cells: physiological and therapeutical approaches and molecular mechanisms of interaction. A review. Cells Tissues Organs. 2006;182(2):59-78.
48. Funk RH, Monsees TK, Ozkucur N. Electromagnetic effects—From cell biology to medicine. Prog Histochem Cytochem. 2009;43(4):177-264.
49. Zhao Y, Zhan Q. Electric fields generated by synchronized oscillations of micro-

tubules, centrosomes and chromosomes regulate the dynamics of mitosis and meiosis. Theor Biol Med Model. 2012 Jul 2;9:26.
50. Plankar M, Brežan S, Jerman I. The principle of coherence in multi-level brain information processing. Prog Biophys Mol Biol. 2013;111(1):8-29.
51. Zhao Y, Zhan Q. Electric oscillation and coupling of chromatin regulate chromosome packaging and transcription in eukaryotic cells. Theor Biol Med Model. 2012 Jul 3;9:27.
52. Hameroff S, Penrose R. Consciousness in the universe: A review of the "Orch OR" theory. Phys Life Rev. 2014;11(1):39-78.
53. Glass L. Synchronization and rhythmic processes in physiology. Nature. 2001;410(6825):277-84.
54. Hameroff S, Nip A, Porter M, Tuszynski J. Conduction pathways in microtubules, biological quantum computation, and consciousness. Biosystems. 2002;64(1-3):149-68.
55. Pilla AA. Mechanisms and therapeutic applications of time varying and static magnetic fields. In: Biological and Medical Aspects of Electromagnetic Fields. Barnes FS, Greenebaum B, Editors. Boca Raton, FL: CRC Press; 2007:351- 411.
56. Binhi VN, Rubin AB. Magnetobiology: the kT paradox and possible solutions. Electromagn Biol Med. 2007;26(1):45-62.
57. Shupak NM. Therapeutic uses of pulsed magnetic-field exposure: a review. Radio Sci Bull. 2003 Dec;3072(9-32).
58. Aaron RK, Ciombor DM, Simon BJ. Treatment of nonunions with electric and electromagnetic fields. Clin Orthop Relat Res. 2004 Feb;(419):21-9.
59. Markov MS. Expanding use of pulsed electromagnetic field therapies. Electromagn Biol Med. 2007;26(3):257-74.
60. Hulme J, Robinson V, DeBie R, Wells G, Judd M, Tugwell P. Electromagnetic fields for the treatment of osteoarthritis. Cochrane Database Syst Rev. 2002(1):Cd003523.
61. McCarthy CJ, Callaghan MJ, Oldham JA. Pulsed electromagnetic energy treatment offers no clinical benefit in reducing the pain of knee osteoarthritis: a systematic review. BMC Musculoskelet Disord. 2006 Jun 15;7:51.
62. Cao LY, Jiang MJ, Yang SP, et al. Pulsed electromagnetic field therapy for the treatment of knee osteoarthritis: a systematic review. Zhongguo Gu Shang. 2012;25(5):384-8. Chinese.
63. Ryang We S, Koog YH, Jeong KI, Wi H. Effects of pulsed electromagnetic field on knee osteoarthritis: a systematic review. Rheumatology (Oxford). 2013;52(5):815-24.
64. Li S, Yu B, Zhou D, et al. Electromagnetic fields for treating osteoarthritis. Cochrane Database Syst Rev. 2013 Dec 14;12:Cd003523.
65. Negm A, Lorbergs A, Macintyre NJ. Efficacy of low frequency pulsed subsensory threshold electrical stimulation vs placebo on pain and physical function in people with knee osteoarthritis: systematic review with meta-analysis. Osteoarthritis Cartilage. 2013;21(9):1281-9.
66. Fedorowski A, Steciwko A, Rabczynski J. Low-frequency electromagnetic stimulation may lead to regression of Morris hepatoma in buffalo rats. J Altern Complement Med. 2004;10(2):251-60.
67. Heredia-Rojas JA, Torres-Flores AC, Rodriguez-De la Fuente AO, et al. Entamoeba histolytica and Trichomonas vaginalis: trophozoite growth inhibition by metronidazole electro-transferred water. Exp Parasitol. 2011;127(1):80-3.
68. Islamov BI, Balabanova RM, Funtikov VA, Gotovskii YV, Meizerov EE. Effect of bioresonance therapy on antioxidant system in lymphocytes in patients with rheumatoid arthritis. Bull Exp Biol Med. 2002;134(3):248-50.
69. Hallett M. Transcranial magnetic stimulation: a primer. Neuron. 2007;55(2):187-99.
70. Walsh V, Cowey A. Transcranial magnetic stimulation and cognitive neuroscience. Nat Rev Neurosci. 2000;1(1):73-9.
71. Grisaru N, Yaroslavsky U, Abarbanel J, Lamberg T, Belmaker RH. Transcranial magnetic stimulation in depression and schizophrenia. Eur Neuropsychopharm. 1994;4(3):287-8.
72. Kolbinger HM, Höflich G, Hufnagel A, Müller HJ, Kasper S. Transcranial magnetic stimulation (TMS) in the treatment of major depression: a pilot study. Hum Psychopharmacol. 1995;10(4):305-10.
73. George MS, Wassermann EM, Williams WA, et al. Daily repetitive transcranial magnetic stimulation (rTMS) improves mood in depression. Neuroreport. 1995;6(14):1853-6.
74. Pascual-Leone A, Rubio B, Pallardó F, Catalá MD. Rapid-rate transcranial magnetic stimulation of left dorsolateral prefrontal cortex in drug-resistant depression. Lancet. 1996;348(9022):233-7.
75. Rossi S, Hallett M, Rossini PM, Pascual-Leone A; Safety of TMS Consensus Group. Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation in clinical practice and research. Clin Neurophysiol. 2009;120(12):2008-39.
76. Fitzgerald PB, Brown TL, Marston NA, Daskalakis ZJ, De Castella A, Kulkarni J. Transcranial magnetic stimulation in the treatment of depression: a double-blind, placebo-controlled trial. Arch Gen Psychiatry. 2003;60(10):1002-8.
77. Lefaucheur JP, Antal A, Ahdab R, et al. The use of repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS) to relieve pain. Brain Stimul. 2008;1(4):337-44.
78. Lefaucheur JP, Andre-Obadia N, Antal A, et al. Evidence-based guidelines on the therapeutic use of repetitive transcranial magnetic stimulation (rTMS). Clin Neurophysiol. 2014;125(11):2150-206.
79. Markov MS. Magnetic field therapy: a review. Electromagn Biol Med. 2007;26(1):1-23.
80. Colbert AP, Wahbeh H, Harling N, et al. Static magnetic field therapy: a critical review of treatment parameters. Evid Based Complement Alternat Med. 2009;6(2):133-9.
81. Man D, Man B, Plosker H. The influence of permanent magnetic field therapy on wound healing in suction lipectomy patients: a double-blind study. Plast Reconstr Surg. 1999;104(7):2261-6; discussion 2267-8.
82. Colbert AP, Markov MS, Souder JS. Static magnetic field therapy: dosimetry considerations. J Altern Complement Med. 2008;14(5):577-82. 83. Alfano AP, Taylor AG, Foresman PA, et al. Static magnetic fields for treatment of fibromyalgia: a randomized controlled trial. J Altern Complement Med. 2001;7(1):53-64.
84. Brown CS, Ling FW, Wan JY, Pilla AA. Efficacy of static magnetic field therapy in chronic pelvic pain: a double-blind pilot study. Am J Obstet Gynecol. 2002;187(6):1581-7.
85. Weintraub MI, Wolfe GI, Barohn RA, et al. Static magnetic field therapy for symptomatic diabetic neuropathy: a randomized, double-blind, placebo-controlled trial. Arch Phys Med Rehabil 2003; 84:736-46.
86. Vallbona C, Hazlewood CF, Jurida G. Response of pain to static magnetic fields in postpolio patients: a double-blind pilot study. Arch Phys Med Rehabil. 1997;78(11):1200-3.
87. Pujol J, Pascual-Leone A, Dolz C, Delgado E, Dolz JL, Aldomà J. The effect of repetitive magnetic stimulation on localized musculoskeletal pain. Neuroreport. 1998;9(8):1745-8.
88. Wolsko PM, Eisenberg DM, Simon LS, et al. Double-blind placebo-controlled trial of static magnets for the treatment of osteoarthritis of the knee: results of a pilot study. Altern Ther Health Med. 2004;10(2):36-43.
89. Caselli MA, Clark N, Lazarus S, Velez Z, Venegas L. Evaluation of magnetic foil and PPT Insoles in the treatment of heel pain. J Am Podiatr Med Assoc. 1997;87(1):11-6.
90. Winemiller MH, Billow RG, Laskowski ER, Harmsen WS. Effect of magnetic vs sham-magnetic insoles on plantar heel pain: a randomized controlled trial. JAMA. 2003;290(11):1474-8.
91. Collacott EA, Zimmerman JT, White DW, Rindone JP. Bipolar permanent magnets for the treatment of chronic low back pain: a pilot study. JAMA. 2000;283(10):1322-5.
92. Eccles NK. A critical review of randomized controlled trials of static magnets for pain relief. J Altern Complement Med. 2005;11(3):495-509.
93. McKay JC, Prato FS, Thomas AW. A literature review: the effects of magnetic field exposure on blood flow and blood vessels in the microvasculature. Bioelectromagnetics. 2007;28(2):81-98.
94. Henry SL, Concannon MJ, Yee GJ. The effect of magnetic fields on wound healing: experimental study and review of the literature. Eplasty. 2008 Jul 25;8:e40.
95. Grimnes S, Martinson OG. Bioimpedance and bioelectricity basics. 3rd ed. 2011: London: Academic Press; 2011.
96. Baldwin AL, Hammerschlag R. Biofield-based therapies: a systematic review of physiological effects on practitioners during healing. Explore (NY). 2014;10(3):150-61.
97. Todd K, Simpson CS, Redfearn DP, Abdollah H, Baranchuk A. ECG for the diagnosis of pulmonary embolism when conventional imaging cannot be utilized: a case report and review of the literature. Indian Pacing Electrophysiol J. 2009;9(5):268-75.
98. Billman GE. Heart rate variability—a historical perspective. Front Physiol. 2011 Nov 29;2:86.
99. Xhyheri B, Manfrini O, Mazzolini M, Pizzi C, Bugiardini R. Heart rate variability today. Prog Cardiovasc Dis. 2012;55(3):321-31.
100. Gaebler M, Daniels JK, Lamke JP, Fydrich T, Walter H. Heart rate variability and its neural correlates during emotional face processing in social anxiety disorder. Biol Psychol. 2013;94(2):319-30.
101. Kemp AH, Quintana DS. The relationship between mental and physical health: insights from the study of heart rate variability. Int J Psychophysiol. 2013;89(3):288-96.
102. Moon E, Lee SH, Kim DH, Hwang B. Comparative study of heart rate variability in patients with schizophrenia, bipolar disorder, post-traumatic stress disorder, or major depressive disorder. Clin Psychopharmacol Neurosci. 2013;11(3):137-43.
103. Baldwin AL, Schwartz GE. Physiological changes in energy healers during self-practice. Complement Ther Med. 2012;20(5):299-305.
104. Burleson KO, Schwartz GE. Energy healing training and heart rate variability. J Altern Complement Med. 2005;11(3):391-3.
105. Chien CH, Tsuei JJ, Lee SC, Huang YC, Wei YH. Effect of emitted bioenergy on biochemical functions of cells. Am J Chin Med. 1991;19(3-4):285-92.
106. Critchley HD. Electrodermal responses: what happens in the brain. Neuroscientist. 2002;8(2):132-42.
107. US Food and Drug Administration. Code of federal regulaions: title 21–food and drugs. CFR 882.1540 Galvanic skin response measurement device. http://www.gpo.gov/fdsys/pkg/CFR-2003-title21-vol8/xml/CFR-2003-title21-vol8-sec882-1540.xml. Accessed August 20, 2015.
108. Tsuchita K, Motoyama H. Study of body's energy changes in non-touch energy healing 1. Pranic healing protocol applied for a breast cancer subject. Subtle

Ener Ener Med. 2009;20(2):15-30.
109. Deadman P. The five shu-points. J Chinese Med. 1993;42:31-38. https://www.jcm.co.uk/the-five-shupoints.html. Accessed August 20, 2015.
110. Lambrou P, Pratt G, Chevalier G. Physiological and psychological effects of a mind/body therapy on claustrophobia. Subtle Ener Ener Med. 2003;14(3):767-74.
111. Syldona M, Rein G. The use of DC electrodermal potential measurements and healer's felt sense to assess the energetic nature of qi. J Altern Complement Med 1999;5(4):329-47.
112. Groves DA, Brown VJ. Vagal nerve stimulation: a review of its applications and potential mechanisms that mediate its clinical effects. Neurosci Biobehav Rev. 2005;29(3):493-500.
113. Tracey KJ. Reflex control of immunity. Nat Rev Immunol. 2009;9(6):418-28.
114. Kringelbach ML, Jenkinson N, Owen SL, Aziz TZ. Translational principles of deep brain stimulation. Nat Rev Neurosci. 2007;8(8):623-35.
115. Karas PJ, Mikell CB, Christian E, Liker MA, Sheth SA. Deep brain stimulation: a mechanistic and clinical update. Neurosurg Focus. 2013;35(5):E1.
116. Martin DM, Liu R, Alonzo A, et al. Can transcranial direct current stimulation enhance outcomes from cognitive training? A randomized controlled trial in healthy participants. Int J Neuropsychopharmacol. 2013;16(9):1927-36.
117. Williams ER, Heckman SJ. The local diurnal variation of cloud electrification and the global diurnal variation of negative charge on the Earth. J Geophys Res. 1993;98(D3):5221-34.
118. Anisimov SV, Mareev EA, Bakastov SS. On the generation and evolution of aeroelectric structures in the surface layer. J Geophys Res. 1999;104(D12):14359-67.
119. Oschman JL. Can electrons act as antioxidants? A review and commentary. J Altern Complement Med. 2007;13(9):955-67.
120. Oschman JL. Charge transfer in the living matrix. J Bodyw Mov Ther. 2009;13(3):215-28.
121. Chevalier G, Sinatra ST, Oschman JL, Sokal K, Sokal P. Earthing: health implications of reconnecting the human body to the Earth's surface electrons. J Environ Public Health. 2012;2012:291541.
122. CHI Institute. Products›infratonics››how it works. http://www.chi.us/infratronichowitworks.htm. August 20, 2015.
123. Fry FJ, Ades HW, Fry WJ. Production of reversible changes in the central nervous system by ultrasound. Science. 1958;127(3289):83-4.
124. Gavrilov LR, Gersuni GV, Ilyinsky OB, et al. The effect of focused ultrasound on the skin and deep nerve structures of man and animal. Prog Brain Res. 1976;43:279-92.
125. Tufail Y, Yoshihiro A, Pati S, Li MM, Tyler WJ. Ultrasonic neuromodulation by brain stimulation with transcranial ultrasound. Nat Protoc. 2011;6(9):1453-70.
126. Arendash GW. Transcranial electromagnetic treatment against Alzheimer's disease: why it has the potential to trump Alzheimer's disease drug development. J Alzheimers Dis. 2012;32(2):243-66.
127. Hameroff S, Trakas M, Duffield C, et al. Transcranial ultrasound (TUS) effects on mental states: a pilot study. Brain Stimul. 2013;6(3):409-15.
128. Gregory D. Four decades of music therapy behavioral research designs: a content analysis of Journal of Music Therapy articles. J Music Ther. 2002;39(1):56-71.
129. Thompson JD. Clinical use of sound. Center for Neuroacoustic Research. http://www.neuroacoustic.com/. Accessed August 20, 2015.
130. Atwater FH. Accessing anomalous states of consciousness with a binaural beat technology. J Sci Explor. 1997;11(3):263-74.
131. Brady B, Stevens L. Binaural-beat induced theta EEG activity and hypnotic susceptibility. Am J Clin Hypn. 2000;43(1):53-69.
134. Lane JD, Kasian SJ, Owens JE, Marsh GR. Binaural auditory beats affect vigilance performance and mood. Physiol Behav. 1998;63(2):249-52.
135. Stux G, Berman B, Pomeranz B. Basics of acupuncture. 5th rev ed. 2003, Berlin: Springer; 2003.
134. Wilkinson J, Faleiro R. Acupuncture in pain management. Cont Ed Anaesthesia Crit Care Pain. 2007;7(4):135-8.
135. Aung SK, Chen WP. Clinical introduction to medical acupuncture. New York: Thieme; 2007.
136. Cao L, Zhang XL, Gao YS, Jiang Y. Needle acupuncture for osteoarthritis of the knee. A systematic review and updated meta-analysis. Saudi Med J. 2012;33(5):526-32.
137. Choi TY, Lee MS, Kim TH, Zaslawski C, Ernst E. Acupuncture for the treatment of cancer pain: a systematic review of randomised clinical trials. Support Care Cancer. 2012;20(6):1147-58.
138. Deare JC, Zheng Z, Xue CC, et al. Acupuncture for treating fibromyalgia. Cochrane Database Syst Rev. 2013 May 31;5:CD007070.
139. Hopton A, MacPherson H. Acupuncture for chronic pain: is acupuncture more than an effective placebo? A systematic review of pooled data from meta-analyses. Pain Pract. 2010;10(2):94-102.
140. Shin HS, Johng HM, Lee BC, et al. Feulgen reaction study of novel threadlike structures (Bonghan ducts) on the surfaces of mammalian organs. Anat Rec B New Anat. 2005;284(1):35-40.
141. Lee C, Seol SK, Lee BC, Hong YK, Je JH, Soh KS. Alcian blue staining method to visualize bonghan threads inside large caliber lymphatic vessels and x-ray microtomography to reveal their microchannels. Lymphat Res Biol. 2006;4(4):181-90.
142. Carlsson C. Acupuncture mechanisms for clinically relevant long-term effects--reconsideration and a hypothesis. Acupunct Med. 2002;20(2-3):82-99.
143. Goldman N, Chen M, Fujita T, et al. Adenosine A1 receptors mediate local antinociceptive effects of acupuncture. Nat Neurosci. 2010;13(7):883-8.
144. Langevin HM, Bouffard NA, Badger GJ, Churchill DL, Howe AK. Subcutaneous tissue fibroblast cytoskeletal remodeling induced by acupuncture: evidence for a mechanotransduction-based mechanism. J Cell Physiol. 2006;207(3):767-74.
145. Takahashi T. Mechanism of acupuncture on neuromodulation in the gut–a review. Neuromodulation. 2011;14(1):8-12; discussion 12.
146. Wackermann J, Seiter C, Keibel H, Walach H. Correlations between brain electrical activities of two spatially separated human subjects. Neurosci Lett. 2003;336(1):60-4.
147. Radin D, Stone J, Levine E, et al. Compassionate intention as a therapeutic intervention by partners of cancer patients: effects of distant intention on the patients' autonomic nervous system. Explore (NY). 2008;4(4):235-43.
148. Nelson R, Bancel P. Effects of mass consciousness: changes in random data during global events. Explore (NY). 2011;7(6):373-83.
149. McCraty R, Deyhle A, Childre D. The global coherence initiative: creating a coherent planetary standing wave. Global Adv Health Med. 2012;1(1):64-77.
150. Tiller WA, Kohane MJ, Dibble WE. Can an aspect of consciousness be imprinted into an electronic device? Integr Physiol Behav Sci. 2000;35(2):142-62; discussion 163.
151. Kohane MJ, Tiller WA. Biological processes, quantum mechanics and electromagnetic fields: the possibility of device-encapsulated human intention in medical therapies. Med Hypotheses. 2001;56(6):598-607.
152. Korotkov KG. Williams BO, Bugno TJ, Parsons PH, et al, editors. Human energy field: study with GDV bioelectrography. Fair Lawn, NJ: Backbone Publishing; 2002.
153. Konikiewicz LW. Introduction to electrography: A handbook for prospective researchers of the Kirlian effect in biomedicine. Harrisburg, PA: Leonard's Associates; 1979.
154. Earle L. Electrophotography. San Francisco: And/Or Press; 1975.
155. Boyers DG, Tiller WA. Corona discharge photography. J Appl Physics. 1973;44(7):3102-12.
156. Bankovskii NG, Korotkov KG, Petrov NN. Physical processes of image formation during gas-discharge visualization (the Kirlian effect) (Review). Radiotekhnik Elektronik. 1986 Apr;31:625-43. Russian.
157. Wisneski LA, Anderson L. The Scientific Basis of Integrative Medicine, Second Edition. 2009, CRC Press. p. 205–229.
158. Cohly H, Kostyuk N, Isokpehi R, Rajnarayanan R. Bio-electrographic method for preventive health care. Paper presented at: IEEE 1st Annual Bioscience and Biotechnology Conference Proceedings; March 18-19, 2009; Oak Ridge, TN. http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=5073918. Accessed August 20, 2015.
159. Korotkov KG, Matravers P, Orlov DV, Williams BO. Application of electrophoton capture (EPC) analysis based on gas discharge visualization (GDV) technique in medicine: a systematic review. J Altern Complement Med. 2010;16(1):13-25.
160. Jakovleva E, Korotkov K, eds. Electrophotonic applications in medicine: GDV bioelectrography research. e-book. 2013. ISBN 978-1481932981.
161. Gagua PO GE, Georgobiani LG, Kapanadze A, et al. The GDV technique application to oncology. In: Korotkov K, Tunik A, editors. Measuring energy fields: state of the science. Fair Lawn, NJ: Backbone Publishing; 2004:43-50.
162. Yurth DG. Torsion field mechanics: verification of non-local field effects in human biology. June 23, 2000. http://www.clayandiron.com/news.jhtml?method=view&news.id=1509. Accessed August 20, 2015.
163. Swanson C. Life force, the scientific basis: breakthrough physics of energy medicine, healing, chi and euantum consciousness. Tucson, AZ: Poseidia Press; 2011.
164. Blumenfeld R. Willhelm Reich andcharacter analysis. In: Blumenfeld R, ed. Tools and techniques for character interpretation: a handbook of psychology for actors, writers, and directors. Pompton Plains, NJ: Limelight Editions; 2006:135-7.
165. Bellis M. Wilhelm Reich and the orgone accumulator. About Money. http://inventors.about.com/od/qrstartinventors/a/orgone.htm Accessed August 20, 2015.
166. Gardner M. Fads and fallacies in the name of science. New York: Dover; 1957.
167. Patten T, Hutchison M. Interview with Lt. Col. Thomas E. Bearden (ret). Megabrain Report. Febraury 4, 1991. http://www.cheniere.org/misc/interview1991.htm. Accessed August 20, 2015.
168. Scalar Waves Healing Center. History and health benefits of scalar wave healing.www.wavesofhealing.net/aboutscalarwaves.html. Accessed August 20, 2015.
169. Havelka D, Cifra M, Kučera O, Pokorný J, Vrba J. High-frequency electric field and radiation characteristics of cellular microtubule network. J Theor Biol. 2011;286(1):31-40.
170. Schneider MV. Defining systems biology: a brief overview of the term and field. Methods Mol Biol. 2013;1021:1-11.

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ORIGINAL ARTICLE

Clinical Studies of Biofield Therapies: Summary, Methodological Challenges, and Recommendations

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ABSTRACT

Biofield therapies are noninvasive therapies in which the practitioner explicitly works with a client's biofield (interacting fields of energy and information that surround living systems) to stimulate healing responses in patients. While the practice of biofield therapies has existed in Eastern and Western cultures for thousands of years, empirical research on the effectiveness of biofield therapies is still relatively nascent. In this article, we provide a summary of the state of the evidence for biofield therapies for a number of different clinical conditions. We note specific methodological issues for research in biofield therapies that need to be addressed (including practitioner-based, outcomes-based, and research design considerations), as well as provide a list of suggested next steps for biofield researchers to consider.

INTRODUCTION

Healing practices that purport to sense and modulate "subtle energies" of the body have existed for thousands of years in a wide range of cultures.[1] This family of practices, which includes healing touch (HT), Johrei, Pranic healing, Reiki, qigong and therapeutic touch (TT), is increasingly referred to as *biofield therapies*, a term coined during the US National Institutes of Health Conference in 1992.[2] In this paper, biofield therapies are defined as noninvasive, practitioner-mediated therapies that explicitly work with the biofield of both the practitioner and client to stimulate a healing response in the client.

At this same 1992 conference, *biofield* was defined as "a massless field, not necessarily electromagnetic, that surrounds and permeates living bodies and affects the body."[2] For this paper, we expand the definition to consider biofields as endogenously generated fields, which may play a significant role in information transfer processes that contribute to an individual's state of mental, emotional, physical, and spiritual wellbeing.

A challenge for the general incorporation of biofield therapies into conventional clinical care is the limited understanding of the mechanisms of these therapies within the biomedical paradigm (see Hammerschlag et al, this issue). But despite controversies and current gaps in research, biofield therapies are widely used by the public and by certain patient populations. Patient groups who often report using biofield therapies include those with cancer and those receiving palliative care.[3,4] An epidemiological survey from 2007 states that in the year prior, over 1.2 million adults and 161 000 children reported receiving at least 1 session of a biofield therapy.[5] More recent data from the 2012 National Health Interview Survey reveal that over 3.7 million US adult citizens surveyed "have ever" seen a practitioner for energy healing therapy, with over 1.6 million adults in the US reporting seeing an energy healing therapy practitioner at least once in the past 12 months. Further, only 8% of the survey group reported that any costs of seeing an energy practitioner was covered by insurance.[6]

Other indicators of biofield therapy utilization are that training in these practices is increasingly prevalent among healthcare professionals and that such practices are offered to patients in a limited number of clinical settings, including hospitals.[7] Biofield therapies such as TT are recognized in the *Nursing Intervention Classification Code*[8] and are recognized by some state licensure boards as within the scope of nursing practice. Given the relatively high use of biofield therapies by the US public, coupled with the current paucity of insurance coverage, it is important to examine the evidence base for these therapies to assess their effectiveness for clinical populations.

When assessing clinical effectiveness of biofield therapies, it is important to recognize 2 main distinctions in the manner they are practiced. First, biofield therapies may be delivered either proximally (with the practitioner and the receiver in the same room) or distally (with the practitioner and receiver not in the same room; in some cases, separated by hundreds or thousands of miles). This latter form of distal treatment,

usually called *distant healing*, is described in a separate article in this supplement (Radin et al) and is not further discussed here.

When reviewing clinical trial-based evidence of biofield therapy effectiveness, it should be noted that proximally delivered treatments are performed both with and without physical touch, often within the same clinical session. Thus distinct research questions can be asked when evaluating the evidence base for biofield therapies. We can ask whether these practices have been found effective in trials that assessed the more common, real-world mode of delivery, ie, with the practitioner free to combine hands-on and hands-off procedures. We can also ask, as an approach to more directly examine biofield involvement, whether biofield therapies appear effective when treatment has been delivered only with practitioners moving their hands above and along the body with nonphysical contact.

Clinical trials and recent systematic reviews that address each of these aspects of proximal healing (trials testing combined hands-on and hands-off treatment and trials that have reported using only hands-off treatment) will be summarized in the first section of this article as a means of assessing the strength of the current evidence base for biofield therapy. Following the review of clinical trial-based evidence, we examine the methodological challenges facing the design and implementation of biofield therapy trials. While some attention is given to research design issues shared with other trials of complementary and alternative medicine (CAM) modalities (eg, chronic underpowering due in part to the paucity of funding opportunities), a major focus of this section is on methodological challenges that are particularly unique to clinical trials of biofield therapies, where the nature of what is being tested—what is occurring between practitioner and receiver during a healing session—is unknown.

The final section of this article will utilize the state of the evidence base, together with the identified research design issues to inform a set of recommendations to guide further progress in this emerging area of biofield therapy research. Clinical trials of biofield therapies are of obvious value for assessing whether there is a "there there," as well as to offer directions for physiological studies of endogenous biofields (Hammerschlag et al, this issue). In a reciprocal manner, research on biofield physiology and biofield-related medical devices (Gurfein et al, this issue) is of considerable value for identifying relevant biomarkers that may strengthen the design and outcomes of future clinical trials of biofield therapies.

A separate but related set of therapies, often called energy psychology therapies, combine biofield interventions like tapping on specific points of the face or body with cognitive behavioral techniques. These therapies are often used to target psychological outcomes, such as posttraumatic stress disorder (PTSD), depression, anxiety, and addictions. Energy psychology therapies include Thought Field Therapy, Emotional Freedom Technique, Tapas Acupressure, and others. While this paper precludes the review of these energy psychology therapies, the interested reader may find more information on the IONS (http://www.noetic.org/research/project/mapping-the-field-of-subtle-energy-healing/#eft) and Association of Comprehensive Energy Psychology website (http://www.energypsych.org) about these and other related therapies.

CLINICAL STUDIES OF BIOFIELD THERAPY EFFECTIVENESS: STATE OF THE EVIDENCE

Systematic reviews of clinical trials of biofield therapies have been conducted from a number of different perspectives. Such reviews have included (1) all biofield therapies tested for any condition[9]; (2) all biofield therapies tested for specific conditions, eg, cancer,[10–12] pain,[13] and cardiovascular disease[14]; (3) specific biofield therapies for any condition, eg, HT[15] and Reiki[16–19]; and (4) specific biofield therapies for specific conditions, eg TT for wound healing[20] or for pain.[21] In addition (as briefly discussed above), while biofield therapies are commonly delivered via a combination of hands-on and hands-off procedures, 2 recent systematic reviews have focused on randomized controlled trials (RCTs) of biofield therapies for any condition that have reported use of only nonphysical touch forms of treatment.[22,23]

In this section, we highlight findings from the broadest of the above-listed systematic reviews as an approach to identify those clinical areas with the most promise for integration of biofield therapies into conventional care as well as for future research.

Pain

To date, there have been over 30 published clinical trials reporting effects of biofield therapies for pain in ambulatory and hospitalized patient populations with chronic pain, arthritis, and movement restriction. A systematic review by Jain and Mills[9] that included both RCTs and quasi-experimental studies of biofield therapies applied best-evidence synthesis criteria and suggested that proximally practiced biofield therapies demonstrated strong evidence (evidenced by at least 2 high-quality RCTs and minimal to no conflicting evidence) for reducing self-reported pain intensity (generally measured via the visual analog scale) in a variety of patients, including the elderly and those with chronic pain. Several studies in this review had large effect sizes indicating both statistical and clinical significance. Similar positive findings were reported in a prior independent Cochrane review[16] that examined RCTs of biofield therapies for pain and concluded that biofield therapies reduced pain beyond that of sham- and no-treatment controls. Overall, studies suggest that biofield therapies may be particularly promising for alleviating pain intensity as compared to sham treatments. However, the effectiveness of biofield therapies assessed with pain measures that incorporate more affective and evaluative labeling, such as the McGill Pain Inventory, are less clear.[9]

Research on biofield therapies for pain could benefit, as could pharmacological trials of pain, from interdisciplinary research that complements self-reported pain measures with assessments of other clinically-relevant outcomes (eg, pressure-pain threshold).[24] While many studies report beneficial effects of biofield therapies over and above placebo controls, it is still unclear how biofield therapies lead to reduced pain. For example, it is unclear whether biofield therapy amelioration of pain could be mediated by "bottom-up" processes, such as reductions in cellular inflammation or nociceptive signaling and/or "top-down" processes such as cortical nociceptive control mechanisms. Experimental studies examining the effects of biofield therapies on known objective pain pathways would also be helpful at this juncture. At least 1 study has examined the effects of a biofield therapy (TT) on nociceptive threshold in a mouse model.[25] Studies examining inflammatory immune, neuroendocrine (eg, oxytocin, endogenous opioids), and neural activity correlates (eg, via functional magnetic resonance imaging [fMRI]) would also be useful, and these results could be compared to those found for placebo analgesia[26,27] to determine whether common pathways exist. Finally, given that other practitioner-assisted integrative practices (such as acupuncture) have been shown to be effective for pain,[28] the incorporation of biofield therapies into comparative effective research designs to enable direct comparison with other integrative approaches would be valuable.

Cancer

More than 15 clinical trials have been conducted with biofield therapies in patients with cancer, both during and after conventional biomedical treatment. Most studies have focused on the effects of biofield therapies as adjunctive care to reduce symptoms of pain, fatigue, anxiety, and depression. In a 2010 systematic review, evidence for reducing cancer-related pain with biofield therapies was rated "moderate" in at least 1 high-quality RCT, though "conflicting evidence" was found for reducing fatigue and improving quality of life.[9] Since this review, several high-quality studies of HT for cancer-related symptoms have been published[29-32] with reports of clinically significant reductions in depression and persistent fatigue, as well as positive effects on clinically-relevant biological markers.[29,30] For example, significant effects of biofield treatments have been seen on diurnal cortisol variability in fatigued breast cancer patients as compared to mock treatments or standard care,[30] and in cervical cancer patients, biofield treatment improved depressive symptoms and blunted the drop in natural killer cell cytotoxicity otherwise seen in the relaxation therapy and usual care comparison groups.[29] However, most studies with biofield therapies in cancer have not investigated the potential impact of these therapies on clinical biomarkers. Additionally, not all cancer studies have shown improvements with biofield treatments.[11,32]

Whereas the impact of biofield therapies on cancer tumor markers and other clinical biomarkers has been minimally studied, several preclinical (animal and cell) studies, many with sham controls, have investigated the impact of biofield therapies in various cancer models (Gronowicz et al, this issue). As examples, biofield therapies have been tested on multiple tumor types, with reports of inhibition of DNA synthesis and mineralization in osteosarcoma, inhibition of cell cycle and induction of apoptosis in prostate cancer cells[33] and colorectal cancer cells,[34] and inhibition of migration and invasion of breast cancer cells.[35] Results from these promising preclinical studies suggest a need to further investigate biological signaling mechanisms in biofield therapies in treating cancer and cancer-related symptoms. Importantly, effects of biofield therapies on clinical outcomes and disease trajectory in cancer patients have not yet been investigated.

OTHER CLINICAL CONDITIONS WARRANTING FURTHER STUDY

A few clinical studies have been conducted evaluating biofield therapies on cardiovascular function,[36-39] with promising results in terms of increasing heart rate variability (HRV) and reducing stress-related symptoms such as anxiety, which is known to negatively impact cardiovascular function in coronary patients. Notably, a recent RCT of Reiki on autonomic activity in inpatients during recovery from acute coronary syndrome reported a statistically significant improvement in high-frequency HRV compared to both a classical music control and resting control. Effect sizes for the Reiki condition were comparable to that of propranolol.[36] Another RCT noted the reduction of both anxiety and length of hospital stay for coronary artery bypass graft (CABG) patients receiving HT vs nurse visits alone or treatment as usual, with no differences found between groups on pain medication use or atrial fibrillation incidence.[37] Notably, both of these studies provided very brief interventions: 1 session of Reiki in the coronary syndrome RCT[36] and 3 sessions of HT (1 day before, immediately before, and 1 day after surgery) for the CABG RCT.[37] These studies suggest that even brief biofield interventions can generate salutogenic effects and elicit questions regarding the potential effects with longer durations or frequencies of treatment.

While limited in number, these promising findings suggest a need to further examine the effects of biofield therapies on psychosocial symptoms, cardiovascular function, and cost-effectiveness outcomes in cardiovascular disorders. Due to the paucity of studies in this area, little is known about the potential effects of biofield therapies on physiological indices related to cardiovascular outcomes. Of note, improvements in heart rate homeostasis in rats in response to Reiki relative to sham Reiki[38] suggest that effects of biofield therapies may reach beyond placebo effects. Given that HRV is an important prognostic indicator of cardiovascular events including sudden cardiac death,[39] further

studies examining the potential biobehavioral links between biofield therapies, psychosocial symptom reduction, and clinical outcomes are warranted.

Positive results of biofield therapies have been reported in other populations, including those patients with dementia[40-43] and osteoarthritis,[44,45] as well as pediatric oncology outpatients.[46] In addition, there is need for investigation of biofield therapies in palliative care, where these therapies are often delivered.[47]

Several reviews since the 2010 best evidence synthesis of Jain and Mills have examined clinical research based on the biofield modality.[14,15,19] Overall, these reviews point to the same general conclusions: there is promising but limited evidence based on relatively few studies with insufficient sample sizes as well as methodological issues that could be improved to better understand the effects of biofield therapies in a clinical context.

Because federal and private-sector funding for the study of biofield therapies is notably limited at present, it is important that any studies carefully address the most salient gaps in terms of knowledge and methodology. This will help to augment interest and funding for this important area of clinical research in the future. With this in mind, to aid budding and seasoned researchers in designing the most relevant and scientifically sound clinical studies in biofield therapies, the nature of these methodological weaknesses—with suggestions on how to best improve biofield therapy clinical research—is addressed in the following section.

METHODOLOGICAL ISSUES IN CLINICAL STUDIES OF BIOFIELD THERAPIES

We note that many of the methodological and statistical recommendations previously made for biofield research[48] are similar to the weaknesses of research designs utilized to assess most other CAM modalities. Such flaws commonly lie with aspects of randomization, control groups, blinding, power analysis, intention-to-treat analysis, and assessment of covariates. As general aspects of research design, these issues have been well discussed[49] and will not be reviewed again here. This section will focus on methodological issues more specific to biofield therapy research.

Treatment Considerations: Dosing, Type, and Delivery

Nearly all reviews of clinical studies on biofield therapies note that there is a lack of clarity regarding the extent to which dose, mode of delivery, and type of therapy (eg, Reiki, HT, or TT) impact clinical outcomes.

Dose

Most studies have not been designed in a manner to effectively answer a dose-response question. In particular, it is unclear whether "dose" is simply a reflection of the amount of time and frequency of treatments, since the strength of the therapy may vary according to the practitioner. In real-world practice, most practitioners apply "energy" until they feel that the field of the client/patient has "changed" or an energetic block, excess, or leak has resolved. Individualization of energetic modulation based on the patient's presentation is thought to be important for the most effective treatment. Clearly, this idea runs counter to a research design based on standardized protocols, even when specific aspects of the treatment protocol are described. Yet more creative research designs could be employed to better get at the issue of "dose." This also speaks to the need to develop better means of measuring what is occurring between practitioner and receiver.

Type of Treatment

There is little known at this point about the comparative effectiveness of different biofield healing techniques in terms of either their clinical efficacy for particular conditions or the actual type/quality of healing they provide. Questions around efficacy may arise even within each tradition, as within several of the specific therapies, there are "hands-on" and "hands-off" approaches.

While ultimately comparing and contrasting different forms of biofield therapies for given clinical ailments may prove useful in matching patients with particular types of biofield therapies, the literature base is too sparse to begin to compare different modalities in terms of their efficacy in different patient populations. However, understanding practitioner reports on how different diseases are understood and treated across different biofield healing traditions could be valuable in guiding research at this juncture. Some researchers have begun this process of comparing similarities and differences in practitioners' perceptions of their practice,[50] and further inquiry is needed to determine how different biofield therapy traditions conceptualize and treat different disease populations.

Extent of Touch: Hands-on vs Hands-off Techniques

A major distinction in biofield therapies involves whether the practitioner engages the patient's biofield with direct physical contact (hands-on) or without physical contact (hands-off). Several modalities such as Reiki, HT, and Brennan Healing contain techniques that are both hands-on and hands-off (but in close proximity), with these different techniques used for different purposes. Others (such as Johrei and external qigong) are generally practiced with hands at a slightly further distance from the body.

From a practitioner perspective, comparing a hands-on approach with a hands-off approach may not make sense for a given clinical condition, as the technique is selected based on the clinical presentation and used for a specific effect. However, some scientists who are interested in research concepts and designs to elucidate mechanism of biofield therapies view hands-on approaches as confounded by touch, which has its own beneficial effects that may well be mediated by sensory nerve endings and/or hormonal release. A recent review, which specifically examined only RCTs with non–

physical contact biofield modalities, identified 28 trials with heterogeneous populations that met inclusion criteria (20 of the 28 having sham controls). Further investigation of the subgroup of 18 higher-quality trials revealed that 12 reported significant beneficial effects in at least 1 outcome. However, similar to other reviews, small sample sizes in most studies was noted as a hindrance to drawing definitive conclusions.[22]

For those concerned about "confounding" effects of touch, one approach has been to have "sham" practitioners mimic hands-on as well as hands-off approaches. While the use of sham practitioners may control for effects such as presence, support and attention, touch, skill, and healing intention, this approach may not fully control for actual biofield effects, as electromagnetic emanations exist from all living systems and simple social interactions have been found to produce biofield interaction effects.[51]

As implied above, the study design selection of the biofield therapy and whether to use a hands-on, hands-off, or a combination protocol should depend mainly on the research question. If the focus is on assessing real-world practice, then either an efficacy (sham-controlled) or a comparative effectiveness (usual care comparison) design is appropriate. In this case, the researcher should consult with several practitioners who work with the clinical condition on a regular basis and have known clinical successes with the population of study. The treatment protocol can be guided by what the practitioners have found works best in their clinical practice. On the other hand, if the research focus is more mechanistic and the goal is to determine whether factors such as touch or distance play a role in promoting healing, then the researcher may want to seek biofield therapists who have experience using entirely hands-off (nonphysical touch) treatments in their practice.

Practitioner Selection

A major challenge facing biofield therapy research is how to determine a practitioner's skillset with respect to healing efficacy. Currently, most researchers rely on statements attesting to the practitioner's experience with the clinical condition, how long the practitioner has been in practice, and whether s/he is known to others for his/her clinical expertise. While this is the current process for practitioner selection, it is not optimal for research. What is clearly needed is a procedure to test whether biofield therapists are able to achieve a criterion level of effect in order to be involved in research. While therapy (whether psychotherapy, physical therapy, or biofield healing) can be standardized and manualized for research, the ability to follow and execute a manualized therapy does not necessarily reflect a verifiable level of skill. Tests that might "calibrate" practitioners' ability to interact with the biofield might be useful for prescreening practitioners prior to their participation in a clinical trial.[52]

As a general rule, selection of biofield practitioners depends on the research question. If the researcher seeks to understand whether a local practitioner community (eg, a group of Reiki or HT practitioners who deliver services in a particular hospital or clinic) can affect patient outcomes, a study examining the effectiveness of a specific intervention would be appropriate. For studies designed to examine biofield approaches for a difficult-to-treat or severe clinical condition, studying a practitioner who has demonstrated experience and clinical success in working with that clinical condition may be appropriate.

In summary, questions of dose, type of treatment, and practitioner selection should be guided by the research question and by feasibility of implementation.

CONSIDERATIONS OF MODERATORS, MEDIATORS, AND "MECHANISM"

There has been confusion, by both researchers and funders, regarding the need to include analysis of potential mechanisms in early stage clinical studies of biofield therapies. As with other controversial healing modalities, there is pressure to demonstrate "biologically plausible mechanisms" of biofield therapies. We argue that elucidating mechanisms, while important in helping to understand and even improve upon a therapy's effects, is not essential for conducting rigorous and potentially informative clinical trials of any therapy. It is also the case that clinical trials may be well suited to elucidate treatment moderators (variables that are present in the population prior to the treatment and modify the effects of the treatment on an outcome variable but are not correlated with treatment) and mediators (variables that are part of a causal pathway of effects of the treatment on the outcome variable and therefore modify effects of treatment on the outcome variable).[53] A possible example would be examining whether the gender of the patient significantly predicted outcomes in response to the therapy—ie, whether gender is a moderator of treatment. An example of a mediator would be to examine whether changes in HRV in response to a biofield intervention mediated the effects of the intervention on depression (ie, whether improvements in postintervention depression are fully or partially caused by mid-intervention changes in HRV). Exploration of potential moderators and mediators of treatment may lead to better empirically based hypotheses for testing mechanisms of biofield therapies. In general, clinical trials examining efficacy of biofield therapies as practiced in clinical settings provide important impetus for preclinical research to more clearly examine biologically based mechanisms using experimental paradigms.

A key hindrance to understanding potential mechanisms of biofield therapies is the absence of a reliable measure of the purported biofield emanations from the practitioners. While there have been a few reports regarding emanations from certain practitioners,[54-56] creating a systematic method to examine such bioenergetic signals is a crucial step to better understand the physiological basis of biofield therapy.

The development of systematic methods examining bioenergetic signals from practitioners may help us better understand, for example, whether the efficacy of the healing interaction is directly proportionate to the strength of the biofield emanation, to a particular pattern of biofield emanation, or whether there are other factors apart from or in addition to bioenergetic signaling that significantly contribute to the outcomes of the practitioner/client encounter. As interested engineers and scientists further develop techniques to measure emanations from practitioners at different electromagnetic frequencies, it will be of interest to determine whether specific patterns of bioenergy emanation are predictive of better healing outcomes. At the same time, there are potential pitfalls from assuming that electromagnetic emanations are the sole explanation for the experience and practice of biofield therapies,[50] as they would not account, for example, for the results of distant healing studies carried out in electromagnetically shielded environments (see Radin et al, this issue).[57,58]

Placebo Elements: Main Effects or Moderators?

Much has been written regarding both the limitations and misinterpretation of placebo-controlled randomized trials in biofield therapies and integrative medicine in general.[59] While biofield therapies may serve to enhance the "placebo effect,"[48] it does appear that biofield therapies enhance outcomes over and above sham-controlled groups, particularly for pain.[13] However, placebo elements such as belief in receiving biofield therapy (regardless of group assignment) have also been shown to affect clinically relevant outcomes such as quality of life.[30]

To date, studies examining placebo have been designed to examine whether placebo vs verum treatments were more explanatory of outcomes and were not designed to examine whether placebo variables (such as expectation or patient/practitioner relationship) moderated effects of treatment. It is plausible that there is an interactive rather than an "either-or" process for biofield therapies and placebo responses, such that the enhancement of placebo (ie, self-healing) elements would enhance the delivery and the potential outcomes for biofield therapies.

Thus current data suggest it is unlikely that biofield therapies are reducible to placebo responses alone, but like other forms of mind-body medicine interventions and biomedicine in general,[60,61] biofield therapy may intentionally harness the patient's conscious and unconscious expectancies and desires in synergy with the treatment being delivered to enhance outcomes. Such an effect has been hinted at in current studies in other integrative modalities such as acupuncture.[62-64] In order to adequately examine the potential impact and interaction of placebo elements with biofield therapies, additional studies are needed with sample sizes robust enough to allow for testing of moderation effects with placebo elements.

CAPTURING OUTCOMES FOR BIOFIELD THERAPIES: BIOMARKERS, COST-EFFECTIVENESS, AND QUALITATIVE AND WHOLE-SYSTEMS OUTCOMES

In keeping with the notion of "patients as partners in research," a primary goal of outcomes research for biofield therapy is to identify and evaluate outcomes of highest concern to the prospective patient group. In general, biofield therapies are understood to affect the whole person and therefore a broad array of whole-person outcomes is needed to adequately assess their effects. In addition to patient-identified outcomes, there are clear advantages to capturing outcomes across domains, including biomarkers, clinical response, cost-effectiveness, and qualitative data, so that their relative and combined contributions, in keeping with a more biopsychosociospiritual model, can be determined.

Biomarkers

Biomarkers, defined as physiological variables that have significant clinical relevance to the population being studied, may include measures of immune, endocrine, psychophysiological, autonomic nervous system (including skin conductance and HRV), and other neural functions (including electroencephalography, fMRI, positron emission tomography). Biomarkers may indicate which physiological systems are affected by biofield therapy but do not necessarily shed light on the pathways by which these changes occur nor on the transduction events by which practitioner activity is converted to patient responses that initiate the cascade of physiological changes.

In terms of current biofield therapy research, several studies have examined more "global" biomarkers such as HRV and/or single measures of cortisol or natural killer cell cytotoxicity as outcomes either in healthy or specific clinical populations.[12,13,16,18,29,38-41,43,65-68] Such markers were chosen for ease of acquisition/feasibility and potential relevance to the clinical population being studied. Reported changes in these specific outcomes suggest that biofield therapies have positive effects on physiological processes of clinical relevance.

Cost-effectiveness

In order to better integrate biofield therapies into integrative medicine and clinical practice generally, it is important to consider cost-effectiveness.[69,70] While a full cost-benefit analysis is prohibitory for most early-phase clinical trials of biofield therapies, examining cost-effectiveness outcomes such as changes in medication usage, number of days in hospital, days of treatment, or quality-adjusted life years will be highly useful for aiding decision-making in regard to the value of biofield therapy as adjunctive care in a hospital's or clinic's portfolio of services. Thus we strongly recommend, particularly for clinical trials of biofield therapies being conducted with hospitalized patients or ambulatory patients with frequent clinic visits, that cost-effectiveness assessments be designed as a substudy.

Qualitative Outcomes

Nurses, who are often also biofield therapy practitioners, have designed and conducted many of the biofield therapy trials. The rich interest in qualitative research within the nursing profession has led to inclusion of this type of data collection—eg, patient- and practitioner-reported experience—in many biofield therapy trials.[50,71] These qualitative outcomes are of significant importance in helping to understand the immediate as well as the persisting health effects of biofield therapies, including psychospiritual experiences that are often difficult to capture via surveys of outcomes.

Practitioners of biofield therapies can be a valuable resource in guiding both the practice and the science of biofield therapies and could, with collaborative support of researchers, prepare meaningful case reports and even best-case series on their patients. Best-case series have been found to be useful in guiding the science of CAM therapies in cancer.[72] The process of developing and publishing an effective case report is also well documented.[73,74] Practitioners are encouraged to follow the CARE guidelines (http://www.care-statement.org/) to aid in creating case reports on biofield therapy effects in clinical practice.

EDUCATING TO OVERCOME BARRIERS

A key issue in increasing awareness of this area of study is educating healthcare workers and the general public about biofield theory and research. Because biofield therapies do not involve the use of invasive agents like medication, needles, or supplements and because they invoke concepts that are somewhat foreign to many allopathically trained physicians, discussion around stimulating a healing response by working with energy fields often elicits responses that the entire field of study is fraught with pseudoscience. A significant challenge for this field of study is presented by otherwise well-meaning practitioners and advocates who describe or utilize ill-designed scientific methods to "prove" that their method of healing works. These efforts increase barriers to conducting this work. However, in many cases, the barriers are more due to a general lack of conceptual knowledge about biofields and the need to explain hypotheses about biofields in a manner that can be understood and to ensure that people are educated on the state-of-the-evidence and most salient gaps in the research.

In general, a key strategy for increasing interest in biofield science may be to help others understand that "biofields" do not just apply to "biofield therapies" but rather are relevant to the mechanisms by which mind and body interact to promote healing responses. However, in the context of overcoming barriers to successful conduct of biofield therapy research, we suggest the following steps: (1) understand the language of the target audience/stakeholder and speak within their linguistic frameworks wherever possible; (2) highlight the best science in the area and specifically note aspects such as benefit/harm ratios, clinical effect sizes, clinically relevant outcomes, inconsistent findings, gaps in knowledge, and attrition rates for biofield therapies; and (3) provide case examples and possibly actual exercises that allow the audience/stakeholder to potentially experience a sense of the biofield and arouse curiosity.

Funding is a significant challenge in moving forward with biofield research. The National Institutes of Health's National Center for Complementary and Integrative Health (NCCIH, formerly the National Center for Complementary and Alternative Medicine) currently includes biofield therapies in its strategic plan in the mind and body therapies category, an area with funding priority. NCCIH also identified pain research as a priority, so this may be a fruitful avenue to explore for funding for biofield clinical studies. Other organizations such as the Patient Centered Outcomes Research Institute, which supports research, may support studies in biofield therapies, particularly if there is evidence that there is significant public interest. The Department of Defense could also be an avenue for funding, as pain, traumatic brain injury, and PTSD are clinical problems that have been found to respond to biofield therapies. Donations from private foundations have supported previous research in biofield therapy clinical trials and should also be pursued.

Educating program officers and reviewers at funding agencies about the current state of biofield research is an important step the field must take. This may be accomplished by presenting symposia at professional meetings, creating special peer-reviewed journal issues such as this one, and other specific strategies to inform this important set of stakeholders about the area of research and most strategic areas for investment to move the field forward.

An equally challenging task is educating our colleagues and new investigators in the rigorous study designs and optimal approaches necessary to secure funding to build the evidence base for biofield research. Given the controversial nature of this area, those proposing research in biofield research may be well advised to ask a number of colleagues unfamiliar with the field to carefully review proposals before submission.

Finally, much of this work has been conducted through—and likely will continue to be supported by—philanthropy. Finding champions who have an interest in these types of modalities and inquiring whether they would be willing to contribute to a well-designed study is certainly appropriate and will continue to be needed at this juncture.

SUMMARY AND KEY RECOMMENDATIONS

To summarize, the evidence base regarding clinical effectiveness of biofield therapies is strongest in symptom management for pain and cancer, the 2 conditions that have received the most study. Studies are more sparse but evidence is promising for clinical populations with arthritis, dementia, and heart disease. To better assess the impact of biofield therapies and

evaluate their delivery in various settings, we make the following recommendations for researchers planning future clinical trials in biofield therapies:

1. Expand on studies for promising conditions—eg, pain and cancer—with larger efficacy and comparative effectiveness trials. In addition, conduct pilot studies in populations where present evidence is promising but studies are limited (eg, patients with dementia, cardiovascular disorders, osteoarthritis).
2. Design additional biofield therapy trials aimed at elucidating moderators, mediators, and mechanisms that assess clinically relevant biomarkers.
3. Consider conducting pilot clinical trials of biofield therapies where clinical practice suggests beneficial effects but minimal research currently exists (including but not limited to palliative and pediatric populations).
4. Incorporate "dosing" designs and careful decision-making with respect to the dose and type of therapies and/or practitioners selected for the clinical outcome of interest along with developing protocols that allow individualized treatment.
5. Adopt the "patient as research partner" model to incorporate patient-selected outcome measures.
6. Assess the role of placebo elements—eg, patient beliefs and expectations— as potential moderators of biofield therapy effects.
7. Design trials that incorporate a whole-systems approach to outcome variables, including validated survey outcomes, clinically relevant biomarkers, qualitative data, and cost-effectiveness outcomes.

It is our hope that the next decade will bear significant increase in research efforts of sufficient rigor and size to provide a greater understanding of the potential impact of biofield therapies in clinical care.

REFERENCES

1. Levin J. Energy healers: who they are and what they do. Explore (NY). 2011;7(1):13-26.
2. Rubik B, Pavek R, Greene E, Laurence D, Ward R, Al E. Manual healing methods. In: Rubik B, et al, editors. Alternative medicine: expanding medical horizons: a report to the National Institutes of Health on alternative medical systems and practices in the United States. Washington, DC: US Government Printing Office; 1995:113-57.
3. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. Natl Health Stat Report. 2008;(12):1-23.
4. Kemper KJ, Vohra S, Richard W; Task Force on Complementary and Alternative Medicine; Provisional Section on Complementary, Holistic, and Integrative Medicine. The use of complementary and alternative medicine in pediatrics. Pediatrics. 2008;122(6):1374-86.
5. Molassiotis A, Fernadez-Ortega P, Pud D, et al. Use of complementary and alternative medicine in cancer patients: a European survey. Ann Oncol. 2005;16(4):655-63.
6. US Centers for Disease Control and Prevention. National health interview survey: 2012 data release. http://www.cdc.gov/nchs/nhis/nhis_2012_data_release.htm2012 National Health Interview Survey (NHIS) Adult Complementary and Alternative Medicine Public Use File (ALT).; 2013. Accessed September 2, 2015.
7. Lorenc A, Peace B, Vaghela C, Robinson N. The integration of healing into conventional cancer care in the UK. Complement Ther Clin Pract. 2010;16(4):222-8.
8. Bulechek GM, Butcher HK, Dochterman JM editors. Nursing Interventions interventions Classificationclassification. 5th ed. Philadelphia, PA: Elsevier; 2007.
9. Jain S, Mills PJP. Biofield therapies: helpful or full of hype? A best evidence synthesis. Int J Behav Med. 2010;17(1):1-16.
10. Gonella S, Garrino L, Dimonte V. Biofield therapies and cancer-related symptoms: a review. Clin J Oncol Nurs. 2014;18(5):568-76.
11. Anderson JG, Taylor AG. Biofield therapies and cancer pain. Clin J Oncol Nurs. 2012;16(1):43-8.
12. Pierce B. The use of biofield therapies in cancer care. Clin J Oncol Nurs. 2007;11(2):253-8.
13. So PS, Jiang Y, Qin Y. Touch therapies for pain relief in adults. Cochrane Database Syst Rev. 2008 Oct 8;(4):CD006535.
14. Anderson JG, Taylor AG. Biofield therapies in cardiovascular disease management: a brief review. Holist Nurs Pract. 2011;25(4):199-204.
15. Anderson JG, Taylor AG. Effects of healing touch in clinical practice: a systematic review of randomized clinical trials. J Holist Nurs. 2011;29(3):221-8.
16. vanderVaart S, Gijsen VMGJ, de Wildt SN, Koren G. A systematic review of the therapeutic effects of Reiki. J Altern Complement Med. 2009;15(11):1157-69.
17. Lee MS, Pittler MH, Ernst E. Effects of reiki in clinical practice: a systematic review of randomised clinical trials. Int J Clin Pract. 2008;62(6):947-54.
18. Vitale A. An integrative review of Reiki touch therapy research. Holist Nurs Pract. 2007;21(4):167-79; quiz 180-1.
19. Thrane S, Cohen SSM. Effect of Reiki Therapy on Pain and Anxiety in Adults: An In-Depth Literature Review of Randomized Trials with Effect Size Calculations. Pain Manag Nurs. 2014;15(4):897-908.\
20. O'Mathúna DP, Ashford RL. Therapeutic touch for healing acute wounds. Cochrane Database Syst Rev. 2014 Jul 29;7:CD002766.
21. Monroe CM. The effects of therapeutic touch on pain. J Holist Nurs. 2009;27(2):85-92.
22. Hammerschlag R, Marx BLB, Aickin M, Marx A. Nontouch biofield therapy: a systematic review of human randomized controlled trials reporting use of only nonphysical contact treatment. J Altern Complement Med. 2014;20(12):881-92.
23. Roe CA, Sonnex C, Roxburgh EC. Two meta-analyses of noncontact healing studies. Explore (NY). 2014;11(1):11-23.
24. Chesterton LS, Sim J, Wright CC, Foster NE. Interrater reliability of algometry in measuring pressure pain thresholds in healthy humans, using multiple raters. Clin J Pain. 2007;23(9):760-6.
25. Dos Santos DS, Marta IER, Cárnio EC, de Quadros AU, Cunha TM, de Carvalho EC. Using an experimental model for the study of therapeutic touch. Rev Lat Am Enfermagem. 2013;21(1):442-9. English, Portuguese, and Spanish.
26. Sevel LS, Craggs JG, Price DD, Staud R, Robinson ME. Placebo analgesia enhances descending pain-related effective connectivity: a dynamic causal modeling study of endogenous pain modulation. J Pain. 2015;16(8):760-8.
27. Lui F, Colloca L, Duzzi D, Anchisi D, Benedetti F, Porro CA. Neural bases of conditioned placebo analgesia. Pain. 2010;151(3):816-24.
28. Han JS. Acupuncture analgesia: areas of consensus and controversy. Pain. 2011;152(3 Suppl):S41-8.
29. Lutgendorf SK, Mullen-Houser E, Russell D, et al. Preservation of immune function in cervical cancer patients during chemoradiation using a novel integrative approach. Brain Behav Immun. 2010;24(8):1231-40.
30. Jain S, Pavlik D, Distefan J, et al. Complementary medicine for fatigue and cortisol variability in breast cancer survivors. Cancer. 2012;118(3):777-87.
31. Wong J, Ghiasuddin A, Kimata C, Patelesio B, Siu A. The impact of healing touch on pediatric oncology patients. Integr Cancer Ther. 2013;12(1):25-30.
32. Henry F, Wells N, Slater V, Dietrich, MS, Wisawatapnimit, P, Chakravarthy A. A randomized placebo-controlled pilot study of the impact of healing touch on fatigue in breast cancer patients undergoing radiation therapy. Integr Cancer Ther. 2014;13(2):105-13.
33. Yan X, Shen H, Jiang H, et al. External Qi of Yan Xin Qigong induces G2/M arrest and apoptosis of androgen-independent prostate cancer cells by inhibiting Akt and NF-kappa B pathways. Mol Cell Biochem. 2008;310(1-2):227-34.
34. Yan X, Shen H, Jiang H, Hu D, Wang J, Wu X. External Qi of Yan Xin Qigong inhibits activation of Akt, Erk1/2 and NF-κB and induces cell cycle arrest and apoptosis in colorectal cancer cells. Cell Physiol Biochem. 2013;31(1):113-22.
35. Yan X, Shen H, Jiang H, et al. External Qi of Yan Xin Qigong Induces induces apoptosis and inhibits migration and invasion of estrogen-independent breast cancer cells through suppression of Akt/NF-kB signaling. Cell Physiol Biochem. 2010;25(2-3):263-70.
36. Friedman RS, Burg MM, Miles P, Lee F, Lampert R. Effects of Reiki on autonomic activity early after acute coronary syndrome. J Am Coll Cardiol. 2010;56(12):995-6.
37. MacIntyre B, Hamilton J, Fricke T, Ma W, Mehle S, Michel M. The efficacy of healing touch in coronary artery bypass surgery recovery: a randomized clinical trial. Altern Ther Health Med. 2008;14(4):24-32.
38. Baldwin AL, Wagers C, Schwartz GE. Reiki improves heart rate homeostasis in laboratory rats. J Altern Complement Med. 2008;14(4):417-22.
39. Lampert R, Ickovics JR, Viscoli CJ, Horwitz RI, Lee FA. Effects of propranolol on recovery of heart rate variability following acute myocardial infarction

and relation to outcome in the Beta-Blocker Heart Attack Trial. Am J Cardiol. 2003;91(2):137-42.
40. Woods DL, Beck C, Sinha K. The effect of therapeutic touch on behavioral symptoms and cortisol in persons with dementia. Forsch Komplementmed. 2009;16(3):181-9.
41. Woods DL, Craven RF, Whitney J. The effect of therapeutic touch on behavioral symptoms of persons with dementia. Altern Ther Health Med. 2005;11(1):66-74.
42. Lu DF, Hart LK, Lutgendorf SK, Oh H, Schilling M. Slowing progression of early stages of AD with alternative therapies: a feasibility study. Geriatr Nurs. 2013;34(6):457-64.
43. Woods DL, Dimond M. The effect of therapeutic touch on agitated behavior and cortisol in persons with Alzheimer's disease. Biol Res Nurs. 2002;4(2):104-14.
44. Lu DF, Hart LK, Lutgendorf SK, Perkhounkova Y. The effect of healing touch on the pain and mobility of persons with osteoarthritis: A feasibility study. Geriatr Nurs. 2013;34(4):314-22.
45. Gordon A, Merenstein JH, D'Amico F, Hudgens D. The effects of therapeutic touch on patients with osteoarthritis of the knee. J Fam Pract. 1998;47(4):271-7.
46. Kemper KJ, Fletcher NB, Hamilton CA, McLean TW. Impact of healing touch on pediatric oncology outpatients: pilot study. J Soc Integr Oncol. 2009;7(1):12-8.
47. Henneghan AM, Schnyer RN. Biofield therapies for symptom management in palliative and end-of-life care. Am J Hosp Palliat Care. 2015;32(1):90-100.
48. Warber S, Gordon A, Gillespie B, Olson M, Assefi A. Standards for conducting clinical biofield energy healing research. Altern Ther Health Med. 2003;9(3 Suppl):A54-A64.
49. Witt C, Linde K. Clinical research in complementary and integrative medicine: A practical training book. Münich: Elsevier; 2012.
50. Warber SSL, Cornelio D, Straughn J, Kile G. Biofield energy healing from the inside. J Altern Complement Med. 2004;10(6):1107-13.
51. McCraty R. The energetic heart: Bioelectromagnetic communication within and between people. In: Rosch P, Markov M, editors. Bioelectromagnetic medicine. New York: Marcel Dekker; 2004:541-562.
52. Rubik B, Brooks AJ, Schwartz GE. In vitro effect of Reiki treatment on bacterial cultures: Role of experimental context and practitioner well-being. J Altern Complement Med. 2006;12(1):7-13.
53. Kraemer H, Wilson G, Fairburn C, Agras W. Mediators and moderators of treatment effects in randomized clinical trials. Arch Gen Psychiatry. 2002;59(10):877-83.
54. Yamamoto T, Seto A, Nakazato S, Hisamitsu T. Biophysical study on the phenomenon of human extremely strong magnetic field emission from a healer. J Intl Soc Life Info Sci. 1996;14(2):201.
55. Matsueda H. Photonic emission from human body controlled by will. In: AeroSense.;Thermosense XXII. 2000 Mar 30:252-256.
56. Lo SY. Evidence and mechanism of external Qi in Chinese Medicine. Med Acupunct. 2007; 19(4):201-10.
57. Schlitz MJ, Braud WG. Distant intentionality and healing: assessing the evidence. Altern Ther Health Med. 1997;3(6):62-73.
58. Astin J, Harkness E, Ernst E. The efficacy of "Distant Healing" a systematic review of randomized trials. Ann Intern Med. 2000;132(11):903-10.
59. Lundeberg T, Lund I, Sing A, Näslund J. Is placebo acupuncture what it is intended to be? Evid Based Complement Alternat Med. 2011;2011:932407.
60. Chaput de Saintonge DM, Herxheimer A. Harnessing placebo effects in health care. Lancet. 1994;344(8928):995-8.
61. Colloca L, Jonas WB, Killen J, Miller FG, Shurtleff D. Reevaluating the placebo effect in medical practice. Z Psychol. 2014;222(3):124-7.
62. Linde K, Witt CM, Streng A, et al. The impact of patient expectations on outcomes in four randomized controlled trials of acupuncture in patients with chronic pain. Pain. 2007;128(3):264-71.
63. Zheng H, Huang W, Li J, et al. Association of pre- and post-treatment expectations with improvements after acupuncture in patients with migraine. Acupunct Med. 2015;33(2):121-8.
64. Prady SL, Burch J, Vanderbloemen L, Crouch S, MacPherson H. Measuring expectations of benefit from treatment in acupuncture trials: a systematic review. Complement Ther Med. 2015;23(2):185-99.
65. Díaz-Rodríguez L, Arroyo-Morales M, Fernández-de-las-Peñas C, García-Lafuente F, García-Royo C, Tomás-Rojas I. Immediate effects of reiki on heart rate variability, cortisol levels, and body temperature in health care professionals with burnout. Biol Res Nurs. 2011;13(4):376-82.
66. Wardell DW, Engebretson JC. Biological correlates of Reiki Touch healing. J Adv Nurs. 2001;33(4):439-45. 2000.
67. Tang R, Tegeler C, Larrimore D, Cowgill S, Kemper KJ. Improving the well-being of nursing leaders through healing touch training. J Altern Complement Med. 2010;16(8):837-41.
68. Sneed NV, Olson M, Bubolz B, Finch N. Influences of a relaxation intervention on perceived stress and power spectral analysis of heart rate variability. Prog Cardiovasc Nurs. 2001;16(2):57-64, 79.
69. Pelletier KR, Herman PM, Metz RD, Nelson C. Health and medical economics applied to integrative medicine.Health and Medical Economics: Applications to Integrative Medicine. Explore (NY). 2010 Mar-Apr;6(2):86-99. In: Commissioned for the IOM Summit on Integrative Medicine and the Health of the Public.; 2009.
70. Coulter ID, Herman PD, Nataraj C; Health Unit, RAND Corporation, Santa Monica, CA, USA; School of Dentistry, UCLA, Los Angeles, CA, USA; RAND/Samueli Chair for Integrative Medicine, Santa Monica, CA, USA; Samueli Institute, Alexandria, VA, USA. Economic analysis of complementary, alternative, and integrative medicine: considerations raised by an expert panel. BMC Complement Altern Med. 2013 Jul 25;13:191.
71. Quinn JF, Strelkauskas a J. Psychoimmunologic effects of therapeutic touch on practitioners and recently bereaved recipients: a pilot study. ANS Adv Nurs Sci. 1993;15(4):13-26.
72. Nahin RL. Use of the best case series to evaluate complementary and alternative therapies for cancer: a systematic review. Semin Oncol. 2002;29(6):552-62.
73. Gagnier J, Kienle G, Altman D, Moher D, Sox H, Riley D; CARE Group. The CARE guidelines: consensus-based clinical case report guideline development. J Diet Suppl. 2013;10(4):381-90.
74. Olaku O, Zia F, Santana J, White J. The National Cancer Institute best case series program: a summary of cases of cancer patients treated with unconventional therapies in India. Integr Cancer Ther. 2013;12(5):385-92.

REVIEW ARTICLE

Distant Healing Intention Therapies: An Overview of the Scientific Evidence

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ABSTRACT

This article provides a broad overview of "distant healing intention" (DHI) therapies, ie, intentional healing modalities claimed to transcend the usual constraints of distance through space or time. We provide a summary of previous reviews and meta-analyses that have explored a diverse array of DHI modalities, outcome measures, and experimental protocols. While some significant experimental effects have been observed, the evidence to date does not yet provide confidence in its clinical efficacy. The purported "nonlocal" nature of DHI raises significant methodological and theoretical challenges. We recommend several avenues for improving future research.

INTRODUCTION

Throughout history and in virtually all cultures, reports can be found of individuals who could purportedly heal solely through their caring intentions.[1] Today, the ancient shamanic tradition of healing—or harming—through the application of focused intentions is still vibrantly alive.[2] We refer to these practices generically as "distant healing intention" (DHI) therapies. The present article does not provide a systematic or exhaustive review of the relevant literature. Rather, we have selected representative portions to provide a high level overview of scientific studies of DHI.

DHI may be defined as a compassionate mental act directed toward the health and wellbeing of a distant person.[3] DHI techniques are known by many names, including intercessory prayer, spiritual healing, aura healing, energy healing, energy psychology, shamanic healing, nonlocal healing, therapeutic touch (TT), quantum-touch, qigong, reconnective healing, Johrei, and Reiki.[4] Each of these methods carries its own idiosyncratic theoretical and cultural forms, and some DHI methods include both distant and proximal (but without direct contact) variations. A common feature shared among DHI techniques is the assumption that distance between the healer and healee is not a limiting factor.[5] This "nonlocal" aspect of DHI defies classical physical assumptions and accounts for its controversial status even among alternative biofield therapies.

Despite the challenging assumptions underlying the concept of DHI, its practice is widespread. As of 2000, there were more distant healers in the United Kingdom, some 14,000, than therapists practicing any other form of complementary or alternative medicine (CAM).[6] The same is true in the United States, where DHI is one of the most common healing practices outside of conventional medicine. For example, in a survey of American adults by the US Centers for Disease Control and Prevention's National Center for Health Statistics, of the top 5 most popular CAM healing practices, 3 involved prayer.[6] The most popular CAM practice was prayer for oneself, and the second most popular was prayer for another, another form of DHI.

While prayer for others is understandable as a compassionate act or as a psychological coping mechanism when no other actions are possible, the idea that it might be efficacious at a distance is challenging because of a lack of plausible mechanisms that might allow for healer-patient interactions over a distance.[3,7,8] However, given the well-accepted evidence for quantum nonlocality,[9] which demonstrates the existence of "spooky action at a distance" (as Einstein described it), and especially the growing evidence for quantum coherence effects in living systems,[10,11] possible physical mechanisms for DHI are no longer inconceivable.

Theoretical speculations aside, most experiments studying DHI have focused on a pragmatic question: Does it work? There are 2 aspects to this question. The first is about proof of principle: If person A and person B are strictly isolated by shielding, distance, or time, is there empirical evidence that A can affect B in any way? The second aspect is about DHI's efficacy as a healing therapy: Can A in fact heal B?

Proof-of-principle Studies With Humans

The proof-of-principle question has been examined through 3 classes of experiments: (1) mind-to-mind connections, (2) direct interactions between mind and matter, and (3) laboratory analogs of DHI, known as experiments on "distant mental interactions with living systems" or DMILS. Hundreds of experiments in these 3 classes have been published and meta-analyzed.[12-16] Cumulatively, they provide evidence that the answer to the first question is "Yes, A can affect B at a distance." The effect sizes observed in these experiments tend to be small in magnitude, and it is not entirely clear that the interaction is causal in the classic sense of that term, but the correlations observed in controlled experiments have been independently and suc-

cessfully repeated in laboratories around the world.

The category of experiments that are most closely related to DHI phenomena are the DMILS studies. Three variants of DMILS protocols have been conducted: (1) studies investigating the influence of A's intention on B's physiological state, referred to as "remote intention" experiments; (2) studies investigating the influence of A's attention on B's physiological state while A gazes at B over a 1-way video link, also called "remote staring" experiments; and (3) studies investigating the influence of A's intention on B's attention or behavior, known as "remote helping" experiments.

Physiological variables studied in DMILS experiments have included electrodermal activity, heart rate, blood volume pulse, electrocortical activity (via electroencephalogram [EEG]), and brain blood oxygenation (via functional magnetic resonance imaging [fMRI]), as well as studies from functional near-infrared spectroscopy (fNIRS) and electrogastrogram (EGG).[5,17-20] A typical protocol in these studies involves periods where A directs intention or attention toward B for 30 seconds, followed by A relaxing for 30 seconds, and then this cycle is repeated in a randomized and counterbalanced fashion for 20 minutes. Meanwhile, B is strictly isolated from A and asked to simply maintain an open and relaxed attitude. In remote helping studies, B may be asked to gaze at a candle and when B notices his or her mind wandering, he or she is asked to press a button.

Experiments using these protocols have been repeated scores of times in a half-dozen independent laboratories, allowing for meta-analytical assessments. The most recent reviews of remote intention and remote staring experiments were published in 2004 by Schmidt et al.[12] Remote helping studies were reviewed also by Schmidt in 2012.[13]

In reviewing remote intention experiments, Schmidt found 40 studies. A funnel plot indicated no selective reporting bias, but 4 of those studies were deemed to have insufficient methodological quality and were dropped from further analysis. The remaining 36 experiments involved 1015 individual test sessions, and the resulting effect size was homogeneous and statistically significant (Cohen's d=0.106, P=.001). Effect sizes were found to correlate significantly with overall study quality (r=–0.43).

For remote staring experiments, 15 studies consisting of 379 sessions were retrieved. Those studies again revealed a homogeneous effect size (Cohen's d=0.128, P=.013), and there was a nonsignificant correlation between study quality and effect size (r=0.26). For remote helping experiments, 12 studies were found, of which 11 were comprised of 576 sessions. The distribution of effect sizes was homogenous, and the effect size was again similar to the results of the 2 other meta-analyses (Cohen's d=0.114, P=.029).

Schmidt's analyses of the 3 classes of DMILS experiments identified a combined total of 62 studies with 1970 individual sessions contributed by approximately 3000 participants. The similar effect sizes across these studies (Cohen's d=0.106, 0.128, and 0.114) suggested successful conceptual replications. Schmidt proposed that because these studies were conducted in different experimental contexts, with different types of dependent variables, and in independent laboratories, if the results of these studies were due to an artifact, it would have to be a fairly simple problem that was inadvertently repeated by all or most of the investigators.

Schmidt suggested that a possible candidate for this potential artifact might be the counterbalancing sequence, which if not handled correctly could introduce a bias in the data due to drifts in the physiological signals. But after analyzing the actual methods employed in these studies, he was able to reject that artifact as implausible. Schmidt also noted that the remote intention meta-analysis revealed a negative correlation between study quality and effect size, which might reflect methodological problems in evaluation of those studies. However, when effect sizes were weighted by quality, the lower-quality studies did not strongly influence the overall effect size. Also, lower-quality studies were mostly due to inadequately described methods in taking skin conductance measurements, and in any case, it was not clear how that could have biased the overall findings because the same issue would have applied to both intentional influence and resting conditions. That in turn would have resulted in increased variance in both conditions and thus a reduced effect size. As a result of his analysis, Schmidt concluded that the DMILS studies provided proof-of-principle that focused intention and attention do affect the human body and behavior from a distance.

Studies Involving Simple Life Forms and Animals

Controlled DHI experiments involving simple living systems have also been conducted, primarily using the "intention" protocol mentioned above. The advantage of studying the effects of DHI in plants, cells, and animals is that in comparison to trials involving humans where the expectations, meaning, and context of an intervention can strongly affect outcomes, simpler life forms may be less susceptible to such concerns, allowing for more circumscribed outcomes. Examples of studies reporting statistically significant effects under randomized and blinded conditions include enzymes,[21] fungi,[22] yeast,[23,24] bacteria,[25] cancer cells,[26] red blood cells,[27] fibroblasts, tendon cells (tenocytes), and bone cells (osteoblasts).[28] Experiments where significant results were not observed include glial and cancer cells.[29] An important limitation in assessing this literature is that the extent of selective reporting has not been carefully studied to date, so it is difficult to estimate whether the studies with significant outcomes were due to genuine effects or to chance.

Animal disease models have also been used to investigate the effects of DHI. These have included testing for amyloidosis in hamsters,[30] murine malaria,[31] and experimentally induced goiter and surgical wounds in mice. For example, in one study, Watkins and Watkins

reported quicker recovery from anesthesia in animals receiving DHI.[32] That observation was later successfully replicated by Schlitz.[33] Bengston and Krinsley have reported similar results in a series of conceptual replications involving mammary cancer in mice.[26]

We are aware of only 1 meta-analysis that has attempted to integrate the literature of DHI effects in simple living systems. In 2014, Roe et al completed a meta-analysis of "non-whole-human" studies (including animals, plants, and blood and other cells).[34] Out of 49 studies, treatment arms receiving active healing displayed improved wellbeing outcomes as compared to those not receiving healing (r=.258, 95% confidence interval [CI]=0.239-0.278). However, the overall quality rating of these studies, as assessed by an adapted version of the SIGN 50 methodology checklist (a method of critically appraising the medical literature, developed by the Scottish Intercollegiate Guidelines Network) was low, so the healing effect may have been biased by poor methodologies or by inadequate reporting of methods.

Clinical Efficacy in Humans

Clinical trials testing the effectiveness of DHI have been conducted since the mid-1990s.[4] Both systematic and meta-analytic reviews have been published. One of the first systematic reviews was published in 2000 by Astin et al.[7] They analyzed 23 experiments involving 2774 patients; of them, compared to controls, 13 studies yielded statistically significant treatment effects, 9 showed no effects, and 1 demonstrated a negative effect. In 16 studies where both patients and evaluators were blinded to the condition, the overall medium effect size was (Rosenthal's) r=0.40. In 2001, a systematic review by Jonas et al calculated average effect sizes separately for studies of intercessory prayer (r=0.30) and for energy healing (r=0.46).[35] All of those studies had greater than 80% CONSORT criteria and were classified with "B" grades on an A-to-E scale.

In 2003, Crawford et al updated the literature with a systematic review comparing DHI techniques to hands-on healing interventions.[36] The results showed that out of 90 laboratory and clinical randomized controlled trials (RCTs), DHI studies had higher internal validity (75%) compared to hands-on healing (65%). However, methodological flaws were identified in many of these studies, including inadequacy of blinding, dropped data, poor outcome measures, lack of statistical power estimations, lack of confidence intervals, and lack of independent replication. Thus no firm conclusions could be drawn.

In 2008 and 2009, the Cochrane Collaboration reported 2 systematic reviews, the first examining noncontact TT, healing touch, and Reiki and the second intercessory prayer.[37,38] From the Reiki review, out of 24 RCTs, a total of 1153 participants exposed to TT had significantly lower average pain intensity than unexposed participants, and trials conducted by more experienced practitioners appeared to yield greater effects. Larger effects were also found in Reiki studies in trials conducted by more experienced practitioners. By contrast, the intercessory prayer review did not demonstrate therapeutic efficacy. Out of 10 RCTs involving 7646 patients, there was no overall effect of intercessory prayer on prolonging life, general clinical state, readmission to coronary care unit, or rehospitalization.

Roe et al's more recent meta-analysis of 57 RCTs on humans receiving DHI determined that overall statistically significant effects were obtained in the active treatment conditions as compared to controls (r=0.203, CI=0.180-0.232).[34] To further study the clinical effectiveness of DHI in patients with diagnosed health conditions, Baur and Mai conducted a review (in preparation) of 57 studies, where a DHI intervention was compared to placebo or an active control, and graded them via the SIGN 50 criteria. Overall, 27 studies (47%) demonstrated at least 1 significant outcome favoring DHI compared to an active control or placebo. However, 48% of the significant studies were associated with poor methodological quality, whereas 40% of the adequate quality studies and only 11% of high-quality trials demonstrated statistically significant results.

Baur and Mai further found that the clinical DHI study designs were heterogeneous, suggesting that some of the irreproducible results may have been due to unknown or uncontrollable factors. For example, in intercessory prayer studies, it is not possible to control who is actually praying for patients; what they are praying for; how they pray; possible differences between their usual prayer practice and what they actually performed during the experiment; the relationships among healers, patients, and investigators; the meaning and context of the therapy and environment; and so on. Dozens of such factors introduce unknown sources of variance that may enhance, reduce, or cancel out genuine effects. Baur and Mai noted that several large-scale, multicenter studies failed to show any discernible differences between patients receiving or not receiving intercessory prayer.[39,40] They concluded that while nearly half of the published studies from their review reported statistically significant effects, it remains unknown whether patient outcomes in successful studies were attributable to the intervention or to variations in methodological rigor, other sources of influence, or interactions among these factors.

THEORETICAL AND OTHER CONSIDERATIONS

The preponderance of evidence for DHI effects in simple living systems and for intercessory prayer is at best suggestive of its effectiveness to alter outcomes. But the proof-of-principle offered by DMILS experiments more clearly indicates the existence of genuine interactions between distant people. This presents us with an evidence-based enigma worthy of serious consideration. However, for many researchers, the mere concept of distant healing continues to elicit significant resistance for two main reasons. The first is based on the

assumption that "action at a distance" is impossible because it violates one or more physical or biological laws.[8,41] The second is founded on the neuroscience-based assumption that the mind is identical to the brain, in which case it does not make sense to propose that the brain activity we call "healing intention" can interact with anything outside of the brain's own body.[42,43]

The first critique was a game-ender for many decades, but today, the "nonlocal" connections of quantum entanglement have been convincingly demonstrated,[20,44-46] establishing that instant physical correlations over macroscopic distances, as well as connections that transcend time, are no longer startling theoretical possibilities but empirical facts. The second critique is predicated on the assumption that subjective mental activity (ie, conscious awareness) somehow mechanically arises out of brain activity in spite of the fact that no one has any idea how this can occur. According to Ralph Adolphs, PhD, writing about the unsolved problems of neuroscience in a 2015 issue of *Trends in Cognitive Science*, one key problem is "How and why does conscious experience arise?"[47] Adolphs ranks this as a problem that may never be solved, to which we might clarify that the word *never* is predicated on the assumption that existing frameworks for understanding the mind-brain relationship are sacrosanct. But if the brain and mind are in fact not identical, as DHI and similar consciousness-related anomalies suggest,[16,48] then new possibilities arise where the mind may be able to interact with the world in ways that the brain cannot. Obviously this does not answer the second critique in a fully adequate way, but it does remind us that "impossibilities" are embedded within a context. Sometimes shifting one's perspective allows us to rethink the unthinkable.

Beyond the theoretical challenges to understanding how DHI may work, we are faced with a host of epistemological challenges. Traditional selection strategies for dependent and independent variables assume that influences are localized, real-time, and explicitly sourced. None of these assumptions may hold for DHI phenomena. Defining the "when" and "where" of intentional effects and their actual source can be exceedingly difficult because anyone involved in a DHI experiment is unavoidably "entangled" with the healing process. For example, Leibovici studied patients with bloodstream infections whom were prayed for retroactively, meaning years after they were first hospitalized.[49] The question explored in that study was whether DHI would be effective not only with spatial distance between the healers and patients but also with temporal distance. Results demonstrated that patients who received "retroactive" intercessory prayer had statistically significantly shorter hospital duration stays and duration of fevers compared to a control group that did not receive the retroactive prayer. From a conventional perspective, that outcome is outrageous, explainable only as a joke or a statistical fluke. But if DHI is in fact a genuine nonlocal phenomenon, then this sort of outcome may be mind-boggling, but it is also permissible.[50]

To help identify the "when" and "where" of DHI effects, as well as the role of investigators' and patients' expectations in potentially modulating these effects, future studies should consider designs where healing spans a range of spatial and temporal distances and where independent teams are led by investigators holding a variety of expectations and beliefs about the possibility of nonlocal influences. To study whether DHI may be better understood in conventional causal terms or via more holistic or even acausal concepts, protocols could be devised that examine dose effects, where the "dose" of intention or attention must be carefully defined and measured. That is, 20 minutes of DHI applied to a patient should not be considered double the dose of 10 minutes because attention invariably wanders. And given that both spatial and temporal distance may not be constraining factors with DHI effects, dose might be better measured in terms of meaning or motivation rather than amount of time.

Because DHI research often attracts hypercritical scrutiny, we recommend that prior to conducting future studies, a comprehensive description of the planned protocol is publicly registered and/or sent to an independent third party. Pre-registration is a growing trend in psychological and medical research to counter problems associated with "questionable research practices," including selective reporting and post-hoc analyses, and as such it seems especially apropos for DHI research.[51] Finally, investigators from orthodox fields who become interested in studying DHI phenomena may assume that the phenomena are simple and easily shoehorned into standard designs; in so doing, they are likely to fall into conceptual traps that specialists have learned to recognize. To avoid this, we recommend that specialists in DHI experimental designs and practices be consulted to ensure that the instruments used to study the phenomena are appropriate for the job.

CONCLUSIONS

Despite the continuing popularity of DHI as an alternative healing modality, when it comes to assessing clinical efficacy, high-quality experiments have so far failed to show reliable effects. The contradiction between persistent popularity and lack of clinical effectiveness may be due on the one hand to some healers, in some contexts, who do seem to produce remarkable outcomes,[26,52] and on the other hand by conventional RCT protocols that may be incompatible with the nature of DHI phenomena.[26,53,54] Tools must match the requirements of the subject, and if the right tools are not available, then new ones must be devised. In other words, it is inadvisable to use a sledgehammer to study the surface structure of a soap bubble.

In contrast to the evidence for clinical efficacy of DHI, assessments of DMILS studies—the laboratory analogs of DHI—are clearer, probably because the latter are easier to operationalize and control and because

DMILS effects manifest as shifts in physiological measures rather than robust healing outcomes. The DMILS studies indicate that DHI effects are on average small in magnitude, but they do exist, and thus in principle, some clinical applications of DHI may be efficacious. Whether future clinical trials can be devised that more clearly reveal that efficacy remains to be seen. In sum, the implications of DHI for basic science epistemology and ontology and for pragmatic efforts to improve health and healing are vast, deep, and perennially intriguing.

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REFERENCES

1. Dossey L. Healing words : the power of prayer and the practice of medicine. 1st ed. San Francisco, Calif.: HarperSanFrancisco; 1993.
2. Halifax-Grof J. Hex Death. In: Angoff A, Barth D, eds. Proceedings of an International Conference on Parapsychology and Anthropology, 1973. New York: Parapsychology Foundation, Inc.; 1974:59-79.
3. Schlitz M, Radin DI, Malle BF, Schmidt S, Utts J, Yount GL. Distant healing intention: definitions and evolving guidelines for laboratory studies. Alternative therapies in health and medicine. 2003;9((3 Suppl)):A31-43.
4. Targ E. Evaluating distant healing: a research review. Alternative therapies in health and medicine. Nov 1997;3(6):74-78.
5. Schlitz M, Braud W. Distant intentionality and healing: assessing the evidence. Altern Ther Health Med. 1997;3(6):62-73.
6. Barnes PM, Powell-Griner E, McFann K, Nahin RL. Complementary and alternative medicine use among adults: United States, 2002. Adv Data. 2004 May 27;(343):1-19.
7. Astin JA, Harkness E, Ernst E. The efficacy of "distant healing": A systematic review of randomized trials. Annals Internal Med. 2000;132:903-910.
8. Sloan R, Ramakrishnan R. The MANTRA II study. Lancet. 2005(366):1769-70.
9. Accardi L, Regoli M. Non-locality and quantum theory: new experimental evidence. In: Tombesi P, Hirota O, eds.Quantum communication, computing, and measurement 3. New York: Kluwer; 2001:313-23.
10. Baars BJ, Edelman DB. Consciousness, biology and quantum hypotheses. Phys Life Rev. 2012;9(3):285-94.
11. Melkikh AV, Khrennikov A. Nontrivial quantum and quantum-like effects in biosystems: Unsolved questions and paradoxes. Prog Biophys Mol Biol. 2015 Nov;119(2):137-61.
12. Schmidt S, Schneider R, Utts J, Walach H. Distant intentionality and the feeling of being stared at: two meta-analyses. Br J Psychol. 2004;95(Pt 2):235-47.
13. Schmidt S. Can we help just by good intentions? A meta-analysis of experiments on distant intention effects. J Altern Complement Med. 2012;18(6):529-33.
14. Bosch H, Steinkamp F, Boller E. Examining psychokinesis: the interaction of human intention with random number generators—a meta-analysis. Psychol Bull. 2006;132(4):497.
15. Radin D, Nelson R, Dobyns Y, Houtkooper J. Reexamining psychokinesis: comment on Bösch, Steinkamp, and Boller (2006). Psychol Bull. 2006;132(4):529-32; discussion 533-7.
16. Storm L, Tressoldi PE, Di Risio L. Meta-analysis of free-response studies, 1992-2008: assessing the noise reduction model in parapsychology. Psychol Bull. Jul 2010;136(4):471-85.
17. Braud W, ed Allobiofeedback: immediate feedback for a psychokinetic influence upon another person's physiology1977. Roll WG, ed. Research in parapsychology.
18. Radin D, Taylor R, Braud W. Remote mental influence of human electrodermal activity: A pilot replication. Eur J Parapsychol. 1995;11:19-34.
19. Radin DI. Event-related electroencephalographic correlations between isolated human subjects. J Altern Complement Med. 2004;10(2):315-23.
20. Radin DI. Entangled minds. New York: Simon & Schuster; 2006.
21. Bunnell T. The effect of "healing with intent" on pepsin enzyme activity. J Sci Explor. 1999;13(2):139-48.
22. Barry J. General and comparative study of the psychokinetic effect on a fungus culture. J Parapsychol. 1968.
23. Grad B. A telekinetic effect on yeast activity. J Parapsychol. 1965;29:285-6.
24. Haraldsson E, Thorsteinsson T. Psychokinetic effects on yeast: an exploratory experiment. Vol 1972: Scarecrow Press Metuchen, NJ; 1973:20-21.
25. Nash CB. Psychokinetic control of bacterial growth. J Soc Psychical Res. 1982.
26. Bengston WE, Krinsley D. The effect of the "laying on of hands" on transplanted breast cancer in mice. J Sci Explor. 2000;14(3):353-64.
27. Braud WG. Distant mental influence of rate of hemolysis of human red blood cells. J Am Soc Psychical Res. 1990.
28. Gronowicz GA, Jhaveri A, Clarke LW, Aronow MS, Smith TH. Therapeutic touch stimulates the proliferation of human cells in culture. J Altern Complement Med. Apr 2008;14(3):233-9.
29. Mager J, Moore D, Bendl D, Wong B, Rachlin K, Yount G. Evaluating biofield treatments in a cell culture model of oxidative stress. Explore (NY). Jul-Aug 2007;3(4):386-90.
30. Snel F, Hol P. Psychokinesis experiments in casein induced amyloidosis of the hamster. JParapsychol 1983;5(1):51-76.
31. Solfvin J. Psi expectancy effects in psychic healing studies with malarial mice. Eur J Parapsychol. 1982;4(2):160-97.
32. Watkins GK, Watkins AM. Possible PK influence on the resuscitation of anesthetized mice. J Parapsychol. 1971;35(4):257-72.
33. Schlitz M. PK on living systems-further studies with anesthetized mice. Paper presented at Parapsychological Association convention; abstracted in Journal of Parapsychology, 1982.
34. Roe C, Charmaine S, Roxburgh E. Two meta-analyses of noncontact healing studies. Explore. 2014;11(1):11-23.
35. Jonas WB. The middle way: realistic randomized controlled trials for the evaluation of spiritual healing. J Altern Complement Med. 2001;7(1):5-7.
36. Crawford CC, Sparber AG, Jonas WB. A systematic review of the quality of research on hands-on and distance healing: clinical and laboratory studies. Altern Ther Health Med. 2003;9(3 Suppl):A96-104.
37. So PS, Jiang Y, Qin Y. Touch therapies for pain relief in adults. Cochrane Database Syst Rev. 2008 Oct 8;(4):CD006535.
38. Roberts L, Ahmed I, Hall S, Davison A. Intercessory prayer for the alleviation of ill health. Cochrane Database Syst Rev. 2009 Apr 15;(2):CD000368.
39. Benson H, Dusek JA, Sherwood JB, et al. Study of the Therapeutic Effects of Intercessory Prayer (STEP) in cardiac bypass patients: a multicenter randomized trial of uncertainty and certainty of receiving intercessory prayer. Am Heart J. 2006;151(4):934-42.
40. Krucoff MW, Crater SW, Gallup D, et al. Music, imagery, touch, and prayer as adjuncts to interventional cardiac care: the Monitoring and Actualisation of Noetic Trainings (MANTRA) II randomised study. Lancet. Jul 16-22 2005;366(9481):211-7.
41. Leder D. "Spooky actions at a distance": physics, psi, and distant healing. J Altern Complement Med. Oct 2005;11(5):923-30.
42. Crick F. The astonishing hypothesis : the scientific search for the soul. New York: Scribner; Maxwell Macmillan International; 1994.
43. Edelman S. Computing the mind: how the mind really works. New York: Oxford University Press; 2008.
44. Kwiat PG, Barraza-Lopez S, Stefanov A, Gisin N. Experimental entanglement distillation and 'hidden' non-locality. Nature. 2001;409(6823):1014-7.
45. Fuwa M, Takeda S, Zwierz M, Wiseman HM, Furusawa A. Experimental proof of nonlocal wavefunction collapse for a single particle using homodyne measurements. Nat Commun. 2015;6:6665.
46. Teo C, Araujo M, Quintino MT, et al. Realistic loophole-free Bell test with atom-photon entanglement. Nat Commun. 2013;4:2104.
47. Adolphs R. The unsolved problems of neuroscience. Trends Cogn Sci. Apr 2015;19(4):173-5.
48. Radin DI. Supernormal. New York: Random House; 2013.
49. Leibovici L. Effects of remote, retroactive intercessory prayer on outcomes in patients with bloodstream infection: randomised controlled trial. BMJ. 2001;323(7327):1450-1.
50. Braud W. Wellness implications of retroactive intentional influence: exploring an outrageous hypothesis. Altern Ther Health Med. 2000;6(1):37-48.
51. Vandenbroucke JP. Preregistration: when shall we start the real discussion? Eur J Public Health. Aug 2015;25(4):555-6.
52. Omura Y. Impression on observing psychic surgery and healing in Brazil which appear to incorporate (+) qi gong energy & the use of acupuncture points. Acupunct Electrother Res. 1997;22(1):17-33.
53. Bengston WF. Methodological difficulties involving control groups in healing research: parallels between laying on of hands for the treatment of induced mammary cancers in mice to research in homeopathy. J Altern Complement Med. Apr 2004;10(2):227-8.
54. Bengston WF, Moga M. Resonance, placebo effects, and Type II errors: some implications from healing research for experimental methods. J Altern Complement Med. Apr 2007;13(3):317-27.

ORIGINAL ARTICLE

A Consideration of the Perspectives of Healing Practitioners on Research Into Energy Healing

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ABSTRACT

Energy healing is a complex intervention with the purpose of enhancing wholeness within the client. Approaches to complex interventions require thoughtful utilization of a wide range of research methods. In order to advance the research in this field, we sought to understand the healing practitioners' point of view by reviewing qualitative literature, research reviews, and commentary written by and about practitioners. Further, we conducted a brief survey among healers, asking their opinions on types and topics of research in this field. Emerging from this inquiry is an overview of the healers' state required for successful healing, the importance of the clients' contribution, the heterogeneity of the process of healing, and the importance of choosing appropriate outcomes to reflect the goal of wholeness. Beyond attending to measurement of these nuanced aspects, we propose utilization of research designs appropriate for complex interventions, more use of qualitative research techniques, consideration of large data registries, and adoption of the perspectives of realist research. An important gap identified was the overall lack of understanding of the clients' experience and contribution to the healing encounter.

INTRODUCTION

Healing research and biofield science have contributed to advances in understanding energy healing practices. However, energy healing is a complex intervention with the purpose of enhancing wholeness within the client. Approaches to complex interventions require thoughtful utilization of a wide range of research methods.[1,2] In order to facilitate additional progress, we propose specifically taking into consideration practitioners' views on research into biofield science and healing. One approach is to ask what we know about practitioners' experiences in the healing encounter and consider how we could design research, paying attention to that information. Another approach is to ask practitioners what they think needs to be researched and how. Since our goal is to inform future research, we believe that both pathways will yield interesting fruit, and we discuss both approaches in this article, along with reflection on some potential research approaches.

REVIEW OF HEALERS' VIEWS

We begin with a look at qualitative research,[3-12] reviews,[13-15] and commentary[16-19] to construct a picture of the healing process and issues as experienced by those most knowledgeable, the healing practitioners themselves. A few caveats are in order. We employed a nonsystematic search of the literature on healing practitioners, adding articles in a snowball fashion from references and additional searches. Much of this research literature, whether qualitative or quantitative, has focused around specific types of healing such as therapeutic touch (TT), healing touch, or Reiki, with very few authors purposefully attempting to bridge across disciplines.[3,11,13,14] In pursuing this work, we were struck by the fact that much of the relevant research on healers' perspectives is situated in the nursing literature. In this discussion, we will attempt to synthesize across disciplines while acknowledging that the fit may not be perfect for the tenets and practices of every healer.

Definitions of Healing

Healing comes from the Old English word *haelan* meaning "whole" and thus signifies the process of becoming more whole or assisting another in that endeavor, even during failing health or death.[5-7,13,15,19] Egnew further clarifies wholeness as becoming whole in the physical, emotional, intellectual, social, and spiritual aspects of the self.[20] Additional nuances of the meaning of healing are increased order, coherence, temporality, and balance.[6,13] Another prominent description of healing encompasses a journey of transformation in which there is transcendence of suffering and new meanings are found.[5,13,14] It is quite clear that *healing* is not synonymous with *curing*, which focuses on elimination of the signs and symptoms of disease. Understanding this definition is critical as we contemplate the measurement of appropriate outcomes for healing interventions.

Definitions of Healers

In keeping with the above definitions of healing, Zahourek defines *healers* as catalysts to a process that results in an integrated, balanced whole person. She further specifies that healers employ the intentional

influence of one person on another without known physical means of intervention.[15] Archetypally, the healer has a desire to serve others; a focus on repair of mind, body, and spirit; and an ability to channel energy to this end.[13] Cooperstein defines healers as those who beneficially affect the physiology of living organisms by laying on of hands, prayer, energy transfer, and shamanic or other mystical practices.[3] This latter definition is useful in enumerating the methods employed but it misses out on other important aspects of the person that ideally should be affected: emotional, intellectual, social, and spiritual wellbeing that can lead to increased wholeness.

Definition of Energy Healing

Common terms used in the field of energy healing include *energy healing*, *energy medicine*, *energy therapies*, *laying on of hands*, and *spiritual healing*.[17] While there is a great deal of cross pollination within and across traditions, a useful categorization of the spectrum of energy healing includes

- East Asian traditions, which include systems such as Reiki and qigong;
- Western professional traditions, such as TT and healing touch, often practiced by nurses;
- bioenergy traditions, a family of healing theories and methods originating primarily in Eastern Europe; and
- contemporary metaphysical traditions that include spiritual healers and are exemplified by well-known North American healers such as Barbara Brennan, PhD, DTh; Rosalyn Bruyere, DD; and Donna Eden, who all have eclectic backgrounds in other established traditions.[14]

This diversity of practice challenges the traditional medical research process in which we are accustomed to specifying a well-defined and uniform intervention.

Common Assumptions

One of us (SW) has proposed that

> *there is a coherent worldview expressed by energy healers that emanates from many cultural and disciplinary perspectives, and that describes the world in energetic terms [that go] beyond our common Western notions of the electromagnetic nature of all life forms, and [are] based on the extrasensory perceptions of healers and the philosophies they have been taught.*[11]

Key tenets of this worldview include[13,17,18]

- the existence of a universal life force or vital energy flowing through and available to all beings;
- the existence of a subtle energy system or biofield that interpenetrates the physical anatomy of the human body and extends outward beyond it;
- the idea that in ill health, the human energetic field is out of balance or congested, free flow is blocked, which diminishes the normal self-healing capacity;
- the belief that the practitioner can detect abnormalities in the energy system, sometimes before physical manifestations, and restore the capacity for self-healing;
- the contention that the practitioner's conscious healing intent and compassion are essential to the effectiveness of therapy; and
- the assertion that the healing outcome is not dependent on the client's beliefs.

Despite the allure of finding common ground, Levin points out that each of these suggestions could be refuted in some way by some healers; for example, spiritual healers might well hesitate to speak of universal life energy and might exclusively attribute the source of healing to God.[14] In the following sections, we will explore these and other constructs in order to build up our understanding of the process we would like to measure with greater veracity.

Sources of Healing Energy

In general, descriptions reveal that the healer must connect or come into resonance with a source of healing such as God, divine love, spirit, the universal life force, or the earth's energy.[11,13] The healer then channels this energy from outside the self or acts as facilitator or conduit of this energy to which the client may help themselves.[11,14] Others assert that healing comes more directly from an intervention of God, a mediation of spirits, or the assistance of other external agents. Some would situate the healing power with the healers who activate their hands and send a flow of energy.[14]

Nature of the Biofield

Two of us (RB, KW) participated in research supporting the existence of the biofield, both at University of California, Los Angeles, with Valerie Hunt, EdD (RB)[21] and in the laboratory of Fritz Popp, PhD,[22] in Kaiserslautern, Germany (RB, KW), using what he called a biophoton camera that measured the particles of the biofield. Much of Dr Popp's work was done with plants showing that when a leaf or branch was cut off, the entire plant exhibited a change in the biofield in reaction to the injury. This research suggests that the aura or human biofield is an electromagnetic field that surrounds and interpenetrates the body. Several other authors expound on the classical bioelectromagnetic nature of the field around living organisms,[23-25] but in building theories of the biofield, nonclassical fields described by the equations of quantum physics[24] or the physics of nonlinear, dynamical, nonequilibrium living systems[25] are also contributory. Work in theory and subtle energy detection may further illuminate mechanisms of action underpinning biofield energy healing.

Healers' Personal Journeys

The healer may initially have innate sensibilities or unusual experiences for which they have no cultural frame[12] or may experience an unaccountable summoning or calling to the work.[8] This can lead to separation or isolation from family and community[9,13] and intense personal suffering.[13] The individual enters their "healership" as they begin a process of education and development of knowledge about healing, often within a particular discipline.[6,9,12,14] This is accompanied by personal introspection, growth, and ultimately transformation that leads them to heal themselves.[9,12-14] They come to embody wholeness, practicing self-care physically, mentally, emotionally, and spiritually, and committing to self-management of the ego and motivations.[12] Their experiences bring them to a "radical empathy," with an ability for deep connection to others and desire to alleviate their suffering.[13] They have mastered skills required for healing others and are able to reintegrate within their communities in a new role.[8,9,13]

Healers' Readiness to Heal in the Moment

There is general consensus across disciplines that 3 major states within the healer are paramount to effective healing: compassion, focus, and intention.[14] Compassion involves unconditional love, a desire to help, a deep caring, and a shared humanity. The healer meets clients where they are and loves them for who they are in the moment.[12,14,15,19] Focus includes authentic presence[19]; concentration[14]; being centered, grounded, and relaxed; getting the self out of the way; reaching a mental stillness where the healer is aligned with the energy source, open and sensitive to altered perceptions.[12,15] The third essential state includes intention for the client's wholeness[19] and/or intention for the client's specific needs assessed in the moment.[15]

Experienced healers (RB, KW) agree that healing is a consciously focused activity yet point out that a more useful term than *intention* might be *volition.* One uses will not to influence outcome but to initiate energy flow; then the process becomes kinesthetic as energy moves. Healers, because healing means the transfer of energy from one field to another as well as sometimes physically manipulating the client's body with energy, have found healing to be a physical—one might even say athletic—endeavor and not one of thought and feeling alone. From a research perspective, we need measures of all of these cardinal attitudes or states: compassion, focus, intention, and volition.

States of Consciousness Involved

The concept of focus encompasses a shifting state of consciousness from a concentration that is entered into purposefully with practice, meditation, prayer, or affirmations and keeping the healer's will out of the way[14] to expanded, profound, or visionary states of consciousness. These latter states might include access to spiritual entities, intuition, multiple realities, or experiences of the world of spirit, ineffable sensations, altered perceptions, and transcendence.[6,8] In some electroencephalography (EEG) studies of healer-healee dyads, the healer's brain shifts to alpha waves and the healee's brain shifts to the same wave state.[26] In a systematic review, EEG changes were inconsistent across studies, but in some forms of healing, heart rate variability shifted to a more aroused state during healing activity.[27] This shift of consciousness and physiology within the healer appears to be linked to the healing.

The Role of Specific Techniques or Discipline

The study of modalities is a part of the development of the healer as identified above. It doesn't seem to matter what the system is as long as the healer is well trained in some discipline. Great healers exist in all traditions as do skilled but ineffective healers.[14] According to one study, by investigating technique, "participants learned the process of giving up control, letting go of fear, developing courage, preparing self, engaging in self-reflection, and developing confidence."[6] Healers need a basic background in energy anatomy as well as physical anatomy and physiology. The trained healer learns to channel energy and turn that flow of energy on and off with accuracy (RB, KW). Quinn however acknowledges that "often the techniques are just a cover, a way of getting in."[19] The real requisites of healing are compassion, focus, and intention, regardless of technique.

Healer/Client Relationship

The call for compassion and intention highlights the importance of relationship within the healing encounter. The healers interviewed by one of us (SW) also spoke of compatibility and collaboration as critical to the process, as well as creating a sense of trust and adhering to ethical standards. Communication underpins the whole process, which includes setting the stage, sharing information during the treatment, and debriefing after the session.[11] Likewise, Enzman Hines emphasizes connection and co-created relationships. Additionally there is an "energetic intimacy" or "shared consciousness of the transpersonal fields."[8,13] Each of these constructs would be important to observe or measure in a research setting.

Client/Healee Contribution and Perceptions

People who are ill undergo threats to wholeness that generate suffering, involving physical, psychological, social, and spiritual dimensions of the person.[20] Clients of energy healers come with a variety of needs and play an active role in the process that reflects an interplay of belief and "readiness to heal."[10] Important beliefs include the belief in the healer or practice and the belief in the body's ability to heal. Readiness to heal includes a relaxed openness to the healing energy and to change, an intention or desire to heal, and a willingness to engage with the process and release suffering.[10,13,14] Clients also have a kind of veto power in that

they can "put up a wall" or block the healing. This negative response can change with experience.[10]

When asked about their experiences, clients, whether healthy or in a critical care unit, describe energy feelings predominantly as warmth and tingling along with quiescent feelings of being relaxed, sleepy, calm, or peaceful.[4,7] In one study, cardiac care unit patients were more stable, had less pain, and less anxiety; most requested the energy treatment again.[18]

Outcomes That Matter

Given the definitions of healing, the explication of the process and roles of both the practitioner and the client, what are the most relevant outcomes to measure in trials and when do we employ them? We need measures of wholeness, suffering, transformation, and transcendence. If healing is a journey, we need to thoughtfully select the timing of measurements to correspond to our understanding of the timeframes involved which may not be immediate.[2,28] The Self-Assessment of Change Scale, a new measure developed for complementary and alternative therapies, may be particularly relevant in capturing the profile of suffering and the transformative changes that have been described as indicative of healing.[29,30] Other selected outcomes need to include but also go beyond physiology or disease symptoms and attend to emotional, intellectual, social, and spiritual issues.[20] For example, in oncology settings, energy healing trials have included measures of pain, fatigue, health function, safety, mood, and quality of life, as well as harmony and balance that are important elements of whole-person healing.[16] These latter, more difficult-to-measure aspects of healing may require validation of additional outcome measures, as has been done for the Brief Serenity Scale.[31]

We have explored qualitative and review literature to discern the practitioners' point of view on the process of healing and have begun to consider how that view could inform the research endeavour. We now turn to healing practitioners themselves to investigate their views on research into energy healing in its many forms.

SURVEY OF HEALING PRACTITIONERS

Our searches of the literature (albeit not systematic) suggest that relatively little research has been undertaken with the specific aim of understanding practitioner perspectives of healing, and almost none that has asked them what research they think should be conducted. Therefore, we decided to undertake a small pilot project of our own.

Pilot Methods and Results

The most straightforward way of gaining data on practitioner perspectives is to ask them via a simple questionnaire. To help us with the framing of this article, we designed a brief questionnaire and circulated it to about 60 energy or spiritual healers in the United Kingdom (UK) via their membership in the UK Confederation of Healing Organizations (CHO).[32] The survey was approved by the trustees of the CHO. After the 3-week deadline for responses, we had obtained 44 replies (a response rate of around 70%).

The first question we asked was "How important do you think it is to undertake research on energy healing?" We asked respondents to circle 1 of 5 options, ranging from "very important" to "not at all important," with "indifferent" as the middle option. All 44 respondents circled 1 option: 29 said that research was very important, 13 that it was fairly important, and 2 respondents were indifferent about research. None of the respondents considered research to be unimportant.

Our second question asked healers "Which type of research do you think could be of most value?" We provided them with 6 options as well as a free text "other" category. Our options were clinical trials, collection of data about healing encounters, observing interactions between practitioners and clients, understanding the experience of practitioners, understanding the experience of clients, experiments on mechanisms of actions, and other—in that order. We asked healers to record their top 3 options. Forty-three people completed this question appropriately; the other one marked nearly all the boxes and had several options as their top priority. We have tabulated the number of participants who gave each option as one of their top 3 priorities in Table 1.

Table 1 Number of Respondents Prioritizing Each Research Option

Type of Research	Number Ranking 1, 2, or 3 (ranked 1)
Understanding the experience of clients	32 (17)
Clinical trials	26 (15)
Collection of data about healing encounters	20
Experiments on mechanisms of action	18
Observing interactions between practitioners and clients	13
Understanding the experience of practitioners	9
Other (various different suggestions)	4

Our third question concerned who should carry out the research; we offered the options of energy healers, doctors, scientists, or others. Only 30 of the respondents provided us with options with more suggesting scientists than any other categories, and many who ticked the "other" box suggested clients (or ex-clients), collectives, or professional organizations should carry out the research. Several people noted that they thought the research should not be carried out by anyone with a vested interest in the outcomes.

Our final question asked "What research question would you most like asked about energy healing?" with a free text space for the response. Thirty-five of the 44 respondents completed this section of the questionnaire. We fitted the responses to the 6 categories used in the second question: 12 were about the experience of the client, 9 about mechanisms of action, 8 about trials or collection of data on healing encounters, 6 concerned data collection about interactions, and 4 about

the experience of practitioner. In addition, under the "other" theme, 2 people suggested that we should study the effect of the physical and mental health of the healer on responses, one highlighted research on pain relief, and one thought that sorting out the core concepts around what healing is was the priority. Finally, 3 people highlighted the need for educational research about healing and energy. In Table 2, we provide some quotes from those responses themed as being about the clients' experience.

Table 2 Healer-generated Questions for Future Research on Client Experiences

Participant Questions
In what way does healing affect the clients' feelings of wellbeing and health?
What do clients feel when exposed to different forms of healing or allopathic treatments for different conditions?
Does adding healing to traditional medical care improve symptoms and quality of life?
When and where is the most energy felt by the client?
What difference does energy healing make to the client's general wellbeing?
What changes does the client notice during the session, and how long did it last?
How and in what ways does energy change the client and move them towards health?
How does it improve the way the client feels?
What physical changes occur in clients as a result of energy healing?

These data should obviously be treated with great caution. Our numbers are small, and the respondents were all energy healers from the UK with links to the CHO, so they are unlikely to be representative of the movement as a whole. Furthermore, those who responded are likely to be the people who have more interest in research than those who did not. The questionnaire had not been piloted (this small study is the pilot for a larger project that we hope to undertake in both the UK and the United States), and we were not able to talk to respondents about how they viewed the questionnaire. The time constraint also meant that circulation of the forms by members of the CHO's board was unsupervised and somewhat haphazard. Finally, the order in which the options were offered may have affected the answers, and it was clear that our question about who should be doing the research was not well understood by many respondents.

Nevertheless, it is quite clear that some healers think research is a high priority, and some think the most important area to be explored is the experience of their clients. Not only was client experience voted the highest priority in response to question 2, it also came up as the most important area in the response to the open question. Further, several respondents suggested that clients should be involved in carrying out the research.

Methodological Issues: How Can We Research the Experiences of Healers and Their Clients?

The methodological approach needed to answer a research question obviously depends upon the question. In this article, we are discussing the perspectives of healing practitioners, so the research questions revolve around the thoughts, feelings, and actions (cognition, emotion, and behavior) of practitioners of energy healing and related techniques. The heterogeneity of healing practices as well as the beliefs and behaviors that surround them can be major obstacle to many of our current research techniques, both qualitative and quantitative. However, our pilot questionnaire survey of the views of healing practitioners provides some guidance on issues and research methods they find compelling.

Qualitative Methods

Qualitative research methods offer an approach that can be applied to the experiences of both healers and clients. Healers have been interviewed by 2 of the authors of this article (PD, SW).[11] In addition to in-depth or semistructured interviews, focus groups can be undertaken, and sensory ethnographic techniques and other qualitative techniques can be used.[33] Anthropological or ethnographic approaches can also be used to observe behaviors of healers and their interactions with clients or to try to understand the healing movement better.[34] Qualitative research is useful to develop understanding of a practice and generate theories or models of processes. However, qualitative research also has its limitations, most obviously the limitations on generalizability due to the relatively small numbers of people who can be included in such work.

Development of Large Databases

The healers we surveyed suggested that we should collect more data about healing and healing interactions. We agree and would like to suggest the development of databases or registries of healing. Large databases or registries containing both survey-type data and other quantitative measurements are a recognized way of helping us to monitor health practices and interventions.[35,36]

Large observational databases or registries have been used to explore a number of other complex medical issues. There are 2 types of registry: those concerned with specific diseases (such as cancer registries) and those concerned with a specific intervention (such as energy healing). Databases on interventions have been particularly valuable in surgical contexts.[37] Surgery, like healing, is a complex intervention with great heterogeneity in the contexts and ways in which it is practiced. Total joint replacement is an example. Randomized controlled trials of joint replacement (vs no replacement) have never been carried out and would be difficult to conduct, but surgeons and their clients "know" that this surgery works, just as many energy healers and their clients "know" that healing energy can work. Furthermore, in each case of healing or joint replacement, the treatment does not work for everyone, which

raises issues about who responds and why. Using the National Joint Replacement Registry in the UK, we have been able to provide some answers to such questions, uncovering, for example, the importance of the size of prostheses used and likely causes of mortality.[38,39]

A large database of healing events could be developed with the help of organizations like the UK CHO that helped us with this article. It would depend on the cooperation of individual healers (and perhaps their clients) as well as their societies and organizations so that data from as many healers as possible could be collected, thus reducing bias. Such a database could be developed by the regular submission of questionnaire data from healers in relation to client-healer interactions. The database could be used to explore simple questions, such as who seeks out healing and why, as well as to explore the heterogeneity of the practices used and the outcomes of healer-client interactions. If the initiative were international, we could explore cultural differences and new research questions would be bound to emerge from analysis of the data. We believe that a well-designed large database about energy healing would allow us to make important discoveries about the "what, when, and why" of healing responses.

Implications for Trial Design

Clinical trials were advocated by many energy healers, but to conduct research that remains true to the healers' experience, we need to include the awareness of the "energetic" state of both the client and the practitioner. Zahourek asserts that research and hard data "can be nearly meaningless if the experience of the healer and healee, and the total process, is not fully understood."[15] Thoughtful creation of standardized scales that capture relevant characteristics of healers, clients, and their relationships may make an important contribution to our ability to more accurately test the effectiveness of biofield energy therapies.[11] An additional level of complexity stems from the understanding that relevant outcomes are holistic and are expected to cross many domains of a person's wellbeing. The UK Medical Research Council has made numerous recommendations on the design of research into complex interventions, and these might thoughtfully guide the conduct of future trials, including embedding evaluation of the process of the intervention within the trial.[1]

With regard to healers, we could consider documenting sociodemographics, elements of their journeys and training, their level of experience,[16] their reaction to the environment and research protocol, their physical and emotional status at the time of healing,[15] and their ability to come to compassion, focus, and intentionality. The Subjective Experience of Therapeutic Touch Scale (SETTS) developed by Krieger and Winstead-Fry[40] reliably differentiates experienced TT healers (in numbers of treatments) from both inexperienced and untrained individuals. Further, better scores on SETTS correspond to better patient ratings of effect but not necessarily to years of experience.[41] This might be a good starting place for development of a scale that would measure the requisite aspects of healing—compassion, focus, intention, and energy direction—and be applicable across a variety of healing disciplines.

For clients, we could measure sociodemographics, beliefs as discussed above, and readiness to heal and document their experiences during the healing encounter as well as their perception of effectiveness. A useful tool might be the Effectiveness of Therapeutic Touch Scale employed by Ferguson.[41] Again, adaptation may be appropriate to broaden the applicability.

When trials are used, it is important to employ therapies as they are normally practiced, including all usual treatment procedures: adequate session time, number of sessions and intervals between them, and individualized rather than standardized therapy protocols. Elements such as touch or noncontact healing need to be considered. Appropriate trial designs need to be used, and innovative approaches, such as step-wedge designs, cluster randomized trials, and prerandomization, can be considered.[1] Appropriate comparison groups must be selected depending on the design, including usual care, waitlist controls, or sham controls (placebos).[1,16,42] Two of us (RB, KB) who are experienced practitioners suggest that a particularly good research design would work with preverbal children or infants for whom one would not attribute success to the placebo effect.

Clearly, study designs should be carefully selected to match the study questions. As we have seen, reviews can help us find commonalities across disciplines and important divergence as well. Qualitative studies can explain phenomena and generate models, theories, and appropriate research questions. Mixed method studies (qualitative and quantitative) have the potential of establishing effect while illuminating elements of patients' beliefs, expectations, and perceptions of the process and the meaning they give to the experience. These data can add to our understanding as to why and how the intervention works, for whom, and in which contexts.[43] Further, there is potential utility in employing the methods of epidemiology and health services research, such as databases or registries.[16]

The Search for Mechanisms of Action

The healers surveyed encouraged experiments on mechanism of action and pose many questions about what the client experiences. We would like to suggest the use of a realist research approach that offers an alternate stance from which to undertake research into complex, context-dependent practices such as energy healing.[44,45] Realist research, which comes from social science and is increasingly used in the fields of public health and policy development, focuses on refining theories by describing how, for whom, and under which circumstances complex interventions work.[46] Realist research and synthesis provide tools that allow us to infer which mechanisms might be responsible for a specific type of outcome and could thus provide new insights into the process of healing and the design of future studies.[47,48]

CONCLUSIONS

Energy healing is a complex intervention encompassing significant heterogeneity of healing practice, with dependence on the state of the healer, the healee, and their relationship. We recommend that these factors be taken into account by employing designs that are suited to complex interventions, emphasizing understanding of the process, and measuring variables related to the health, beliefs, and behaviors of individual healers and their clients. Healing is to make whole, so measured outcomes must go beyond physiology and attempt to document transformation in cognitive, emotional, social, and spiritual domains as well. After reviewing the literature and asking the healers themselves about uncharted areas, it is clear that the experience of the client and the client's contribution to the healing encounter deserve much greater recognition in our inquiries into energy healing. Finally, given the complexity of energy healing and the human participants, it is important to embrace other research methods in addition to clinical trials including the use of qualitative techniques, large data registries, and innovative realist research that seeks to understand what works for whom in which contexts.

To view or download the full-text article, visit: www.gahmj.com/doi/full/10.7453/gahmj.2015.014.suppl

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REFERENCES

1. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ. 2008 Sep 29;337:a1655.
2. Paterson C, Baarts C, Launsø L, Verhoef MJ. Evaluating complex health interventions: a critical analysis of the 'outcomes' concept. BMC Complement Altern Med. 2009 Jun 18;9:18.
3. Cooperstein MA. The myths of healing: a summary of research into transpersonal healing experience. J Am Soc Psych Res. 1992;86(2):99-133.
4. Cox C, Hayes J. Physiologic and psychodynamic responses to the administration of therapeutic touch in critical care. Complement Ther Nurs Midwifery. 1999 Jun;5(3):87-92.
5. Egnew TR. Suffering, meaning, and healing: challenges of contemporary medicine. Ann Fam Med. 2009 Mar-Apr;7(2):170-5.
6. Enzman Hines M, Wardell DW, Engebretson J, Zahourek R, Smith MC. Holistic nurses' stories of healing of another. J Holist Nurs. 2015 Mar;33(1):27-45.
7. Hayes J, Cox C. The experience of therapeutic touch from a nursing perspective. Br J Nurs. 1999 Oct 14-27;8(18):1249-54.
8. Hemsley MS, Glass N, Watson J. Taking the eagle's view: using Watson's conceptual model to investigate the extraordinary and transformative experiences of nurse healers. Holist Nurs Pract. 2006 Mar-Apr;20(2):85-94.
9. Slater VE, Maloney JP, Krau SD, Eckert CA. Journey to holism. J Holist Nurs. 1999 Dec;17(4):365-83.
10. Warber SL, Cornelio D. The client's role in biofield energy healing—a qualitative study. Focus Altern Complement Ther. 2003;8(4):551.
11. Warber SL, Cornelio D, Straughn J, Kile G. Biofield energy healing from the inside. J Altern Complement Med. 2004 Dec;10(6):1107-13.
12. Warber SL, Cornelio D. Becoming an energy healer: A qualitative exploration. Paper presented at: 14th Annual International Society for the Study of Subtle Energies & Energy Medicine Conference; June 2004; Colorado Springs, CO.
13. Kenny G. The healers journey: a literature review. Complement Ther Clin Pract. 2012 Feb;18(1):31-6.
14. Levin J. Energy healers: who they are and what they do. Explore (NY). 2011 Jan-Feb;7(1):13-26.
15. Zahourek RP. Intentionality in transpersonal healing: research and caregiver perspectives. Complement Health Pract Rev. 1998;4(1):11-27.
16. Potter PJ. Energy therapies in advanced practice oncology: an evidence-informed practice approach. J Adv Pract Oncol. 2013 May;4(3):139-51.
17. Pierce B. The use of biofield therapies in cancer care. Clin J Oncol Nurs. 2007 Apr;11(2):253-8.
18. Steckel CM, King RP. Nursing grand rounds. J Cardiovasc Nurs. 1996 Apr;10(3):50-4.
19. Quinn JF. The intention to heal: perspectives of a therapeutic touch practitioner and researcher. Advances J Mind-body Health. 1996;12(3):26-9.
20. Egnew TR. The meaning of healing: transcending suffering. Ann Fam Med. 2005 May-Jun;3(3):255-262.
21. Hunt VV, Massey WW, Weinberg R, Bruyere R, Hahn PM. A study of structural integration from neuromuscular, energy field, and emotional approaches. Boulder, CO: Rolf Institute of Structural Integraton; 1977.
22. Popp FA. Principles of complementary medicine in terms of a suggested scientific basis. Indian J Exp Biol. 2008 May;46(5):378-83.
23. Movaffaghi Z, Farsi M. Biofield therapies: biophysical basis and biological regulations? Complement Ther Clin Pract. 2009 Feb;15(1):35-7.
24. Rein G. Bioinformation within the biofield: beyond bioelectromagnetics. J Altern Complement Med. 2004 Feb;10(1):59-68.
25. Rubik B. The biofield hypothesis: its biophysical basis and role in medicine. J Altern Complement Med. 2002 Dec;8(6):703-17.
26. Cade MC, Coxhead N. The awakened mind: biofeedback and development of higher states of awareness. New York: Element Books; 1996.
27. Baldwin AL, Hammerschlag R. Biofield-based therapies: a systematic review of physiological effects on practitioners during healing. Explore (NY). 2014 May-Jun;10(3):150-61.
28. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ. 2008 Sep 29;337:a1655.
29. Ritenbaugh C, Nichter M, Nichter MA, et al. Developing a patient-centered outcome measure for complementary and alternative medicine therapies I: defining content and format. BMC Complement Altern Med. 2011 Dec 29;11:135.
30. Thompson JJ, Kelly KL, Ritenbaugh C, et al. Developing a patient-centered outcome measure for complementary and alternative medicine therapies II: refining content validity through cognitive interviews. BMC Complement Altern Med. 2011 Dec 29;11:136.
31. Kreitzer MJ, Gross CR, Waleekhachonloet OA, Reilly-Spong M, Byrd M. The brief serenity scale: a psychometric analysis of a measure of spirituality and well-being. J Holist Nurs. 2009 Mar;27(1):7-16.
32. The Confederation of Healing Organisations. Welcome to the Confederation of Healing Organisations. http://www.the-cho.org.uk/. Accessed July 7, 2015.
33. Sunderland N, Bristed H, Gudes O, Boddy J, Da Silva M. What does it feel like to live here? Exploring sensory ethnography as a collaborative methodology for investigating social determinants of health in place. Health Place. 2012 Sep;18(5):1056-67.
34. Kiefer CW. Doing health anthropology: research methods for health scientists. New York: Springer; 2006.
35. Black N. Why we need observational studies to evaluate the effectiveness of health care. BMJ. 1996 May 11;312(7040):1215-8.
36. Hornberger J, Wrone E. When to base clinical policies on observational versus randomized trial data. Ann Intern Med. 1997 Oct 15;127(8 Pt 2):697-703.
37. Campbell B, Patrick H; REGISTER Group. International collaboration in the use of registries for new devices and procedures. Br J Surg. 2012 Jun;99(6):744-5.
38. Hunt LP, Ben-Shlomo Y, Clark EM, et al; National Joint Registry for England, Wales and Northern Ireland. 90-day mortality after 409,096 total hip replacements for osteoarthritis, from the National Joint Registry for England and Wales: a retrospective analysis. Lancet. 2013 Sep 28;382(9898):1097-104.
39. Smith AJ, Dieppe P, Howard PW, Blom AW; National Joint Registry for England and Wales. Failure rates of metal-on-metal hip resurfacings: analysis of data from the National Joint Registry for England and Wales. Lancet. 2012 Nov 17;380(9855):1759-66.
40. Krieger D. Therapeutic Touch as transpersonal healing. New York: Lantern Books; 2002.
41. Ferguson CK. Subjective experience of TT: psychometric examination of an instrument Austin, Texas: Dissertation Abstract International, University of Texas at Austin; 1986.
42. Warber SL, Gordon A, Gillespie BW, Olson M, Assefi N. Standards for conducting clinical biofield energy healing research. Altern Ther Health Med. 2003 May-Jun;9(3 Suppl):A54-64.
43. Verhoef MJ, Casebeer AL, Hilsden RJ. Assessing efficacy of complementary medicine: adding qualitative research methods to the "Gold Standard". J Altern Complement Med. 2002 Jun;8(3):275-81.
44. Pawson R, Tilley N. Realistic evaluation. London: Sage; 1997.
45. Pawson R. The science of evaluation: A realist manifesto. London: Sage; 2013.
46. Pawson R. Evidence-based policy: a realist perspective. London: Sage; 2006.
47. Hardwick R, Pearson M, Byng R, Anderson R. The effectiveness and cost-effectiveness of shared care: protocol for a realist review. Syst Rev. 2013 Feb 12;2:12.
48. Hawkins A. The case for experimental design in realist evaluation. Learn Commun Int J Learn Soc Context. 2014;14:46-59.

ORIGINAL ARTICLE

Barriers to the Entry of Biofield Healing Into "Mainstream" Healthcare

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ABSTRACT

In this article, we describe barriers to the entry of biofield healing into mainstream contemporary science and clinical practice. We focus on obstacles that arise from the social nature of the scientific enterprise, an aspect of science highlighted by the influential work of Thomas Kuhn (1922-1996), one of the most important—and controversial—philosophers of science in the 20th century. Kuhn analyzed science and its revolutionary changes in terms of the dynamics within scientific communities. Kuhn's approach helps us understand unconventional medical theories and practices such as biofield healing. For many years, these were called "complementary and alternative medicine" (CAM). However, because most people use nonmainstream approaches in conjunction with conventional treatments, the National Institutes of Health and many practitioners now prefer "Complementary and Integrative Medicine" (CIM) where *integrative* implies "bringing conventional and complementary approaches together in a coordinated way."[1] Biofield healing fits the integrative model well, provides a novel approach to therapeutic intervention, and is developing in a manner that can integrate with current medical science in simple ways. Yet, it still remains outside the conventional framework because of its conceptual bases, which contrast sharply with conventional assumptions regarding the nature of reality.

BIOFIELD HEALING AS A NASCENT PARADIGM

Alternate Paths: Assimilation or "Revolution"

Biofield healing is not yet a fully developed paradigm. Rather, it is at the pre-paradigmatic stage that Kuhn said is characterized by a challenging set of interesting observations; the same ground is covered repeatedly, and consequently, new investigators are not at a disadvantage; the field is largely empirical rather than theoretical.[2] These features reflect the lack of internal consensus regarding fundamental characteristics of the pre-paradigmatic stage. This is illustrated by the articles in this issue; we find a variety of definitions even for the term *biofield*. This is typical of a new perspective, from which novel ideas may advance to become full paradigms. Enough paradigmatic features have emerged around biofield healing to stimulate both intense resistance from some in healthcare and yet substantial acceptance and active use by others.

Before an area of research and practice becomes a fully competitive new paradigm, it encounters 2 major possibilities: assimilation or accommodation, a metaphor from biology developed by Jean Piaget (1896-1980) to describe learning as adaptation.[2] In assimilation, an input (an experience or idea) is incorporated into the existing structure, as in digestion. The existing structure is not changed, but the input may be disintegrated and become unrecognizable. If a nascent paradigm is assimilated, it will not become a mature paradigm nor will it be revolutionary, although it may still make substantial contributions to the dominant paradigm. In accommodation, the input is not "digestible," so the preexisting structure must change unless it destroys or permanently resists the challenger. When a nascent paradigm forces accommodation, it retains its essential character and may revolutionize its field. Assimilation is the natural goal of the dominant system because it "feeds" the system and avoids the disintegration of existing structures that have proven adaptive and in which members of the field have substantial investment. In contrast, accommodation of input preserves the integrity of the input while the receiving system is radically changed. Accommodation may be minor or it may be revolutionary, as in ecology when excess nutrients cannot be assimilated by a pond and the pond becomes a marsh.

Biofield healing is developing into a paradigm that implicitly presents the divergent paths of assimilation-vs-accommodation for CIM in general and biofield healing in particular. The assimilation path would facilitate the integration of CIM within conventional medicine by emphasizing possible common mechanisms, as in chiropractic care and much of nutritional healing; on this path, biofield healing practices would become a part of conventional medicine with customary explanations such as measurable energy frequencies or placebo. Accounting for apparently anomalous healing observations, conventional medicine habitually utilizes a standard set of existing medical explanations ranging from suggestion and placebo to fraud. In the former instance, practices may be accepted as basically psychological treatments (a common medical view of spiritual healing/coping); the use of fraud as an explanation invalidates the practice and bars its entry.

The path of accommodation is more inherently in conflict with current medical/scientific thinking and potentially revolutionary. It therefore stimulates resistance, but it also holds out the possibility of retaining

the most striking aspects of biofield healing and revolutionizing medical science.

A primary difference between the assimilation and accommodation paths is that the assimilation/integration path involves attenuating or giving up fundamental principles. This attenuation occurred when chiropractic care achieved greater acceptance through assimilation. It is noteworthy that in order to pursue this path, chiropractic care had to give up its "biofield-like" explanations and resort to more conventionally acceptable neuromuscular explanations, a move that still generates controversy in the field. In contrast, the "paradigm shift" path seeks to retain the novel fundamental views of biofield healing and revolutionize Western medicine. The integration approach has immediate appeal because it reduces conflict and facilitates entry into the healthcare marketplace; the revolutionary idea generates greater resistance but holds the possibility of retaining the fundamentally novel aspects of biofield theory and practice. Of course, the 2 are not mutually exclusive, and we can see both being pursued at present. The evolution of the National Institutes of Health (NIH) Office of "Alternative" Medicine to the National Center for "Complementary and Alternative" Medicine to the most recent National Center for Complementary and "Integrative" Health is a clear example of assimilation taking place. In the integrative model, there is no longer a need for "alternative" or "unconventional" perspectives. This dynamic has important implications for efforts to negotiate the barriers to mainstream entry.

Despite resistance to its potentially revolutionary implications, the market for biofield healing and other CIM practices has grown. Conventional medical clinics and hospitals have made major investments to offer select CIM practices to patients and staff.[3] This development is in part a result of growing research on the effectiveness of a broad range of CIM healing practices. As is often seen with new paradigms, even as the evidence builds, support for the old paradigm and resistance to change increases in some quarters. This phenomenon is especially prevalent in the practice of medicine, which is a conservative enterprise by nature. But medicine is empirical and pragmatic as well as conservative, which is why CIM has penetrated medical practice to a substantial extent as well as stirring controversy and resistance. Consumers are even more empirical and pragmatic with little concern for theoretical consistency, and their interest has been a major driver of CIM in the healthcare marketplace.[4] The preference for clinical results over consistency with current scientific theory is a powerful factor in favor of the continuing advance of those biofield practices that show results.

Healing vs Curing

CIM practices are often jointly referred to as "healing." The word *healing* suggests a process of becoming whole, derived as it is from the ancient Indo-European root *kailo* meaning "whole" and related to the words *wholesome* and *health*, as well as *holy*, *hallowed*, and *halo*. As this etymology shows, *healing* has always had a spiritual connotation. One's return to wholeness may be physical, psychological, spiritual, or all three.[5] In contrast, the contemporary meaning of *curing* is the elimination of (mostly physical) disease. One may be cured of disease but not be returned to wholeness; such is the case when disease and treatment traumatize one psychologically and/or spiritually. Conversely, one may be healed but not cured, transcending sickness and transformed positively even as the body declines or dies. This is the reason the word *healing* is seldom used in medical discourse, except to describe naturally occurring processes of the organism, as in wound healing. The broader meaning of healing also suggests its ancient roots, a time when curing was less likely and healing was a primary goal. From the integrative medicine viewpoint, the healing/curing contrast embodies a large part of the difference between CIM and conventional biomedicine. Nevertheless, this does not mean that biofield healing is an inherently spiritual practice.

A Fundamentally Different Ontology/Lexicon

A lexicon is the set of lexemes (fundamental units of meaning) that comprise a language. Kuhn borrowed this term from conventional linguistics, and it typically refers to natural languages such as English or Spanish. Kuhn used the term to analyze the specialized languages that develop within science. For Kuhn, a lexicon constitutes an object of knowledge and the taxonomies within a lexicon reflect its underlying ontology. The differences between scientific paradigms are found both in different terms, often neologisms (candidate lexemes for the language) and in different meanings for the same terms. *Biofield* is an example of a neologism: it is a word rarely used in conventional science or medicine, and when it is used, it is usually accompanied by the term *putative*, explicitly excluding it from the accepted lexicon.[6-8] The biofield use of the term *energy* illustrates the use of a common scientific term that has specialized meanings in biofield discourse. Overlapping terms between scientific lexicons, *energy*, for example, creates serious problems of understanding between paradigms. This contributes to the incommensurability that Kuhn described existing between competing paradigms.

Much CIM practice implies the role of "subtle energies" in illness and health: that is, energies that are subtle in the sense of being difficult to detect. This is a neologism that implies an unconventional part of the energy spectrum in the biofield taxonomy. *Biofield healing* is a broad contemporary term that aggregates those CIM practices that most explicitly refer to such energies, as indicated by the definition of *biofield* used by the National Center for Complementary and Alternative Medicine (NCCAM) prior to its adoption of the term *integrative* at NIH:

> *putative energy fields* [that] *have defied measurement to date by reproducible methods. Therapies*

involving putative energy fields are based on the concept that human beings are infused with a subtle form of energy.[9]

The NIH definition of *biofield* clearly covers practices such as acupuncture, healing touch (HT), Reiki and external qigong, all of which have become more popular in the United States in recent decades.[7,10] But the exact scope of biofield healing is uncertain because a single practice may be understood as bioenergetic by some proponents and not by others. For example, chiropractic was founded on the idea that a subtle energy called "innate intelligence" flowed into the human body through the nervous system, so healing required the removal of impediments to its flow through the spinal cord (called subluxations of the spine). However, some modern chiropractic practitioners explain chiropractic within a mechanical, musculoskeletal framework.[11] The musculoskeletal view fits easily with the conventional medicine paradigm and facilitates integration within the healthcare system, but it is very different from the founding principles of the field.[12,13] Conversely, the *qi* account of acupuncture harmonizes well with the biofield concept, but explanations of acupuncture as mediated by the nervous system or as placebo do not. The central disputed issue is whether the entities and processes posited by biofield healing are the same, or at least continuous with, the entities and processes currently understood within conventional science.

The most fundamental meaning of *biofield* refers to the energetic properties of and energies generated by living organisms; this includes both forces conventionally recognized by Western science (eg, the electrical signals of the nervous system and the piezoelectric effects of collagen, tendon, bone, and DNA) and such disparate concepts of bioenergy as *qi*, *prana*, or "vital energy," as well as whatever forces may be associated with "intention." But biofield practitioners and researchers do not seek merely to add some new concepts to the existing ideas of science. *Biofield* is intended to integrate much of what is included in both CIM and conventional Western medicine that does not involve a chemical, surgical, or mechanical manipulation or pure psychotherapy, utilizing the concept of the biofield.[14]

There are mixed opinions about the role of subtle energies in many CIM systems. However, for practices such as Reiki or external qigong, currently, it is unlikely there is a foundation for physical causation as classically understood. Reliance on factors that "defy measurement" by current scientific techniques makes therapeutic effects reported for such practices "anomalous" in the sense used by Kuhn. They lie outside the bounds of current scientific knowledge, but more than that, explaining such effects appears to require the acceptance of causal agents and processes long ago rejected by modern science such as "life force" or "spirit." They appear to have a great deal in common with Mesmer's "animal magnetism."[15]

The individual traditions now claimed by biofield proponents were once seen as alien to modern science and, therefore, not subject to scientific investigation. That was the situation for acupuncture in the United States prior to President Nixon's visit to China in 1972. But Chinese efforts to integrate acupuncture and other *qi*-based therapies within a framework of modern medical science and growing evidence of their effectiveness led ultimately to a reassessment and efforts to assimilate acupuncture effects into a Western framework. Because of its breadth, the concept of biofield healing greatly complicates such efforts at straightforward assimilation. It is very difficult to bring the diverse practices of biofield healing ranging from the needling of points on *qi* meridians to intercessory prayer under a coherent explanation using current scientific concepts. That has led critics to use psychological explanations such as suggestion and the placebo response to bring biofield healing into the conventional healing theory/paradigm. Such explanations, however, are inherently contrary to biofield theory. The alternative is to create a new framework that incorporates many current scientific concepts along with the radically novel concepts that have developed with the idea of the "biofield." Such incorporation, however, suggests that the current concepts be understood differently in important ways. As Sharrock and Read make apparent in their analysis of Kuhn's philosophy of science and scientific revolutions, "paradigms are not produced *de novo*, they are in important part constituted out of the prior paradigm. . . . [T]he new paradigm will reconceive the prior paradigm's achievements" in its own terms.[16]

This, the inclusion of conventional science within biofield discourse, is what sets biofield healing apart from the individual older traditions like acupuncture and prayer. And herein lies a major source of resistance and misunderstanding. As Sharrock and Read put it, using a classic example, "Kuhn argues that Newton and Einstein take the universe to be populated by different fundamental entities": eg, mass is not the same thing in Newton's Laws as it is in Einstein's universe, so one cannot translate one paradigm into the other. When a scientific revolution moves the scientific consensus from one paradigm to another "the furniture of the universe changes."[16] The use of the word *energy* in the biofield discourse, as opposed to its standard physical meaning conventionally used in medicine, is the crucial example here. Kuhn argues that such differences in meaning, applied to the same words, is what makes different paradigms incommensurable and leads advocates of competing paradigms not so much to disagree when arguing as to "talk past each other." This is what is meant when we refer to understanding something "in terms of" a particular interpretation. "The furniture of the universe" is a metaphor for ontology, the fundamental basis of a paradigm. In philosophy of science, this is not ontology in the metaphysical sense; rather, as Quine's principal of logical commitment puts it, not "what things exist, but how to determine what things a theory claims exist" shifting from the metaphysical assertion

to an epistemological stance.[17] This kind of contingent view is crucial for the equitable consideration of competing ontologies; conventional medicine and biofield healing are currently engaged in such competition.

The biofield approach, then, finds the energy-referenced ideas of the various healing systems to which it refers to be an advantage. The ancient and crosscultural distribution of these practices cries out for a grand modern theory that can coordinate the disparate practices and theories of the individual traditions, some of them thousands of years old: lost wisdom, wrongly discarded by reductionist science, in need of modern explanation. From the standpoint of modern medicine, these ancient patterns are similar. Nevertheless, diverse interpretations exacerbate the problem, piling anomaly on top of anomaly. It is because of this that biofield healing offers not just a novel idea but the beginning of what may become a radically different paradigm. The nascent theories developing in the biofield discourse reconceive and thereby incorporate and coordinate existing medical knowledge with subtle energy.

PARTICULAR CHARACTERISTICS OF BIOFIELD HEALING THAT STIMULATE RESISTANCE

If we are correct that biofield healing represents a potential revolutionary paradigm in healthcare, we expect that resistance to it would follow from both features internal to biofield discourse and others internal to conventional science and medicine, features that we should find in the ontologies, and therefore the lexicons, of each.

Allegations of Pseudoscience

Subtle energies hold a central and defining place within biofield healing but are absent from the lexicon and ontology of conventional science. The resulting clash of ontologies raises the "demarcation issue," the philosophical effort to clarify the criteria for deciding whether an activity that calls itself science really is science or if it is *pseudoscience*, an important term in the lexicon of conventional science.[2,18]

The assertion that certain ideas and practices are not science—although they claim to be—would be a very strong defense against revolutionary criticism. Under the heading of "pseudoscience," this assertion has been used against CIM in precisely this way. Consider the following quote from an article published in the *British Medical Journal* entitled "UK universities offer degrees in 'pseudoscience,' *Nature* article says."[19] This article quotes pharmacologist David Colquhoun (University College London, Pharmacology) who is involved in an effort to have CAM teaching removed from UK universities: "Most complementary and alternative medicine (CAM) is not science because the vast majority of it is not based on empirical evidence."[20] The use of empirical evidence is a common defining aspect of science, and CIM is often accused of lacking it. Actually, there has been a great deal of empirical research on CIM, much of it with positive results, as documented in other articles in this issue. But definitions of what counts as empirical evidence has proven to be a contentious topic in itself. Within science, the term *empirical* developed highly specialized meanings, becoming what Ryle called an "achievement term" based on the logical positivist understanding of "sense experience."[21] The controversy over whether and how to use subjective report as data is one aspect of the resulting controversy that is especially pertinent to biofield healing.

The anomalous aspects of biofield healing, including distant effects of mind on living systems and the role of healing intention suggest the "paranormal," making a connection to parapsychology. And skeptics have long dismissed parapsychology as a "pseudoscience."[22-24] Many scientists and scholars consider this wholesale dismissal of parapsychology unjustified, and the tactics used against parapsychology over the past 140 years are clear examples of the dynamics that Kuhn delineated regarding the way that conventional science resists revolutionary new findings.[25-30] But the stigma remains. Therefore, this link yields additional barriers to the entry of biofield (and other energetic) healing into the mainstream. But the quantum mechanical observation of nonlocal effects, what appears to be action at a distance, is currently being used advantageously in parapsychology to build a bridge to emerging concepts in the latest conventional science.[31-33] Those concepts may prove central to the understanding of biofield effects and even of consciousness and its potential role in healing. Although parapsychology is still marginalized and stigmatized in conventional scientific discourse, it is growing in its evidential base and acceptance. This connection holds both risk and potential for biofield healing and should be approached cautiously but seriously.

The boundary issue has been a constant source of disagreement among scientists and philosophers for more than a century.[34] The movement of particular ideas back and forth between being accepted as science and being labeled pseudoscience shows that the boundary being sought is a social construction rather than an immutable natural feature. The appropriate response of biofield healing advocates must be to continue doing their empirical work and clarifying their own definition of the boundary of science. If biofield healing does emerge as part of a new medical paradigm, then, presumably, that will bring with it some salutary modifications to the boundaries of scientific medicine.

Popular Support: A Problem?

Acceptance and support of biofield healing and other CIM practices has developed more rapidly in the public than among scientists and physicians.[4,35-38] Popular support was obvious in the 1800s at a time when it was not even clear which medical approach was conventional and which was alternative, as homeopathy, magnetic healing, herbalism and many other health systems flourished. With the reform of the medical schools in the late 19th century and the devel-

opment of medical licensure in the early 20th, the distinctions became clearer. Although biomedicine became dominant, most of the 19th century traditions, from homeopathy to herbalism to religious healing, retained a following through the 20th century. In the latter part of the century, these traditions that were diminished but never died out experienced a renaissance. Empirical findings are sometimes published in popular magazines and books, and support comes from private funding and foundations. The foundation for such publications and funding is the interest and the experience of ordinary people. CIM healing is a grassroots movement, and this is a part of its strength.

Public support led to the study of unconventional cancer treatments by the Congressional Office of Technology Assessment in the 1980s; this was a striking move considering that the NIH already had in place a large and thriving National Cancer Institute (NCI),[39] but public advocates argued that the NCI was too biased to perform an objective evaluation. Then in 1992, Congress established the Office of Alternative Medicine (OAM) at NIH, again responding to public support and the support of some members of Congress with their own positive CAM stories to tell. The following year, Eisenberg and colleagues published the first systematic, national study of CAM use, followed by a second systematic study in 1998. Their findings were surprising to most: overall CAM utilization by Americans was high (34% within the past 12 months) and climbing (up to 42% in the 1998 study).[40] Perhaps more startling, though, was that CAM use was positively associated with education. The stereotype of those who used unconventional healthcare was summed up in a 1994 article in *JAMA* that noted 6 common characteristics of CAM users: recent immigrants, living in ethnic enclaves, don't speak much English, were educated outside the United States, and maintain a "high degree of ethnic identity": that is, the author notes, those who are "less acculturated."[41] But Eisenberg et al found just the opposite: "the highest use reported by nonblack persons from 25 to 49 years of age who had relatively more education and higher incomes."[40] Others have made the same finding.[42,43] The stereotype was obviously wrong. In 1998, OAM was elevated to the status of a national center, NCCAM, again showing the continued level of public support.

The problematic aspect of popular support harkens back to the science/pseudoscience boundary issue. The demarcation of science requires that scientists have expertise formally attained through extensive education. Educational credentials indicate a scientist as much as licensure indicates a true physician. This boundary reflects the assumption that only the properly educated can understand the procedures and the evidential outputs of real science. That being assumed, support by nonscientists coupled with loud resistance by (some) scientific experts appears to support the pseudoscience label, but the finding that better educated patients are more likely to use CAM complicates and undermines this interpretation. The issue at hand is that conventional work has a great advantage in acquiring funding and publishing findings; in fact, everything involving peer review is much harder for unconventional approaches. These obstacles create a Catch 22 for fields that challenge the dominant paradigm: without funding and peer-reviewed publications, the work is assumed not to meet high scientific standards, and meeting those standards is a prerequisite for funding and publication.

The Spirit Problem

The most fundamental barrier separating biofield healing from mainstream science lies in the spiritual associations of many of the healing practices that have been brought under its aegis: biofield healing observations appear anomalous with respect to conventional paradigms because they lack a conventionally recognized biological mechanism, and material biological mechanisms are central to the definition of the modern scientific medical paradigm.[44,45] The power of this obstacle is enormous, and it is magnified by the implicit connection to religion. Although many biofield healing proponents reinterpret religious practices such as "the laying on of hands" and religious meditation in nonreligious ways, the association remains pervasive. Reiki and HT, for example, look a great deal like the religious "laying on of hands." Furthermore, spirituality is a personal orientation to the transcendent, which to almost all humans has meant orientation to the world of spirits: God(s), angels, souls, Jinn, etc.[46] The "world of spirits" obviously is nonmaterial. It is, therefore contrary to materialism and conventional biological mechanisms.

Religion is the institutional aspect of this orientation. Therefore, not all spirituality is religious, but religions are inherently spiritual. Religious beliefs are heavily dependent on faith (belief without empirical evidence). The contemporary consequence of this is the view of spiritual healing as nonrational and therefore, presumably, not scientifically investigable. For example, in 1999 Arnold Relman, MD, the highly respected former editor of the *New England Journal of Medicine*, made the following statement at a conference on CAM at the University of Pennsylvania School of Medicine: "Science denies religion and that is what distresses advocates of CAM because CAM has a spiritual foundation."[5] This is one of the most important underlying sources of barriers to the entry of biofield healing research into the scientific and medical mainstream.

The "Life Force" Problem (Vitalism)

An emphasis on various kinds of energy is almost universal in CIM healing (and definitive for biofield healing), and it is crucial in mediating the concepts of harmony, balance, integration, and wholeness. But the connection (if any) of energy in this sense to energy in the conventional, physical sense as "the capacity to do work" is unclear. In some cases, such as *qi*, the English

word *energy* seems more like a metaphor than a simple translation. This issue becomes stark when we speak of an energy unique to living things: vital energy. Among other things, this is contrary to the conventional view that life processes can be reduced to very complex forms of the same processes found in nonliving things (eg, chemicals, molecules). This element potentially places biofield healing within the tradition that in Western thought has been called *vitalism*:

> *The belief that the activities of living organisms are due to a VITAL FORCE. . .that is different from other physical forces in the universe. Other names have been used for this living force or principle: DEMIURGE; ELAN VITAL; ENTELECHY; NOUS (PLATO); PSYCHE (ARISTOTLE). Vitalism. . .contend(s) that there is an ultimate, radical, and real dichotomy between living (organic) and nonliving (inorganic) phenomena. . . . Usually this force is regarded as being nonphysical, invisible, intangible, and. . . possessing a unity of its own that can exist independently of the physical bodies to which it gives life.*[47]

Vital force has been seen as the power behind emergent evolution, consciousness, self-regulation, and the innate healing capabilities of living creatures. Thus, this concept provides links among a great variety of specific theories of healing and general physical and metaphysical theories. It is also one reason that healing modalities and religious beliefs have such a strong affinity. However, it is also the case that vitalism was explicitly discarded in the development of modern medicine and biology. As philosopher Simon Blackburn states, "The consensus among philosophers and biologists is that it [vitalism] offers no explanatory advantage that the life sciences need."[17]

The perceived obsolescence of vitalism, coupled with vitalism's strong apparent connection with CIM in general and biofield healing in particular, gives biofield healing an archaic look in the eyes of conventional scientists. One response to this contentious issue would be to assume that eventually the energy of living things will be understood in a way that harmonizes with current physical views of energy and assimilated to conventional biology. For some, this is probably comfortable, but for others, it would erode the uniqueness of the biofield and would not address some of the more distinct aspects of biofield healing. If, on the other hand, one argues that the biofield (the energetic aspect of life) is inextricably bound up with the life force, it could be proposed that the generative force for the biofield is the life force itself. Then the biofield might even be proposed as the basic source of life and consciousness. This move would emphasize the uniqueness of the biofield and its effects, and simultaneously, it would establish that the biofield and contemporary biomedicine are definitely incompatible paradigms and unlikely to integrate.

Lack of a Broad Academic Infrastructure in the Biofield Domain

Biofield healing has been marginalized and has not developed the kind of academic infrastructure that has been so fruitful for mainstream science and medicine. History and philosophy of science, bioethics, medical sociology, and anthropology are integral parts of the social foundation of mainstream science and medicine. But while healing researchers often employ concepts and materials from such disciplines, most scholars in those fields have never paid any substantial attention to CIM as a set of important modern practices. These disciplines are expected to provide a critical attitude toward the biases of conventional scientists, but regarding CIM, most have simply replicated the biases of the mainstream.[48-51] This presents a challenge. To counter the negative stereotypes of CIM typically purveyed by scholars currently interested in health matters, biofield healing needs to develop its own solid infrastructure of scholarship in order for theory and practice to grow in a thoughtful manner. The special journal issue that this article sits in is an example of that attempt.

GENERAL CONCEPTS IN SCIENCE FROM WHICH BARRIERS TO BIOFIELD HEALING FLOW

Rationality

A basic problem in the resistance of conventional science to novel findings is the unwillingness to accept that things exist that we cannot currently measure or observe directly. This is often incorrectly attributed to the demands of rationality, but there are many phenomena of scientific interest that are not accessible directly yet are rationally inferred. In astrophysics, "dark matter," invisible to telescopic observation but inferred from its effects on visible matter, is an example.[52] Less exotic but more relevant clinically, pain can only be observed by the one experiencing it, and all quantification and neurophysiological correlates are entirely inferential. The inferences about dark matter and pain, when done correctly, are rational. Rational inferences about the biofield and bioenergetic effects observed through effects on living systems are equally rational. An example of this type of work is that done by Jonas and colleagues who performed a series of studies exploring the relationship of conventional energy to bioenergy. The results indicated that is it possible to investigate this connection and that it is to disentangle the differences through experiments in shielding, distance, and molecular blockers.[53-56]

Unfortunately, in controversial areas of science, those places near the boundary, the use of *rational* to mean "consistent with existing conventional theory" has become a common way of stigmatizing disfavored ideas as "not rational," especially those that do not seem to admit material explanation. This is now standard with regard to any alleged cause that appears not to be material, what Einstein called "spooky action at a distance." The usage of *rational* and *irrational* to characterize ideas themselves, rather than the reasoning that

led to them, is a kind of slang constituting a set of theoretical conclusions with neither explicit argument nor evidence. This is what sociologists call labeling, and it is a major source of inaccurate stereotyping.[57] Because biofield healing appears at present not to operate through ordinary physics, it suffers unfairly from the "not rational" assumption. This attribution is made all the stronger by the nonmaterial and nonrational character assigned to spirituality and the relationship of spiritual healing to biofield healing.

A classic example of the "rationality=materialistic" explanation claim is provided by the notion of prior theoretical plausibility, which has often been used to reject novel CAM findings. For example, on November 10, 1999, at a conference on CAM held at the University of Pennsylvania in Philadelphia, Marcia Angell (then editor of the *New England Journal of Medicine*) participated in a panel that addressed questions of editorial bias against CAM. Disclaiming bias against good scientific studies of CAM, Angell stated that in order to be good science, a study must offer a plausible biological mechanism for effects reported. Otherwise, the study would not be believable.[45] She then gave examples of well-designed CAM studies with sound statistics that produced positive results that "could not be true" (ie, had no plausible biological mechanism) and so should not be believed or published. One of these was a study of moxibustion for breech presentation that had recently been published in *JAMA*.[58] Effects that do not seem to rely on conventionally recognized physical forces, such as biofield healing, obviously are not consistent with a currently understood "plausible biological mechanism," and thus would fail Angell's test.[59]

The theoretical plausibility criterion implies the following:

1. Existing conventional scientific knowledge is an adequate measure of whether an unconventional claim is true. Therefore,
2. if a practice is not plausible on the basis of current theory, there is no reason to think that it may work (ie, it is not rational), and
3. empirical evidence of an event that is not theoretically plausible can be rejected out of hand. It must not have happened, or it cannot have happened as described. There must be (undetected or even undetectable) bias in the observation. So
4. acceptance of theoretically implausible claims would require the abandonment of (be inconsistent with) current scientific knowledge.

Individually and as a group, these ideas support expert paternalism and suggest that a process of free inquiry open to diverse views is unnecessary and counterproductive in science, except within narrow bounds internal to conventional scientific theory. Obviously, this is a defense of the existing paradigm against potentially revolutionary claims; observations that are theoretically implausible are anomalous in terms of the existing paradigm from which the theory at issue comes. In CIM, this suggests that the patient's autonomous right to refuse conventional treatment and to use legal alternatives is merely the right to be wrong.[45]

This reductive doctrine assumes a coherent scientific unity of all valid knowledge, present and future, such that new knowledge claims can be evaluated, prior to collecting new data, on the basis of their prospects for assimilation into contemporary science. That which has the potential to be assimilated may be true, what does not assimilate must be false. This criterion is what philosopher Paul Feyerabend called "the consistency condition," saying it is "unreasonable because it preserves the older theory, not the better theory. . . . It eliminates a theory or a hypothesis not because it disagrees with the facts; it eliminates it because it disagrees with another theory."[60]

Objectivity

Another central criterion of contemporary scientific method, related to rationality, is reliance on observations that are what philosophers call "public." That is, they can be made repeatedly by anyone using the proper technique. The assurance of this public nature in modern science is the availability of mechanical instruments to record the observable facts. So it is assumed that by eliminating the subjective human observer, the machine registry of something is purely objective. Of course, intention and vital energy do not register directly or consistently on available mechanical devices. We may call this "the machine registry" barrier. As described in another article in this issue, biofield scientists have created a number of devices intended to detect aspects of the biofield. Some of these have produced repeatable effects with results that conform to biofield healing expectations: for example, the devices using gas discharge visualization based on the Kirlian effect.[61-64] Nonetheless, the continued rejection of Kirlian photography by conventional science shows how difficult it is to get such novel instruments accepted. This generates another major barrier regarding biofield healing, leading critics to dismiss the topic as purely "subjective."

The machine registry issue is part of the "objective" observation criterion, and this is another central methodological obstacle for biofield healing. It arises from current notions about subjectivity and objectivity. This is a topic on which many healing researchers and practitioners disagree markedly with conventional scientists.[65-67] Interestingly, it is an issue on which many in modern society are changing their views.[66,68] Pure "objectivity" is increasingly being recognized as impossible, and subject/object boundaries are being reconsidered.[69-72] In some ways, this is helpful to healing researchers, but it also substantially raises the guard of conventional thinkers. For many scientists, the interest in the subjective dimension of healing is another indication of the postmodern rejection of objectivity, a trend which they see as threatening rationality altogether. Fortunately for biofield healing,

there are many current avenues developing for reconceiving the matter of objectivity. The role of the observer in quantum effects is one major example, but perhaps more methodologically relevant to biofield healing is the recognition that quantitative methods in research need to be combined with appropriate qualitative methods; "mixed methods" are becoming the state of the art in much research.[73-75] The stimulus for these developments in medicine includes the realization that omission of quality of life (QOL) and poor attention to adequate pain control in medicine have had a negative impact on quality of care. Both QOL and pain are among the medical outcomes where biofield healing has been able to demonstrate clear effects. This should be developed systematically within biofield research.

BARRIERS INTERNAL TO MEDICAL SCIENCE AND PRACTICE

The Materialism of Modern Medicine

Modern medicine emerged in the mid-19th century with the development of bacteriology, anesthesia, and antiseptic practice in surgery and the development of a physical and chemical foundation for medical practice. At this time, medicine began to turn from vitalism as a foundational principal to a mechanistic view rooted in materialism. In the conventional view, these changes allowed modern/allopathic medical science to retain all that was most effective during the ascent from prescientific superstition, making that which did not fit the reductionist biomedical model obsolete and left to folk medicine and quackery.[76-78] Skeptics assert that CIM practices are among these. Their claim benefits from CIM's openness to the possible effectiveness of ancient practices such as acupuncture. Many of the barriers we have described above relate to this obsolescence argument from conventional skeptics. But this view was also applied to botanical healing as recently as the 1970s.[79] Today, pharmaceutical companies scour the world for ancient herbal healing traditions to analyze and evaluate with clinical trials. This makes a powerful analogical argument against the assumption that the healing practices of ancient and non-Western societies were nothing but placebos.

The Guild Interests of Mainstream Science and Medicine

The claims and aspirations of biofield healing are in competition with those already in the mainstream of cultural authority: funding, patients, prestige, and status. They also challenge the deeply held emotional investment of mainstream scientists and doctors, which is most often expressed in terms of commitment to the public good. This personal investment issue always produces strong defenses and resistance to change in mature paradigms. This is also a major source of paternalism. When this investment is challenged, the response is often severe and couched in terms of protecting the public. The development and use of these arguments are a part of the social process of science as Kuhn (1962) demonstrated, and defense of medicine's guild interests always constitutes bias no matter how well founded the defense may be.[2] Despite all efforts to reduce scientific inference to a kind of rational calculus, no observations speak for themselves; interpretation is always required, and interpretation always offers space for differing viewpoints. This becomes severe when a scientific dispute involves contrary paradigms. At this point, the concepts and methods designed to reduce scientific bias and prejudice become powerful tools in the dispute and objectivity can be lost. As Kuhn showed, this does not always even involve valid argument or contradiction; rather, proponents of the clashing paradigms simply talk past each other. In this case, there is no engagement, and the winner is often the most powerful rather than the one with the best evidence.

"Peer" Review

In conventional science, publication, funding, promotion, and tenure are the backbone of the scientific process, and they are governed by peer review. Peer review developed after science became a mature paradigm involving extensive technical training by accredited institutions; with this came the development of increasingly technical language and complex instrumentation. The net result has been that lay persons, the public in general, have less and less true understanding of science and its findings. Peer review, intended to guarantee that decisions in these areas are made by true experts, is a natural response to the increasingly arcane nature of scientific knowledge. Peer review has a natural built-in seniority system wherein theory enhances the expertise of reviewers. This works moderately well in mainstream science, especially with the most conventional work. In newer areas, this process has real inertia because of confirmation bias, and that is a problem.[80] In unconventional areas such as biofield healing, the peer review system is a large obstacle. In the first issue of Prometheus Books' *Scientific Review of Alternative Medicine*, the editor, Wallace Sampson said of preexisting CAM journals that "at least one . . . claims that its articles are peer-reviewed," but they are really devoted to "articles and theories that are outside the borders of science and objective reality."[81] Until the advent of his new journal, Sampson said, "there has been no truly scientific, peer-reviewed journal specializing in [CAM]."[81] Or as he put it in an interview when asked about peer-reviewed work in a CAM publication, "they may be their peers, but they aren't our peers." Many, even rigorously done studies in CIM face difficulties in making it through the peer-review process (or even getting a review) of top mainstream journals, a barrier demonstrated in several studies of the impact of peer review on "acceptance levels" of CIM research.[82-84]

Rhetoric

All professions develop persuasive arguments to justify their practices and defend their authority, what we may call professional rhetoric. Understandably,

much of medicine's rhetoric centers on issues of risk, harm, and benefit. This is an issue of real concern to the public, and the history of medicine is filled with illustrations of the danger of harm by unintended consequences or poorly tested remedies. So the issue is valid and important, but very often, these claims are greatly exaggerated when CIM is under consideration. For example, in 2003, one of the authors (DJH) of this article took part in a debate regarding CIM at the Medical University of South Carolina. His opponent in the debate was Lawrence Schneiderman, MD, a well-known critic of CIM. In 2000 Dr Schneiderman published an article in the *Cambridge Quarterly of Healthcare Ethics*. In the debate, Hufford was able to show that each of Dr Schneiderman's examples of CIM's weakness lacked sound evidence.[85] For example, in dismissing "Lorenzo's oil," an alternative treatment (erucic acid) for adrenoleukodystrophy (ALD) made famous by a movie of the same name, Dr Schneiderman denounced the oil as "fraudulent" and stated that "worse than being merely useless, it was toxic as well," an assertion accompanied by a footnote citing Hugo Moser, MD, an expert on ALD and the physician who cared for Lorenzo when he first began to receive the special oil.[86] But in the year of the debate (2002), Dr Moser had publicly said that if he had a son with ALD, he would put him on Lorenzo's oil, noting that "Things have been publicized as treatments with much less evidence."[87] Regarding Dr Schneiderman's characterization of the oil as "toxic" based on a letter by Dr Moser to the editor of the *New England Journal of Medicine*, Dr Moser had actually said that some patients experienced a reduction in their platelet counts during a clinical trial but that this resulted in "no clinically important bleeding" and their counts returned to normal when the oil was removed from their diet.[88] Remarkably, critics of CIM have asserted that even the use of spiritually oriented CIM therapies used clinically to comfort the desperately ill involve the risk of great harm.[89,90]

The assertion of fraud is related to the assertion of risk. If a practice is fraudulent, then it is by definition ineffective; therefore, the risk:benefit ratio in such an instance is always unfavorable because the risk is always greater than possible benefit. Fraud and harm are also linked historically in the idea of quacks victimizing and harming innocent though gullible people. Angell's comments about claims to have achieved "impossible" results, as quoted above, provide a rationale for attributions of fraud that is the same as Hume offered 250 years ago, "that it is always more likely that people are lying than that natural law is being broken."[91] But this assertion begs the question by concealing its conclusion in its initial premise. The use of such circular reasoning by highly skilled intellectuals shows the depth of the bias involved.

HOW SHOULD HEALING RESEARCHERS RESPOND TO MAINSTREAM BARRIERS?

Solid, systematic research that is scrupulously rigorous is the most important response for biofield healing research to mainstream barriers. But for research to be solid and systematic cannot mean that it must serve the most conservative values of conventional medical research. For example, biofield research should not and could not make solid progress if it were to accept Angell's rule of being explicable by biological mechanisms already accepted by medical science. And finally, it is necessary for the biofield healing research community to be bold and innovative in responding to the current cultural situation in which the public is as enthusiastic for this research as conventional science and medicine are resistant. That background is fraught with both opportunities and risks. Currently, as these topics acquire a certain cachet and a clear economic value because of growing public demand, the field is gaining many new friends, and influential figures are offering themselves as leaders. We should always keep in mind that newfound popularity brings a whole new set of risks to those long accustomed to being unpopular.

REFERENCES

1. Complementary, alternative, or integrative health: what's in a name? https://nccih.nih.gov/health/integrative-health. Accessed May 12, 2015.
2. Kuhn TS. The structure of scientific revolutions. Chicago, IL: University of Chicago Press; 1962.
3. Hospital-based integrative medicine: a case study of the barriers and factors facilitating the creation of a center. http://www.rand.org/pubs/monographs/MG591. Accessed July 21, 2015.
4. The use of complementary and alternative medicine in the United States: cost data. https://nccih.nih.gov/news/camstats/costs/costdatafs.htm. Accessed July 21, 2015.
5. Hufford DJ. Evaluating complementary and alternative medicine: the limits of science and of scientists. J Law Med Ethics. 2003;31(2):198-212.
6. Yount G, Patil S, Dave U, et al. Evaluation of biofield treatment dose and distance in a model of cancer cell death. J Altern Complement Med. 2013;19(2):124-7.
7. Rindfleisch JA. Biofield therapies: energy medicine and primary care. Primary Care. 2010;37(1):165-79.
8. Running A. Decreased cortisol and pain in breast cancer: biofield therapy potential. evidence-based complementary and alternative medicine. Evid Based Complement Alternat Med. 2015;2015:870640.
9. Jain S, Mills PJ. Biofield therapies: helpful or full of hype? A best evidence synthesis. Int J Behav Med. 2010;17(1):1-16.
10. Miles P, True G. Reiki—review of a biofield therapy history, theory, practice, and research. Altern Ther Health Med. 2003;9(2):62-72.
11. Strang VV. Essential principles of chiropractic. Davenport, IA: Palmer College of Chiropractic; 1984.
12. Kaptchuk TJ, Eisenberg DM. Chiropractic: origins, controversies, and contributions. Arch Intern Med. 1998;158(20):2215-24.
13. Meeker WC, Haldeman S. Chiropractic: a profession at the crossroads of mainstream and alternative medicine. Ann Intern Med. 2002;136(3):216-27.
14. Hintz KJ, Yount GL, Kadar I, Schwartz G, Hammerschlag R, Lin S. Bioenergy definitions and research guidelines. Altern Ther Health Med. 2003;9(3 Suppl):A13-30.
15. Pattie FA. Mesmer and animal magnetism: a chapter in the history of medicine. Hamilton, NY: Edmonston Publishing; 1994.
16. Sharrock WR, Rupert. Kuhn: philosopher of scientific revolution. Cambridge, UK: Polity Press; 2002.
17. Blackburn S. The Oxford dictionary of philosophy. Oxford, UK: Oxford University Press; 1994.
18. Yurevich A. Cognitive frames in psychology: demarcations and ruptures. Integr Psych Behav Sci. 2009;43(2):89-103.
19. Spurgeon D. UK universities offer degrees in "pseudoscience," Nature article says. BMJ. 2007; 334:659.
20. Colquhoun D. Science degrees without the science. Nature. 2007;446(7134):373-4.
21. Ryle G. The concept of mind. New York, NY: Routledge; 2009.
22. Hines T. Pseudoscience and the paranormal. 2nd ed. Amherst, NY: Prometheus Books; 2003.
23. Leary M. Why are (some) scientists so opposed to parapsychology? Explore. 2011;7(5):275-7.
24. Shermer M. Psychic drift. Why most scientists do not believe in ESP and psi phenomena. Sci Am. 2003;288(2):31.
25. Dossey L. Why are scientists afraid of Daryl Bem? Explore. 2011;7(3):127-37.

26. Schwartz SA. The blind protocol and its place in consciousness research. Explore. 2005;1(4):284-9.
27. Schwartz SA. Nonlocality and exceptional experiences: a study of genius, religious epiphany, and the psychic. Explore. 2010;6(4):227-36.
28. Walach H, Kohls N, Belschner W. Transpersonal psychology—psychology of consciousness: chances and problems. Psychother Psychosom Med Psychol. 2005;55(9-10):405-15.
29. Mossbridge J, Tressoldi P, Utts J. Predictive physiological anticipation preceding seemingly unpredictable stimuli: a meta-analysis. Front Psychol. 2012;3:390.
30. Mossbridge JA, Tressoldi P, Utts J, Ives JA, Radin D, Jonas WB. Predicting the unpredictable: critical analysis and practical implications of predictive anticipatory activity. Front Hum Neurosci. 2014;8:146.
31. von Lucado W, Romer H. Synchronistic phenomena as entanglement correlations in generalized quantum theory. J Conscious Stud. 2007;14(4):50-74.
32. Walach H. Generalized entanglement: a new theoretical model for understanding the effects of complementary and alternative medicine. J Altern Comp Med. 2005;11(3):549-59.
33. Walach H, Kohls N, von Stillfried N, Hinterberger I, Schmidt S. Spirituality: the legacy of parapsychology. Arch Psych Rel. 2009;31(3):275-306.
34. Pfeffer J. Barriers to the advance of organizational science: paradigm development as a dependent variable. Acad Manage Rev. 1993;18(4):599-620.
35. Barnes PM, Bloom B, Statistics DoHI, et al. Complementary and alternative medicine use among adults and children—United States, 2007. US Department of Health and Human Services Center for Disease Control; 2008.
36. Tindle HA, Davis RB, Phillips RS, Eisenberg DM. Trends in use of complementary and alternative medicine by US adults: 1997-2002. Altern Ther Health Med. 2005;11(1):42-9.
37. Flannery MA, Love MM, Pearce KA, Luan JJ, Elder WG. Communication about complementary and alternative medicine: perspectives of primary care clinicians. Altern Ther Health Med. 2006;12(1):56-63.
38. Ben-Arye E, Frenkel M, Klein A, Scharf M. Attitudes toward integration of complementary and alternative medicine in primary care: perspectives of patients, physicians and complementary practitioners. Patient Educ Couns. 2008;70(3):395-402.
39. Assessment USCOoT. Unconventional cancer treatments. Washington, DC: US Government Printing Office;1990.
40. Eisenberg DM, Kessler RC, Foster C, Norlock FE, Calkins DR, Delbanco TL. Unconventional medicine in the United States—prevalence, costs, and patterns of use. N Engl J Med. 1993;328(4):246-52.
41. Pachter LM. Culture and clinical care. Folk illness beliefs and behaviors and their implications for health care delivery. JAMA. 1994;271(9):690-4.
42. Astin JA. Why patients use alternative medicine: results of a national study. JAMA. 1998;279(19):1548-53.
43. Barnes PM, Powell-Griner E, McFann K, Nahin RL. Complementary and alternative medicine use among adults: United States, 2002. Adv Data. 2004(343):1-19.
44. Kuhn T. The structure of scientific revolutions (2nd edition). Chicago, IL: University of Chicago; 1970.
45. Hufford D. Complementary and alternative medicine and cultural diversity: ethics and epistemology converge. In: Callahan D, editor. Complementary and alternative medicine: the scientific and pluralistic challenge. Washington, DC: Georgetown University Press & The Hastings Center; 2001.
46. Hufford D. Methodology. In: Cobb M, Puchalski CM, Rumbold B, editors. Oxford textbook of spirituality in healthcare. Oxford, UK: Oxford University Press; 2012:309-22.
47. Angeles P. A dictionary of philosophy. New York, NY: Barnes & Noble Books; 1981.
48. Vickers A, Goyal N, Harland R, Rees R. Do certain countries produce only positive results? A systematic review of controlled trials. Control Clin Trials. 1998;19(2):159-66.
49. Pittler MH, Abbot NC, Harkness EF, Ernst E. Location bias in controlled clinical trials of complementary/alternative therapies. J Clin Epidemiol. 2000;53(5):485-9.
50. Sood A, Knudsen K, Sood R, et al. Publication bias for CAM trials in the highest impact factor medicine journals is partly due to geographical bias. J Clin Epidemiol. 2007;60(11):1123-6.
51. Fan KW. Bias and other limitations affect measures of journals in integrative and complementary medicine. J Med Libr Assoc. 2015;103(3):148-51.
52. Murdin P. Dark Matter: Its Nature. In: Heck A, ed. Encyclopedia of astronomy and astrophysics. Bristol, United Kingdom Nature Publishing Group; 2002:1-8.
53. Jonas W.B.; Chez RA. Definitions and standards in healing research: First American Samueli Symposium. Altern Ther Health Med. 2003;9(3 Suppl):A1-104.
54. Kiang JG, Marotta D, Wirkus M, Wirkus M, Jonas WB. External bioenergy increases intracellular free calcium concentration and reduces cellular response to heat stress. J Investig Med. 2002;50(1):38-45.
55. Jonas WB, Crawford C, editors. Healing, intention and energy medicine: science, methodology and clinical implications. London, UK: Churchill Livingston; 2003.
56. Jonas WB, Ives JA. Energy medicine. In: Micozzi M, editor. Fundamentals of complementary and alternative medicine. 4th ed. St Louis, MO: Elsevier; 2011:197-212.
57. Gigerenzer G, Selten R. Rethinking rationality. In: Gigerenzer G, Selten R, eds. Bounded rationality: the adaptive toolbox. Cambridge, MA: Massachusetts Institute of Technology; 2002:1-12.
58. Cardini F, Weixin H. Moxibustion for correction of breech presentation: a randomized controlled trial. JAMA. 1998;280(18):1580-1584.
59. Angell M, Kassirer JP. Alternative medicine—the risks of untested and unregulated remedies. N Engl J Med. 1998;339(12):839-41.
60. Feyerabend P. Against method. London, UK: Verso; 1988.
61. Chiang Lee H, Wah Khong P, Ghista D. Bioenergy based medical diagnostic application based on gas discharge visualization. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society. 2005;2:1533-6.
62. Kostyuk N, Cole P, Meghanathan N, Isokpehi RD, Cohly HHP. Gas discharge visualization: an imaging and modeling tool for medical biometrics. http://www.hindawi.com/journals/ijbi/2011/196460/. Accessed September 10, 2015.
63. Bell IR, Lewis DA, 2nd, Brooks AJ, Lewis SE, Schwartz GE. Gas discharge visualization evaluation of ultramolecular doses of homeopathic medicines under blinded, controlled conditions. J Altern Comp Med. 2003;9(1):25-38.
64. Haun J, Patel N, Schwartz G, Ritenbaugh C. Evaluating the use of gas discharge visualization to measure massage therapy outcomes. http://www.hindawi.com/journals/ijbi/2011/196460/. Accessed September 10, 2015.
65. Sointu E. Complementary and alternative medicines, embodied subjectivity and experiences of healing. Health. 2013;17(5):530-45.
66. Daston L. Objectivity. Cambridge, MA: MIT Press; 2007.
67. Good IJ. Speculations in hard and soft science. Futures. 1970;2(2):176-9.
68. Hard science versus soft science. Am J Orthod Dentofacial Orthop. 1998 Oct;114(4):467-8.
69. Goldenberg MJ. On evidence and evidence-based medicine: lessons from the philosophy of science. Soc Sci Med. 2006;62(11):2621-32.
70. Code L. Taking subjectivity into account. In: Ruitenberg CW, Phillips DC, editors. Education, culture and epistemological diversity. Vol 2. The Netherlands: Springer; 2012:85-100.
71. Nonaka I, Toyama R. The theory of the knowledge-creating firm: subjectivity, objectivity and synthesis. Ind Corp Change. 2005;14(3):419-436.
72. Schmaus W. Science as social knowledge: values and objectivity in scientific inquiry by Helen E. Longino (book review). Vol 23. Newbury Park, CA: Sage Periodicals Press; 1993:562.
73. Johnson RB, Onwuegbuzie AJ. Mixed methods research: A research paradigm whose time has come. Educ Res. 2004;33(7):14-26.
74. Mertens DM. Research and evaluation in education and psychology: integrating diversity with quantitative, qualitative, and mixed methods. Thousand Oaks, CA: Sage Publications; 2014.
75. Morgan DL. Paradigms lost and pragmatism regained methodological implications of combining qualitative and quantitative methods. J Mixed Methods Res. 2007;1(1):48-76.
76. Brown H. Cancer quackery: what can you do about it? Nursing. 1975;5(5):24-26.
77. Cobb B. Why do people detour to quacks. Psychol Bull. 1954;3:66-9.
78. Glymour C, Stalker D. Sounding board. Engineers, cranks, physicians, magicians. N Engl J Med. 1983;308(16):960-4.
79. Offit PA. Do you believe in magic: vitamins, supplements and all things natural. New York, NY: Harper; 2014.
80. Nickerson RS. Confirmation bias: a ubiquitous phenomenon in many guises. Rev Gen Psychol. 1998;2(2):175-220.
81. Sampson W. Why a new alternative medicine journal? Sci Rev Altern Med. 1997;1:4-6.
82. Klassen TP, Pham B, Lawson ML, Moher D. For randomized controlled trials, the quality of reports of complementary and alternative medicine was as good as reports of conventional medicine. J Clin Epidemiol. 2005;58(8):763-8.
83. Lawson ML, Pham B, Klassen TP, Moher D. Systematic reviews involving complementary and alternative medicine interventions had higher quality of reporting than conventional medicine reviews. J Clin Epidemiol. 2005;58(8):777-84.
84. Smith R. Peer review: a flawed process at the heart of science and journals. J R Soc Med. 2006;99(4):178-182.
85. Hufford DJ. Evaluating complementary and alternative medicine: the limits of science and of scientists. J Law Med Ethics. 2003;31(2):198-212.
86. Schneiderman LJ. Alternative medicine or alternatives to medicine? A physician's perspective. Camb Q Healthc Ethics. 2000;9(1):83-97.
87. Rubin R. Lorenzo's oil brings hope for the afflicted: new findings support unorthodox treatment for rare brain disorder. USA Today. 2002;1A, 2A.
88. Zinkham WH, Kickler T, Borel J, Moser HW. Lorenzo's oil and thrombocytopenia in patients with adrenoleukodystrophy. N Engl J Med. 1993;328(15):1126-7.
89. Sloan RP, Bagiella E, Powell T. Religion, spirituality, and medicine. Lancet. 1999;353(9153):664-7.
90. Sloan RP, Bagiella E, VandeCreek L, et al. Should physicians prescribe religious activities? N Engl J Med. 2000;342(25):1913-6.
91. Hume D. An enquiry concerning human understanding. Section X, Parts I-II. In: Alston W, editor. Religious belief and philosophical thought. New York, NY: Harcourt, Brace & World; 1963:408-19.

ORIGINAL ARTICLE

Challenges and Opportunities Faced by Biofield Practitioners in Global Health and Medicine: A White Paper

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ABSTRACT

Biofield therapies (BTs) are increasingly employed in contemporary healthcare. In this white paper, we review specific challenges faced by biofield practitioners resulting from a lack of (1) a common scientific definition of BT; (2) common educational standards for BT training (including core competencies for clinical care); (3) collaborative team care education in complementary and alternative medicine (CAM) and in integrative health and medicine (IHM); (4) a focused agenda in BT research; and (5) standardized devices and scientifically validated mechanisms in biofield research. We present a description of BT and discuss its current status and challenges as an integrative healthcare discipline. To address the challenges cited and to enhance collaboration across disciplines, we propose (1) standardized biofield education that leads to professional licensure and (2) interprofessional education (IPE) competencies in BT training required for licensed healthcare practitioners and encouraged for other practitioners using these therapies. Lastly, we discuss opportunities for growth and a potential strategic agenda to achieve these goals. The Academy of Integrative Health and Medicine (AIHM) provides a unique forum to facilitate development of this emerging discipline, to facilitate IPE, and to further increase the availability of BT to patients.

BIOFIELD THERAPIES

Definition

Biofield therapies is a term coined by the National Center for Complementary and Alternative Medicine (NCCAM, known from 2015 onward as the National Center for Complementary and Integrative Health [NCCIH]) to categorize therapeutic approaches within energy medicine that involve using the body's energy field (biofield) for therapeutic benefit.[1] *Energy medicine* is defined as including "veritable" energy fields that can be measured for diagnosis and treatment and "putative" energy fields (also called biofields) that do not have standardized, reproducible measurements.[2] Veritable energy fields include vibration (such as sound waves), lasers, light, and magnetism. Putative energies are based on the belief that a subtle form of vital energy infuses all living systems. Many of the world's traditional medicine (TM) and CAM disciplines, systems, and professions acknowledge this concept as a vital or life force that is central to organizing and healing processes in biophysical systems. This central feature within TM and CAM healing systems is referred to by many terms, including *prana* in Ayurvedic medicine, "the innate" in chiropractic, *vis medicatrix naturae* or "vital force" in naturopathic medicine, and *qi* (or *ch'i*) in acupuncture and Oriental medicine (AOM). Healing touch (HT) and qigong also are examples of putative energy healing modalities. Consequently, several TM and CAM disciplines, in addition to nursing, physical therapy, and massage therapy, are included in the broad community of practice using BTs.

NCCAM originally classified energy medicine (BTs) as 1 of 5 CAM domains, and NCCIH currently classifies energy medicine under the broader term of "mind-body practices." However, because these therapies have roots in many global healing traditions and disciplines, it is best classified as an emerging science and profession that is recognized and integrated into various systems. Selected examples of BTs and the disciplines that employ them are listed in Table 1.[3-5]

Table 1 Selected Examples of Biofield Therapies (BTs) and the Modalities and Disciplines That Use Them[3-5]

Selected Categories and Types of BTs		Disciplines Using BTs
• Acupressure	• phototherapy	• Acupuncture and Oriental medicine
• Aura balancing	• polarity therapy	• Allopathic medicine
• BodyTalk	• Pranic Healing	• Ayurvedic medicine
• Electrodermal therapy	• qigong	• chiropractic
• Healing Touch	• Reiki	• homeopathic medicine
• holographic repatterning	• reflexology	• massage therapy
• Johrei	• sound therapies	• naturopathic medicine
• magnet therapy	• Therapeutic Touch	• nursing
	• Zero Balancing	• physical therapy
		• Tibetan medicine
		• Unani medicine

An Interprofessional Presence

As Table 1 illustrates, many disciplines and communities of practice employ BTs, and interprofessional education is becoming an increasing focus for IHM.[6,7] This interprofessional presence has 2 important implications: it provides the terrain for evolution of these therapies into a distinct, licensed discipline, as described later in this paper, and it establishes a firm foundation on which to include standardized IPE com-

petencies in BT discipline–level education. This underscores the opportunity for distinguishing the levels of training required and how current trends in integrative health may be synergistic.

Modality-level or Discipline-level Education? The Importance of Definition and Standardization

It is important to distinguish between BT used as a singular therapy or used as a modality. Some healthcare practitioners may employ 1 type of BT as a single therapy that defines their practice (eg, Reiki) while practitioners in other disciplines (eg, nursing) may employ selected BTs as 1 modality within a broad armamentarium of approaches. Some modalities, such as nutrition therapy or pharmacology, are found within multiple healthcare disciplines, and training and standards for these modalities vary. In licensed healthcare professions, a modality may be defined by state licensing and accreditation standards and board examinations. Yet other modalities, such as botanical medicine, also have become "emerging professions," and this is a potential avenue for BT (as discussed below). Distinguishing between modality-level and discipline-level training and practice, therefore, becomes essential to defining education and training requirements.[8,9]

NCCIH's legislative mandate specifies a collaborative research mission across CAM and conventional modalities, disciplines, and systems, and the modality of BT is now included among these. Despite legislative progress, BT remains one of the most marginalized and poorly understood of the CAM modalities, and integrating its practitioners into conventional health and medicine is challenging. However, the potential exists for it to develop further as a healthcare discipline, and we propose that this can be beneficial to all disciplines, organizations, communities of practice, and patients. For example, when a modality or a therapeutic approach, such as nutrition or lifestyle therapy, also develops into a distinct discipline, the discipline itself becomes a resource and potential benefit to other fields that include these approaches.

The Role of Integrative Health and Medicine in Advancing Biofield Therapies

IHM embraces CAM and global healing traditions alongside conventional treatments. Integrative healthcare programs for cardiovascular disease, for instance, may offer nutrition, fitness, and meditation services to prevent future cardiovascular events, and medical doctors may work alongside naturopathic physicians, nurses, AOM or traditional Chinese medicine (TCM) practitioners, chiropractors, and other CAM and TM providers within integrative team settings. The Academic Consortium for Integrative Medicine & Health (formerly the Consortium for Academic Health Centers for Integrative Medicine) and the AIHM define the term *integrative medicine* as "the practice of medicine that reaffirms the importance of the relationship between practitioner and patient, focuses on the whole person, is informed by evidence, and makes use of all appropriate therapeutic approaches, healthcare professionals and disciplines to achieve optimal health and healing."[10] In 2014, NCCAM acknowledged the increasing presence of integrative healthcare, stating "The integrative trend is growing among providers and healthcare systems. Driving factors include marketing of integrative care by healthcare providers to consumers who perceive benefits to health or well-being, and emerging evidence that some of the perceived benefits are real or meaningful."[11]

"Integrative health care" and "integrative health and medicine" have emerged as new phrases representing a pluralist healthcare system. These include all healthcare disciplines that share common values, including CAM, TM, integrative medicine as a subspecialty of biomedicine, holistic nursing, holistic medicine, and emerging allied health disciplines that practice according to shared values and philosophies (eg, AIHM, Academic Consortium for Complementary and Alternative Healthcare [ACCAHC], and Integrative Healthcare Policy Consortium [IHPC]).

Brief Description and Current Professional Status of Selected Biofield Therapies

Many BTs are used successfully in hospitals, clinics, and other healthcare settings[12] by biofield practitioners and/or by other healthcare practitioners trained in specific therapies. The 4 most common therapies are reviewed below as examples of practice and education in the field.

1. Therapeutic Touch (TT) was the first modality in BT to conduct nursing research and to provide nursing continuing education credits. Therapeutic Touch International Association (TTIA) was established as Nurse Healers-Professionals Associates in 1973 by Dolores Krieger, PhD, RN, and Dora Kunz. Numerous clinical trials of TT (1975-present) indicate its potential efficacy and effectiveness for diverse conditions, including pain, nausea, and anxiety[13]; neonatal health conditions[14]; and cancer.[15] The credentialing process to become a qualified TT practitioner includes completing coursework totaling a minimum of 26 hours and applied work with a TT mentor of at least 36 hours throughout a 1-year period.
2. Reiki, developed in the early 20th century by Japanese monk and educator Mikao Usui, is based on the concept that an unseen "life force energy" flows through organisms and sustains life. A 2002 survey by NCCAM and the National Center for Health Statistics found that more than 2.2 million US adults have used Reiki and an increasing number of licensed healthcare professionals are seeking training in Reiki.[16,17]
3. Reiki is not taught in the usual sense but through a process of transfer or attunement. The training program includes 3 levels that must be taught by

an experienced teacher or "master." A licensed teacher completes at least 1 year of requirements, including required classes, passing a written exam, submitting a written thesis, completing a minimum of 100 full Reiki treatments, and co-instructing classes. Requirements for maintaining licensure help ensure Reiki training is rigorous, consistent, and verifiable. Reiki classes are available internationally.

4. Qigong is the practice of aligning breath, body, and mind for health, meditation, and martial arts. Traditionally, qigong training has been esoteric and clandestine, with knowledge passed from master to student through lineages that maintain their own unique interpretations, ethical emphasis, and methods. Research in qigong has been conducted for a variety of medical conditions.[18-20]
5. HT was developed by Janet Mentgen, BSN, RN, and further developed into a certification program by the American Holistic Nurses Association (AHNA) in 1989. In 1996, Healing Touch International (HTI, now called Healing Beyond Borders) was established as the certification body for healthcare professionals—a significant benchmark in professionalization. HT is now a continuing-education, multilevel nursing program in energy-based therapy taught by certified HT instructors. Continuing education is recognized through the AHNA and the National Certification Board for Therapeutic Massage and Bodywork (NCTMB).

Participants who successfully complete the core curriculum can use the designated title Healing Touch Practitioner (HTP) and are eligible to apply for certification following a 1-year mentorship. Healing Beyond Borders administers certification through a separate review by the certification board using standardized criteria. The average training requires 2.5 to 3 years. Instruction is available internationally in universities, medical and nursing schools, and other settings.

Diversity of Current Academic Stakeholders and Resources in Biofield Therapies

Academic stakeholders and resources that include some form of biofield therapeutics training within their system of care range from communities of practice to programs, modalities, and therapeutic approaches to full disciplines and systems of care (see the Appendix for a list of these resources). These include subsets of training within degree programs in regulated and recognized disciplines and systems of care and programs offered by communities of practice and by modality-level training programs. Accredited education leading to licensure is available in acupuncture, AOM, chiropractic, massage therapy, naturopathic medicine, osteopathic medicine, and homeopathic medicine. These licensed disciplines provide modality-level training in BTs (under differing names) within their academic curricula. TM training in subsets of BTs also exists.

Types of Training Programs in Modalities and in Therapeutic Approaches

Certificate programs and degrees are available from private workshops and schools. Workshops include TT, Reiki, and HT. Private schools such as The Barbara Brennan School of Energy Healing, Boca Raton, Florida; Rev Rosalyn Bruyer's Healing Light Center Church, Sierra Madre, California; and Eden Energy Medicine Ashland, Oregon; also offer certification. These certifications are not state licensed, although most provide nursing continuing education credit. Private programs that do not have a relationship with recognized accreditation and state licensure are not eligible for student loans, which poses a major obstacle for many students.

Degree Programs in Disciplines and Systems

Acupuncture and Oriental Medicine Degrees

Although the scope of this paper does not include a full assessment of training programs available within all disciplines and systems of medicine, AOM is one example of a recognized and regulated field that includes BT core competencies in its training. The Accreditation Commission for Acupuncture and Oriental Medicine (ACAOM) is recognized by the US Department of Education and accredits master's degree, certificate, and diploma programs in acupuncture and Oriental medicine (www.acaom.org provides a list of schools offering accredited education). Although specific academic requirements vary, most acupuncture schools require 3 years of training, and Oriental medicine programs require 3 to 4 years. Many schools require a bachelor's or associate's degree for admission. The National Certification Commission for Acupuncture and Oriental Medicine (NCCAOM) oversees certification in acupuncture and Oriental medicine, administers the Asian Bodywork Therapy exam, and lists state-by-state requirements for certification and licensure in acupuncture and Oriental medicine (see www.nccaom.org). Healthcare practitioners who use energy medicine can seek certification in BT. These programs, such as HT, are endorsed by the AHNA and by the NCTMB.

Master's Degree in Holistic Nursing, Integrative Medicine, or Integrative Health

These programs address individuals seeking more formal instruction and credentials that will be accepted among conventional healthcare organizations and delivery systems. The programs (like the one offered via National University sites) are designed for current and future healthcare practitioners and researchers and typically accept students with undergraduate degrees in nursing, premedicine, or most other healthcare majors.

Master of Science in Nursing or Holistic Nursing

Holistic nursing programs train nurses for advanced practice nursing or clinical nurse specialization. Some fully accredited nursing schools offer ener-

gy medicine in their integrative nursing curriculum (eg, the program at the University of Colorado at Colorado Springs).

Doctorate in Nursing

The doctorate of philosophy (PhD) and the doctorate of nursing practice (DNP) are available at major universities. Many of these degrees include BT in their core curriculum (as at the University of Minnesota's Center for Spirituality and Healing, Minneapolis).

Crossdisciplinary Education in Biofield Therapies

Various BTs are used by a wide range of healthcare practitioners in TM, CAM, and IHM. Despite requests to institute collaborative training in BT throughout CAM and conventional disciplines, systems, and modalities, crossdisciplinary training or IPE is minimal. AIHM, launched in 2013, provides a unique venue for IPE through its critical forums for collaborative education by developing team care and by stimulating innovative research on the transdisciplinary concept of life force or vital force (the biofield). IPE and collaborative scientific discovery among stakeholders can potentially contribute to improved outcomes of care.[2] Reports from the following leading national healthcare organizations support IPE development.

- The White House Commission on Complementary and Alternative Medicine (WHCCAM) recommended in its 2002 report regarding health practitioner education and training that (1) the education of CAM and conventional practitioners should be designed not only to improve public health and ensure public safety, but also to increase the availability of and collaboration among qualified CAM and conventional healthcare practitioners (recommendation 10); (2) CAM and conventional training programs should include curricula to enhance collaboration among students and that such efforts should be widely supported by organizations, researchers, educators, and practitioners (recommendation 10.3); and (3) increased funding from the federal, state, and private sector should be available to "expand and evaluate CAM program development at accredited CAM and conventional institutions" (recommendation 10.4).[21]
- IHPC enacted a call to act on the WHCCAM recommendations in 2004 with 2 projects to serve increased interest between educators in conventional disciplines (medicine, nursing, public health, and allied disciplines) with educators in CAM and TM disciplines. IHPC first cofounded ACCAHC in part to sustain "a network of global educational organizations and agencies, which will promote mutual understanding, collaborative activities and interdisciplinary healthcare education."[22] IHPC then convened diverse health educators in the National Education Dialogue (NED) to Advance Integrated Healthcare project to establish a strategy to create common ground among educators in integrative health education and to inform "leaders of diverse healthcare disciplines about the priorities of educators in creating collaborative, integrated care."[23] More than 95% of participants described interdisciplinary collaboration as key to advancing integrative healthcare. NED and ACCAHC share a vision of a healthcare system that is "multidisciplinary and enhances competence, mutual respect, and collaboration across all CAM and conventional healthcare disciplines."[8]
- The Institute of Medicine (IOM) of the National Academy of Sciences in its report *Complementary and Alternative Medicine in the United States* (2005) called for comprehensive care that is effective and safe, including "effective interventions from all sources"[24] and observed that collaborative education is needed for both conventional medical and for CAM practitioners.

CHALLENGES TO INTEGRATION

Although many approaches, disciplines, and systems using BTs have existed for thousands of years (ie, Chinese and Ayurvedic medicines), the challenges to full integration are multifactorial.

Lack of a Common Lexicon for Biofield Therapies

Various BTs lack common terminology and a unifying definition. Currently, a clearly defined biofield mechanism and a standardized technology to assess the biofield are not readily available; therefore, a common definition of the biofield has not been attained in the scientific community. This lack of uniform agreement on accepted terminology, principles, and standards of practice has led to confusion among the medical community, educators, and patients.

Lack of Common Educational Standards Including Core Clinical Competencies for Training in Biofield Therapies

Therapies that treat the biofield and the human energy system are generally absent from conventional and nursing healthcare education.[2] Although there are many training programs for CAM and TM disciplines, professions, systems, and modalities that include aspects of BT, not all are regionally and professionally accredited in the United States or Canada; global recognition of standards varies by country, and a school's accreditation status and government recognition are important considerations for student loans and career options. For example, while there are accredited degree programs and certifications for AOM and other recognized disciplines, there are only a few standardized training programs specifically for energy medicine practitioners. Some programs like HT offer training and certification in BT; however, there currently is no recognized state licensure for biofield. Although many government-recognized CAM and TM systems include some BTs as modalities, this is complicated by the exis-

tence of many differing therapies, training standards, theories, practices, and clinical approaches.

Lack of Collaborative Team Education in Biofield Therapies

Despite inclusion of Martha Rogers' 1994 theory of the Science of Unitary Human Beings[25] in nursing education, most conventional medical and nursing schools do not acknowledge (or teach) the existence of the human energy system. There is increasing acceptance of BT, as illustrated by the inclusion of modalities like HT, TT, and Reiki at major medical centers.[11] Yet the concept remains debated in nursing, and the North American Nursing Diagnosis Association (NANDA) has removed the diagnostic category of Disturbed Energy Fields from the 10th edition of its diagnostic manual.[26] In order to achieve collaborative healthcare teams and acceptance of biofield modalities, continued focus on educating physicians and nurses in BT is critical.

Lack of a Focused Agenda and Quantitative Data in Biofield Therapies Research

Of studies conducted, most include small populations and are not amenable to the quantitative analysis required within current definitions of "evidence," so they are discounted by many conventional institutions. In its early history, energy medicine therapies, especially "electrical therapies," were considered unscientific, did not reflect the dominant materialist worldview, and therefore were not supported within the biomedical field that has expanded rapidly since the publication of the *Flexner Report* in 1910. As a result, this field (including research on its potential mechanisms and benefits) has not received adequate research attention or funding.

Lack of Standardized Devices and Scientifically Validated Mechanisms to Assess the Human Biofield

Clearly defined mechanisms and standardized technology to assess the biofield are not readily available. No scientific agreement exists on the definition of biofield. This lack of agreement on terminology, principles, technology, mechanisms, and standards of training and practice and the consequent limited data have led to confusion among the medical community and patients.

ADDRESSING KEY CHALLENGES

To successfully establish crossdisciplinary research, interprofessional education, and collaborative practice in BT requires further evolution of the existing community of practice along the continuum of an emerging profession. Although the process of "professional formation" is not frequently elucidated in the development of disciplines, it is nevertheless a defined process within a framework of 5 standards or benchmarks that can provide the structure and legitimation required to achieve wider integrative goals. These standards, as defined by the University of California, San Francisco (UCSF) Center for the Health Professions,[27] are (1) establishing a definition/description of the profession, (2) establishing safety and efficacy standards, (3) attaining government and private sector recognition, (4) establishing education and training (accreditation and academic standards), and (5) establishing a proactive practice model and viability of the profession.

Applying these standards improves understanding, acceptability, and legitimacy of the field. An organized approach to attaining these benchmarks provides the framework that supports growth of the profession and enhanced acceptance ("social closure"[28]) among the public, legislators, and other healthcare professions. An immediate opportunity exists to enhance efforts in the education and training benchmark by increasing interprofessional education and collaboration among the integrative healthcare disciplines (including integrative and holistic physicians, nurses, and other healthcare practitioners) that incorporate BT. Such interprofessional training, resulting in team care, can enhance patient experience, improve patient outcomes, and increase understanding among provider groups as recommended by WHCCAM, NED, and IOM.

Role of the Academy for Integrative Health and Medicine

In 2013, AIHM was created to serve as a vehicle to enhance interprofessional collaboration, education, and leadership among all healthcare disciplines, stakeholders, and organizations. AIHM is a direct response to the national mandates issued between 2002 and 2005. Enhancing interdisciplinary education in all IHM and CAM disciplines, systems, and modalities (including BT) is a key objective of AIHM. Its mission is also to advance scientific understanding of the nature of health and healing, including advancing theory-driven research.[29] Several organizations and workgroups have addressed the scientific development of theory-driven research and/or education.[30,31] AIHM's mandate is to foster transformation of healthcare and global health creation through education, research, and leadership, based on the core philosophies and values of IHM. This mandate will enable AIHM to become a leading forum for future expansion on transdisciplinary scientific work and education about the biofield.

A Strategic Plan to Address Specific Challenges

To meet the challenges to integration cited above, we propose that education in BTs be standardized to lead to professional licensure and that interprofessional education in BT be supported to enhance collaboration among all disciplines. Table 2 outlines a broad strategic plan that addresses the key challenges identified. A focused and systematic effort to accomplish the 3 actions outlined will further enable BT to become a recognized licensed profession with professional and safety standards, increased research evidence, and public and legislative legitimation.

Table 2 Strategic Plan to Address Specific Challenges and Enhance Professional Licensure and Interprofessional Education in Biofield Therapies (BTs)

Identified Challenge	Proposed Targeted Action
• No common scientific definition of BT • Lack of common educational standards for training in BT	• Establish interdisciplinary scientific and educational collaboration enabling the discipline to consolidate its definition, core principles and theories, educational standards, and core competencies, thereby establishing the identity of BT as a profession.
• Minimal collaborative education in complementary and alternative medicine and integrative health and medicine	• Increase training across provider groups in team care, consultation, collaboration, comanagement, and referral.
• No focused agenda across stakeholders in BT research • No standardized devices and scientifically validated mechanisms in BT	• Support transdisciplinary research, scientific discovery, and research question prioritization in BTs to expand understanding of health, healing, and illness and collectively clarify the potential and scope of BT as a healing practice. Develop agreements on standardized devices and validated mechanisms for research.

Framework to Achieve the Strategic Plan

Achieving transdisciplinary research and interdisciplinary education and practice in BT (as outlined in Table 2) requires evolution of the current community of practice to a licensed discipline with consequent professional and public legitimation. This evolution is defined by specific developmental benchmarks, as noted previously. We propose the following 3 categories of defined actions that address the fundamental steps of professional formation in addition to the direct actions required to enhance interprofessional education.

1. Establish Biofield Therapies as an Emerging Profession

We intend to convene diverse BT stakeholders over a 3-year period to define the field and establish core standards for the profession of BT. This requires that we understand and apply the basis of professional formation, distinctions between professions and emerging professions, and UCSF's 5 standards for emerging professions and related benchmarks of professional formation (listed above). Table 3 provides a brief list of definitions employed within the current lexicon of "professional formation," the formal process by which communities of practice like BT can evolve to an established, accredited profession. Table 4 lists specific actions and goals to achieve these standards.

2. Establish International Interdisciplinary Training in Biofield Therapies

To do so, we must apply concepts of interprofessional education and collaborative or team care and recognize and implement the following priorities established by NED:

a. Facilitate development of interinstitutional relationships and geographically based groupings of conventional and CAM institutions and disciplines in diverse regions.
b. Promote student and faculty exchanges, create new clinical opportunities, facilitate integrated postgraduate and residency programs, and provide opportunities for students to audit classes and share library privileges.
c. Create resource modules for distinct CAM (including BT), conventional, and emerging disciplines (approved by the disciplines) that can be used in several formats (eg, from supporting materials, such as glossaries, to complete curriculum models).
d. Develop a website and other forums to share educational and faculty resources for teaching or administrative functions (eg, interinstitutional relationship agreements).
e. Continue multidisciplinary work to create a concise statement of core values that resonates with other disciplines and can guide efforts to create quality integrated healthcare education.
f Collaboratively develop and sponsor continuing education initiatives to attract participants from diverse disciplines, including resources that prepare students and practitioners for collaborative practice in integrated clinical settings.
g. Develop materials to support collaboration among all providers engaged in integrative healthcare.

3. Host a Series of International Interdisciplinary Scientific Forums

AIHM would convene forums with biofield thought leaders to expand biofield research, scientific discovery, and education. AIHM would then publish each forum's conclusions and recommendations as a series of white papers for advancing the BT discipline.

SUMMARY

IHM has now begun to more fully realize the potential of working with the human biofield. Bringing professional standards and rigor to BT as an emerging discipline while maintaining its diversity of principles and practices can enable these therapies to become increasingly accessible to patients, physicians, and to integrative health practitioners in training. Scientific discovery and further understanding of the nature of health, healing, and illness have the potential to increase as the field becomes more accessible to scientific evaluation. Interprofessional education has been acknowledged as an effective vehicle for preparing future healthcare practitioners, and this can be enhanced through greater recognition of common ground and exploration of diverse epistemologies. The

Table 3 Useful Definitions for Clarifying the Process Required for Transition of Biofield Therapies to an Emerging Profession

Term	Definition
Community of Practice (CoP)	"A CoP includes individuals who share a common interest, trade, or craft, and who exchange information and knowledge about it. Sharing knowledge can be intentional or can be a passive result of involvement with the group. Three key features exist within all CoPs: a shared domain of interest, a community of interaction and learning, and shared resources and tools regarding their practice."[32] "A CoP is distinguished from a profession by its position and actions concerning public accountability." (unpublished material)
Emerging profession	"[A] developing profession which has undertaken and has successfully achieved a number of the benchmarks along the continuum of professionalization and accountability: and which have evidence that others are being developed. The profession begins to 'emerge' as a significant number of the key benchmarks are established. An emerging profession contains the basic characteristics of a profession; these characteristics or benchmarks are in various stages of actual development."[8,9]
Healthcare discipline	A branch or domain of knowledge, instruction, or learning. Nursing, medicine, physical therapy, and social work are examples of health-related or professional disciplines.[33] For the sake of this discussion, the terms *profession* and *discipline* can be used interchangeably. A "whole-healthcare system" is also a healthcare discipline. Not all healthcare disciplines consider themselves whole-healthcare systems; for example, direct entry midwifery, although a healthcare discipline, does not consider itself a whole-healthcare system. Naturopathic medicine, chiropractic medicine, acupuncture and Oriental medicine, and Ayurvedic medicine are healthcare disciplines that also are whole systems of healthcare.[8]
Healthcare system	A discipline or system of healthcare is "the structure or whole formed by the essential principles or facts of a science or branch of knowledge or thought: an organized or methodically arranged set of ideas, theories or speculations. . . . [This] may imply that the component units of an aggregate exist and operate in unison or concord according to a coherent plan for smooth functioning."[34] "Whole medical systems" involve complete systems of theory and practice that have evolved independently from or parallel to allopathic (conventional) medicine. Many are traditional systems of medicine that are practiced by individual cultures throughout the world. Major Eastern whole medical systems include traditional Chinese medicine (TCM) and Ayurvedic medicine, one of India's traditional systems of medicine. Major Western whole medical systems include homeopathy and naturopathy. Other systems have been developed by Native American, African, Middle Eastern, Tibetan, and Central and South American cultures."[35] "A 'whole system' of healthcare is typically titled by its system name, and is usually comprised of modalities. Therapeutic interventions exist within these modalities. A whole system or discipline of healthcare may incorporate a discrete, limited amount of knowledge or a group of strategies from another system or discipline [as a] modality, rather than incorporating the entire system itself."[8]
Modality	A form of application or employment of a therapeutic agent or regimen.[36] A modality for one profession may be another healthcare profession's entire discipline or system. Examples of modalities found within many healthcare systems are diet and nutrition therapy, physical medicine, and pharmacology, among others. Training and standards for modalities vary between systems. In licensed healthcare professions, they may be defined by state licensing and accreditation standards and board examinations. Some modalities, such as botanical medicine, also are "emerging professions." Distinguishing between modality-level and discipline-level training and practice is essential.[8,9]
NCCAM Legislation	Legislation (Public Law 113-296) that created the National Center for Complementary and Alternative Medicine (NCCAM) uses the language "complementary and alternative medicine (CAM) modalities, disciplines and systems" throughout to describe the purpose and focus of NCCAM's research. For example, " the Director of the Center shall identify and evaluate alternative and complementary medical treatment, diagnostic and prevention modalities in each of the disciplines and systems with which the Center is concerned, including each discipline and system in which accreditation, national certification, or a State license is available."[37] These terms guide NCCAM's research on integration of CAM modalities, disciplines, and systems into mainstream healthcare delivery systems; the composition of NCCAM's advisory council, scientific review panels, research centers, and the investment in CAM (accredited/licensed) research and education facilities.[37]
Profession	" [A] calling or vocation requiring specialized knowledge, methods, skills, and training in a defined preparation or an institution of learning, in the scholarly, scientific, clinical, artful and historical, social and cultural principles underlying such methods and skills. A profession continuously enlarges and evaluates its body of knowledge, functions autonomously in formulation of policy, and maintains by force of organization or concerted opinion high standards of achievement and conduct. Members of a profession are committed to continuing study, are guided by a code of ethics, place service above personal gain, and are committed to providing practical services vital to human and social welfare."[8]
Therapy	A specific treatment for a specific condition or symptom, within a modality or from a combination of modalities. Examples: a vitamin for arthritis or an herb for the flu, or a vitamin and massage therapy for arthritis, etc.[8]
Traditional (world) medicine professions	"Traditional medicine (TM) includes diverse health practices, approaches, knowledge and beliefs incorporating plant, animal and/or mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to maintain well-being, as well as to treat, diagnose or prevent illness. . . . Traditional Medicine arising from the experiences of the past and embedded in the culture of each society cannot stand still and must change and develop. Along with allopathic medicine it shares issues in appropriate and rational use. This includes qualification and licensing of providers, proper use of good quality products, good communication between TM providers and patients and provision of scientific information and guidance to the public. The patient is the ultimate beneficiary of any system of medicine and therefore should have access to good scientific information. The provision of such information is a shared responsibility of TM providers, their professional associations and the government."[38]

professional accountability and patient safety fostered by professional standards and academic rigor built collaboratively across disciplines and practitioners will provide a platform for BT to become more widely available and to enhance the field's contribution to 21st-century medicine and health.

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REFERENCES

1. Anderson JG, Taylor AG. Biofield therapies and cancer pain. Clin J Oncol Nurs. 2012;16(1):43-8.
2. Maret K. Energy medicine in the United States: historical roots and the current status. Loveland, CO: Foundation for Alternative and Integrative Medicine; 2009. http://www.faim.org/energymedicine/energy-medicine-united-states-historical-roots-current-status.html. Accessed July 10, 2015.
3. Rubik B. Measurement of the human biofield and other energetic instruments. In: Freeman L (editor). Mosby's complementary and alternative medicine: a research-based approach. 3rd ed. St Louis, MO: Elsevier Inc; 2008.
4. Jain S, Mills PJ. Biofield therapies: helpful or full of hype? A best evidence synthesis. Int J Behav Med. 2010;17:1-16.
5. Snyder M, Lindquist R. Complementary and alternative therapies in nursing. New York: NY; Springer; 2010.
6. Institute of Medicine. Interprofessional education for collaboration: learning how to improve health from interprofessional models across the continuum of education to practice. Washington, DC: The National Academies Press; 2013.
7. Academy of Integrative Health and Medicine. Academy vision, mission and areas of focus. https://aihm.org/about/mission-values-and-goals. Accessed July 10, 2015.
8. Benjamin P, Phillips R, Warren D, et al; ACCAHC/OCCIM Task Force. Response to a proposal for an integrative medicine curriculum. J Altern Complement Med. 2007;13(9):1021-33.
9. Weeks J, Snider P, Quinn S, O'Bryon D, Haramati A, editors. National education dialogue to advance integrated healthcare: creating common ground. Conifer, CO: Integrated Healthcare Policy Consortium; 2005
10. Consortium of Academic Health Centers for Integrative Medicine. Definition of integrative medicine and health. http://www.imconsortium.org/about/about-us.cfm. Accessed July 10, 2015.
11. National Center for Complementary and Integrative Health. Complementary, alternative, or integrative health: what's in a name? https://nccih.nih.gov/health/integrative-health. Accessed July 10, 2015.
12. Miles P, True G. Reiki–review of a biofield therapy history, theory, practice, and research. Altern Ther Health Med. 2003;9(2):62-72.
13. Anderson JG, Suchicital L, Lang M, et al. The effects of Healing Touch on pain, nausea, and anxiety following bariatric surgery: a pilot study. Explore (NY). 2015 May-Jun;11(3):208-16.
14. Chhugani M, Sarkar S. Therapeutic touch modalities and premature neonate's health outcome: a literature review. J Neonatal Biol. 2014;2:148.
15. Coakley AB, Barron AM. Energy therapies in oncology nursing. Semin Oncol Nurs. 2012;28(1):155-63.
16. Devries S, Dalen J. Integrative cardiology. New York, NY: Oxford University Press; 2011.
17. Swengros D, Herbst AM, Friesen MA, Mangione L, Anderson JG. Promoting caring-healing relationships: bringing healing touch to the bedside in a multihospital health system. Holist Nurs Pract. 2014;28(6):370-5.
18. Xiong X, Wang P, Li X, Zhang Y. Qigong for hypertension: a systematic review. Medicine (Baltimore). 2015;94(1):e352.
19. Sawynok J, Lynch M. Qigong and fibromyalgia: randomized controlled trials and beyond. Evid Based Complement Alternat Med. 2014;2014:379715.
20. Zeng Y, Luo T, Xie H, Huang M, Cheng AS. Health benefits of qigong or tai chi for cancer patients: a systematic review and meta-analyses. Complement Ther Med. 2014;22(1):173-86.
21. White House Commission on Complementary and Alternative Medicine Policy. Final report; March 2002. http://www.whccamp.hhs.gov/finalreport.html. Accessed July 10, 2015.
22. Academic Consortium for Complementary and Alternative Healthcare. Vision, mission, values. http://accahc.org/vision-mission-vals. Accessed July 10, 2015.
23. Weeks J, Snider P, Quinn S, O'Bryon D, Haramati A. National education dialogue to advance integrated healthcare: creating common ground. Progress report. Washington, DC: National Education Dialogue Planning Committee; 2005.
24. Institute of Medicine. Complementary and alternative medicine in the United States. Washington, DC: National Academies Press; 2005.
25. Watson J, Smith MC. Caring science and the science of unitary human beings: a trans-theoretical discourse for nursing knowledge development. J Adv Nurs. 2001;37(5):452-61.
26. Herman TH, Kamitsuru S, editors. Nursing diagnoses: definitions and classification: 2015-2017. 10th ed. Oxford: Wiley Blackwell; 2014.
27. Dower C, O'Neil EH, Hough HJ. Profiling the professions: a model for evaluating emerging health professions. San Francisco, CA: Center for the Health Professions, University of California; 2001.
28. Schleich D. From nature-cure to naturopathic medicine: the institutionalizing of naturopathic medical education in Ontario [dissertation]. Toronto (ON): University of Toronto; 2005.
29. Achterberg CL, Novak JD, Gillespie AH. Theory-driven research as a means to improve nutrition education. J Nutr Educ Behav.1985;17(5):179-84.
30. Standish L, Calabrese C, Snider P. The naturopathic medical research agenda: the future and foundations of naturopathic medical science. J Altern Complement Med. 2006;12(3):341-5.
31. Verhoef M, Koithan M, Bell IR, Ives J, Jonas W. Whole complementary and alternative medical systems and complexity: creating collaborative relationships. Forsch Komplementmed. 2012;19 Suppl 1:3-6.
32. Wenger E. Introduction to communities of practice. http://wenger-trayner.com/introduction-to-communities-of-practice/. Accessed July 10, 2015.
33. Venes D, Thomas CL, editors. Taber's cyclopedic medical dictionary. 19th ed. Philadelphia: F.A. Davis Co; 2001.
34. Webster's third new international dictionary. Chicago: Encyclopaedia Britannica; 1986.
35. National Center for Complementary and Alternative Medicine. Backgrounder: Whole medical systems: an overview. 2004. http://mediaserver-master.centrelearn.com/Content/Files/4405/whole%20medical%20systems%20overview%20NCCAM.pdf. Accessed July 10, 2015.
36. Williams RH, editor. Stedman's medical dictionary for the health professions and nursing. 25th ed. Philadelphia: Lippincott Williams & Wilkins; 1990.
37. HR 4328 (105th) Omnibus Consolidated and Emergency Supplemental Appropriations Act, 1999. Title VI – National Center for Complementary and Alternative Medicine. Pub. L. No. 105-277, 112 Stat. 2681-387 (October 21, 1998). https://www.congress.gov/105/plaws/publ277/PLAW-105publ277.pdf. Accessed July 10, 2015.
38. World Health Organization. WHO traditional medicine strategy 2002-2005. Geneva: World Health Organization; 2002.

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Appendix

Resources in Biofield Therapies

- Academic Consortium for Complementary and Alternative Healthcare
- Academic Consortium for Integrative Medicine and Health
- Academy of Integrative Health and Medicine
- American Holistic Nurses Association
- The Center for Reiki Research
- Foundation for Alternative and Integrative Medicine
- Healing Beyond Borders
- Integrative Healthcare Policy Consortium
- International Association of Reiki Professionals
- The International Center for Reiki Training
- National Center for Complementary and Integrative Health
- National Qigong Association
- The Qigong Institute
- Qigong Research and Practice Center
- The Reiki Alliance