Development of personalized health monitoring using ultra-weak photon emission based on systems medicine concepts

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Chapter 2

A Chinese literature overview on ultra-weak photon emission as promising technology for studying system-based diagnostics

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Abstract

To present the possibilities pertaining to linking ultra-weak photon emission (UPE) with traditional Chinese medicine–based diagnostics principles, we conducted a review of Chinese literature regarding UPE with respect to a system's view of diagnostics. Data were summarized from human clinical studies and animal models published from 1979 through 1998. The research fields can be categorized as follows: 1) human physiological states measured using UPE; 2) characteristics of human UPE in relation to various pathological states; and 3) the relationship between diagnosis (e.g., syndromes) and the dynamics of UPE in animal models. We conclude that UPE has clear potential in terms of understanding the systems view on health and disease as described using traditional Chinese medicine–based diagnostics, particularly from a biochemistry-based regulatory perspective. Linking UPE with metabolomics can further bridge biochemistry-based Western diagnostics with the phenomenology-based Chinese diagnostics, thus opening new avenues for studying systems diagnostics in the early stage of disease, for prevention-based strategies, as well as for systems-based intervention in chronic disease.

Keywords: Ultra-weak photon emission (UPE), traditional Chinese medicine research, diagnosis, reactive oxygen species (ROS).

1. Introduction

The use of ultra-weak photon emission (UPE) in living organisms was first described by Gurwitsch in 1923.[1] At that time, the technical capabilities for measuring radiation using physical devices was rather limited. This technology became more feasible when sensitive photomultipliers were developed in the 1960s in the former Soviet Union. The early data were published primarily in Russian journals,[2,3] with only a fraction of the reports translated into English.[4] Since the 1970s, UPE has been used by research teams in Germany,[5] Australia,[6] Poland,[7] Japan,[8] the United States,[9] and China.[10] UPE has been used successfully in a wide variety of organisms, including bacteria, yeast, plants, animals, and humans, as well as in cells and cellular homogenates derived from living organisms.[5–11]

UPE occurs spontaneously in living organisms, without the need for external intervention.[12] The emission range of UPE is approximately 10–10^3 photons/sec/cm^2. The spectral range of the photons emitted from living systems is 300–750 nm;[13] the photons emitted from human tissue ranges from 420–570 nm.[14] The source of UPE is closely related to the electronic transport and the generation of reactive oxygen species (ROS) during oxidative metabolic processes, with UPE originating from the transition from either the singlet excited state (such as singlet oxygen $^1O_2$) or the triplet excited level of carbonyl species ($^3R{=}O^*$) to the singlet ground state.[15,16] Biological ROS—including the reactions of superoxide radical ($O_2{\cdot}^-$), hydrogen peroxide (H_2O_2), and hydroxyl radical ($HO\cdot$)—are produced dynamically during chemical metabolic redox reactions, including lipid peroxidation and protein/nucleic acid generation; moreover, during these metabolic processes, electrons can become excited, and energy is emitted in the form of photons.[17] Similar to the ROS theory described above, photons can also be released during the metabolism of radical nitrogen species (RNS). ROS causes the oxidation of biomolecules such as nucleic acids, proteins, and lipids, which play essential roles in many cellular processes, including cell signaling, apoptosis, and pro/anti-inflammatory regulation.[18,19]

Therefore, UPE can be measured in order to detect the physiological state of the human body and to measure dynamic changes in health.[12,13,20]

In humans, UPE is usually measured using a photomultiplier tube (PMT) or a charge-coupled device (CCD). Emitted photons can be measured directly through the skin in a light-tight, dark environment.[21,22] The use of UPE as a diagnostic tool for health-related issues in humans has been reviewed recently.[23] The intensity of UPE emitted from the human body can be influenced by several physiological states, including age,[24] gender,[25] biological rhythms,[22,26–29] and conscious activities,[30–32] thus leading to the discovery of putative diagnostic properties of photon emission. For example, hypothyroidism can be diagnosed by measuring the emission of photons from the index finger of human subjects.[33] Furthermore, differences in the intensity of photon emissions have been measured between patients with multiple sclerosis and healthy subjects.[34,35] Moreover, patients with hemiparesis have asymmetrical UPE intensity between the left and right hands, suggesting that measuring photon emission symmetry could be used as a novel diagnostic parameter in addition to measuring UPE intensity.[36,37] Based on the aforementioned experimental observations, UPE has been proposed as a non-invasive indicator of the integrated states and dynamic changes in human health.[12,20,38]

In the newly emerging systems-based view of health, biology can be considered a hierarchy of various levels of organization, ranging from low levels (e.g., biochemistry and molecules) to the cellular and organ levels, all the way up to the integrated systems level.[38] In Western medicine, “omics” technologies are often utilized to study genes, proteins, and metabolites at relatively low organizational levels.[39] Recent work suggests that the dynamic distribution of UPE emissions from the human body can reflect both the health status at a large-scale organization level and the dynamics of the system.[13,20] Similar to UPE, traditional Chinese medicine (TCM) integrates physiological and pathological information at a higher level of organization—i.e., the phenotype level—in order to obtain a holistic description of

the body's state. Two important types of descriptions are frequently used: constitution differentiation and syndrome differentiation.[39–41] However, TCM–based diagnostics is a descriptive, phenomenological approach based on many clinical observations, and the insights regarding molecular and mechanistic biology have been explored only recently.[42] Given that UPE may provide important insight into health at a high level of organization, measuring UPE parameters may provide novel scientific insights into TCM–based diagnostics and may help guide Western medicine towards a systems-based view of life, both from a diagnostic perspective and from an intervention perspective. Therefore, it is important to explore the history of this relationship between UPE and TCM–based diagnostics.

Applications in which UPE has been used to understand and measure systemic organization can be found in Chinese literature; these publications have generally focused on the relationship between UPE and TCM–based concepts in both human and animal studies. In this review, we summarize these studies published in Chinese scientific journals from 1979 through 1998. In studies published between 1979-1998, TCM–based concepts were used to establish UPE experimental designs. After the turn of the century, there was a shift in UPE research interests in China from healthcare to the agricultural area.[43,44] As a result, no more Chinese literature was found regarding UPE and TCM–based concepts after 1998. Because much of the clinical data was published in Chinese, UPE research is relatively unknown among scientists in non-Chinese-speaking countries. By reviewing this literature, we hope to educate scientists in terms of the possibilities regarding linking UPE with TCM–based diagnostics principles. Furthermore, because Western UPE researchers rarely study TCM–based diagnostics from a systemic regulatory perspective, this review will also provide a basis for further research in this specific area.

2. Temporal variations in UPE intensity among healthy human subjects

According to the TCM theory, one's health depends on a dynamic balance between one's physiological state and the surrounding environment. The human body can

adapt in response to many environmental factors (e.g., changes in the seasons) and internal environmental changes (e.g., emotional variations). These patterns of change that result from changes in the internal and external environments are essential for obtaining a diagnosis in TCM. Therefore, Chinese physicians are taught to make a comprehensive diagnosis that includes an evaluation of how the body responds to the surrounding environment at various ages, as well as the effect of seasonal fluctuations.[45–47]

In China, UPE measurements have been used to study temporal changes in human physiological states since the 1980s. Zheng[48] investigated the effect of gender and age on UPE measured from the fingertips of seven groups of healthy subjects; these results are summarized in Fig. 1. In general, the intensity of UPE was higher among males than among females, and UPE intensity tended to increase with age. This association between age and UPE was later confirmed by Sauermann et al..[24] In a separate study, Yan[49] examined the relationship between age and UPE by measuring the specific acupuncture point LI1 (also known as the Shangyang acupuncture point); Yan found higher UPE intensity among young subjects (17-49 years of age) compared with both older subjects (50-72 years age) and children (11-16 years of age).

Yang measured UPE intensity at various acupuncture points located at the extremities and on the torsos of male and female children and adults.[50,51] Consistent with the studies described above, Yang found that UPE intensity was higher in men than in women and higher in adults than in children. The association between UPE intensity and season (i.e., higher photon emission in the summer compared to the winter) that was originally reported by Zheng[52] for the fingers of healthy subjects has been later confirmed with UPE measurements of other body locations by Popp and Cohen,[34] Van Wijk,[53] Bieske et al.,[54] and Jung et al.;[55] importantly, these authors did not refer and probably had no prior knowledge of Chinese literature regarding UPE measurements. These findings indicate that measuring UPE can provide insight

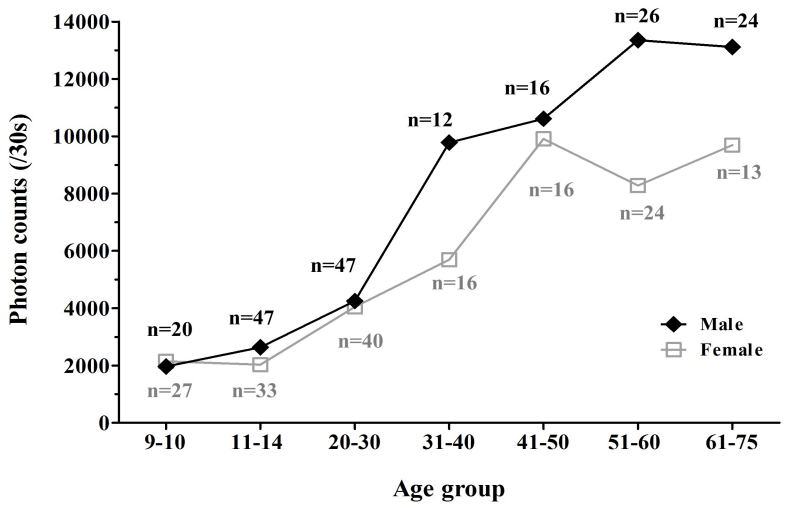

Fig. 1 UPE intensity measured in male and female human subjects at the indicated ages (in years). UPE intensity was measured as the average photon counts (per 30 seconds) of the total photon emission from ten fingertips; the data are the average of five separate measurements per subject.[48]

into the state of harmony between the human body and the environment. Thus, deviations from these temporal rhythms in UPE intensity might be utilized further in order to study the pathological state and TCM–based diagnostic patterns.

3. The association between UPE and pathological state based on TCM–based diagnostic principles

In TCM, illness is viewed as a disruption of the body's dynamic balance. The body's dynamic balance is an abstract way to describe the flow of energy through the entire body, as well as the exchange between the body and the external environment. Measuring this flow of energy—particularly interruptions in this flow—provides important diagnostic information regarding the occurrence of specific illnesses. The aims of acupuncture are to regulate this flow of energy, remove blockages that interrupt energy flow, and help the ailing body re-establish its dynamic homeostasis.[56–60] In Western medicine–based terms, this might indicate a dysregulation of processes, which can be experienced as chronic disease.

The dynamic balance concept was recently correlated with symmetry—and asymmetry—in UPE intensity between the left and right sides of the human body.[13,37,61,62] As far back as the early 1980s, this UPE left-right symmetry was identified by Chinese researchers as an important parameter for distinguishing between health and disease.[52] Thus, healthy subjects can be characterized by a symmetry in UPE intensity between acupuncture points on the two sides of the body.[63–65] Significant differences in UPE intensity at acupuncture points between the left and right sides of the body have been observed in typical "Western" diseases, including hypertension, facial nerve paralysis, and constipation.[63–68] Fig. 2 shows an example of UPE asymmetry measured using acupuncture points on the hand. The left side of the figure shows disease states diagnosed using Western medicine. These specific diseases correspond to acupuncture point locations at which significant UPE asymmetry was measured. The right side of the figure shows the acupuncture point numbers and related meridian channels. These meridian channels always correspond with a diagnosis of the specific corresponding diseases in TCM.[46,63–65,67] Here, UPE may serve to bridge the Western medicine and Chinese medicine concepts. In other words, because UPE can be used to demonstrate potential deviations from homeostasis in a meridian, and because these deviations can also be related to specific Western diseases, UPE provides the opportunity to connect TCM–based diagnoses with specific Western diseases;[61,69] in this way, the long history of knowledge regarding TCM can be used to enrich Western medicine.

Other studies have shown an uneven distribution of UPE intensity at acupuncture points at various body locations.[50,51,70] Higher intensity UPE has been measured at acupuncture points compared with non-acupuncture points; this difference was based on measurements of more than 150 acupuncture points together with their surrounding non-acupuncture points. Thus, the authors suggested that acupuncture points with higher UPE intensity generally coincide with the theoretical meridians.[71–73] Interestingly, Guo et al. used chemical indicators to obtain fluorescence-based

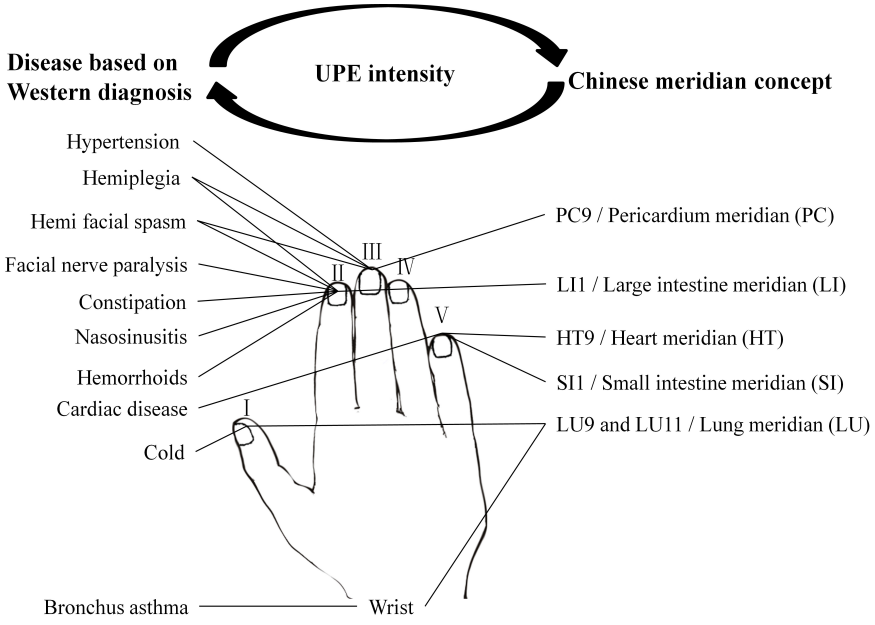

Fig. 2 UPE patterns are related with both the Western medical concept of disease and TCM concepts.[63-65,67] The Western medicine description of diseases corresponding to Chinese acupuncture points and specific UPE intensity asymmetries. I: Thumb; II: Index finger; III: Middle finger; IV: Ring finger; V: Pinkie. PC9: Zhongchong acupuncture point on the middle fingertip; LI1: Shangyang acupuncture point on the index fingertip; HT9: Shaochong acupuncture point on the pinkie fingertip; SI1: Shaoze acupuncture point on the pinkie fingertip; LU9: Taiyuan acupuncture point on the wrist; LU11: Shaoshang acupuncture point on the index fingertip.

images of visible ROS distributions in an animal model and found that the areas with the strongest fluorescence were superimposable on human meridian lines.[74] Given that ROS content defines UPE intensity in living systems,[9,18,19,75,76] the meridian-like lines of ROS activity measured in animals support—albeit indirectly—the correspondence between meridians and UPE intensity in humans.

In traditional Chinese medicine, needles are used to stimulate acupuncture points and to trigger a dynamic interaction between the acupuncture points and the connective tissue along the meridian.[77,78] This dynamic interaction was measured in several Chinese studies by measuring changes in UPE intensity.[79,80] After placing needles in

the acupuncture points of the forearm or calf, UPE intensity will change significantly at the acupuncture points of a finger or toe, respectively. In addition, UPE asymmetry can also be used to measure the therapeutic effect of acupuncture in patients. For example, left-right UPE asymmetry was measured at various acupuncture points on both sides of the body and was found to change following acupuncture.[81] Some studies also examined the therapeutic effect of acupuncture treatment by comparing the concentration changes in ROS-related enzymes and endogenous metabolites before and after treatment; these studies have been performed in both human subjects and animal models.[82–86] In addition, adiposity decreased when ROS-related anti-oxidant products (e.g., a recombinant superoxide dismutase protein) were applied to specific acupuncture points in obese subjects, and this therapeutic effect is similar to the effect of Chinese acupuncture.[86] The aforementioned studies of the therapeutic effect of acupuncture based on UPE and ROS measurements suggest that linking UPE parameters to changes in ROS may provide more opportunities to study the effect of acupuncture at the biochemical level.

4. UPE in relation to Chinese syndromes based in studies using animal models

Chinese studies have provided examples for how to study basic TCM diagnostics concepts using UPE measurements, and this has been supported by similar UPE studies conducted in both Japan[87] and Korea.[37,88] The pattern of UPE in the human body—and the changes in UPE intensity at specific body locations following acupuncture—appear to coincide with the meridian theory of TCM. Thus, the question arises whether UPE can also reflect the Chinese diagnostic syndrome theory.

The term “Chinese syndrome” refers to a combined pattern of physiology, psychology, and pathology in relation to a specific condition. The goal of syndrome differentiation is to understand illness as a pattern of relationships. Typically, several diagnostic procedures are used in order to identify the syndrome; these procedures include inspection, listening and smelling, inquiry, and palpation. Correctly

identifying a Chinese syndrome is the basis of personalized therapies that use Chinese herbs, nutritional advice, acupuncture, physical exercise, and medication.[89,90] To obtain a better understanding of Chinese syndromes from a modern biological perspective, several Western analytical tools—for example, omics-based approaches—have been used to study basic Chinese syndromes in patients with chronic diseases such as rheumatoid arthritis and diabetes. Using this approach, chemical biomarkers have been identified successfully for subtypes of patients with diabetes or rheumatoid arthritis.[91,92]

Given its potential for measuring overarching regulatory processes, UPE may be a useful diagnostic tool for identifying Chinese syndromes. In the Chinese literature, UPE has been used in three animal models to study deficiency syndromes.[10,93–95] Marked reductions in UPE intensity at the acupuncture points located at the governor vessel (gV) and the conception vessel (cV) meridian channels were observed in Yang deficiency rats and Blood deficiency rats, respectively; an increase in UPE intensity was measured after stimulating these acupuncture points.[96] In another study, a rabbit model of Qi deficiency was established by excessive intake of rhubarb. In this model, a rapid decline in UPE intensity, followed by a slow rise in intensity, was measured in the rabbit's ears, reflecting the rabbit's altered dynamics as it progressed from illness to a healthy state.[97] In addition, the UPE level of the rabbit's organs (e.g., the spleen and stomach) decreased considerably, suggesting that UPE can also reveal changes in organs induced by treatment with herbs.[98] The Chinese research showed an intriguing change in UPE intensity related to the specific dynamics of deficiency syndromes. As more UPE parameters are identified in the future, they will likely provide more information regarding Chinese syndromes.

5. Perspective: UPE-guided metabolomics based on TCM –based diagnostics

In this review, we discussed the UPE research that has been performed in China within the past century with respect to physiological and pathological conditions.

Importantly, our review revealed that UPE experimental observations are closely correlated with TCM–based diagnostic concepts. Some researchers have hypothesized that this correlation may be due to the concordance between the coherence theory of photon emissions in humans and the energetic properties of living organisms as developed in TCM.[99,100]

Here, we propose that a UPE-guided metabolomics approach based on TCM diagnostic theory may improve the dialogue between Western medicine and TCM. UPE parameters and TCM diagnostics reflect dynamic responses that arise as a result of internal and/or external disturbances in the human body at a relatively high organizational level. In addition, because its origin lies in oxidative metabolic processes, UPE has been proposed to link to metabolic networks.[20] Various ROS-regulating metabolites have been detected in several diseases, including cardiovascular disease, hypertension, rheumatoid arthritis, and type 2 diabetes.[91,92] Several metabolomics platforms—such as platforms based on amino acids and oxylipins—have been established, and these platforms reflect ROS/oxidative stress products, as well as their biosynthetic pathways.[101–103] Given that ROS play an important role in mechanisms associated with UPE and metabolic processes, they might serve as a direct biochemical bridge between UPE and metabolomics. If UPE parameters can be linked to ROS-related metabolic pathways, the TCM diagnostic principle, which is characterized by UPE, may be related to biochemical mechanisms. Thus, UPE might be used to detect early perturbations, even before they can be detected using metabolomics. In this way, UPE measurements could be used to indicate when metabolomics measurements would be warranted. Alternatively, depending on the UPE parameter that is changed, a specific metabolomics platform can be used for further analysis. In other words, by characterizing TCM diagnostics using UPE parameters, and by studying the relationship between UPE and metabolomics, UPE-guided metabolomics based on TCM diagnostics can be used to improve healthcare.

6. Conclusions

In this review, we discussed the UPE research linked to TCM that was published in the Chinese literature in the last century. Several experimental observations using UPE were found to be highly correlated with TCM–based diagnostic concepts. A UPE-based metabolomics approach guided by the TCM–based diagnostic concept may provide a biochemical bridge between Western medicine and TCM. From this perspective, three areas of UPE-based research should be explored further: *i*) the UPE-based methodologies should be developed and optimized; *ii*) experimental work should bridge UPE with TCM–based diagnostics and metabolomics; and *iii*) dynamic UPE-based data should be integrated with other system-based diagnostic measurements.

Linking UPE, a dynamic diagnostics tool, with omics measurements in systems biology studies will increase our understanding of the diagnosis, prediction, and treatment of many diseases. Moreover, combining UPE with metabolomics based on ROS production might provide an effective approach for studying the relationship between health and disease and will help improve our understanding of the healthy state.

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