

## **Toward Systems Biology Approaches to Cancer Complementary and Alternative Medicine Research**

*Dan Xi and Jeffrey White\**

*Office of Cancer Complementary and Alternative Medicine, National Cancer Institute, NIH*

*\*jeffreyw@mail.nih.gov*

Complementary and alternative medicine (CAM) use in the United States has grown dramatically (1-2). The number of cancer patients using CAM is growing for many reasons one of which includes the belief of whole system care. Many CAM modalities involve whole systems such as Traditional Chinese Medicine (TCM) and homeopathy. Holistic care focuses on the diseased person as a whole of interconnected organs to formulate the therapeutic strategies to create a systemic approach to treat the imbalanced systems of a person.

In Fiscal Year (FY) 2005, the National Cancer Institute (NCI) estimated CAM research expenditures to exceed \$121 million (3). CAM practices are usually descriptive, practical, and empirical. Major categories of CAM therapies include: Alternative Medical Systems, Energy Therapies, Manipulative and Body-Based Methods, Mind-body Interventions, Nutritional Therapeutics, Pharmacological and biologic treatments, and Spiritual Therapies (3).

With the realization that cancer is a chronic complex disease developed from a variety of molecular alterations in the systems and pathways, and with advanced high-throughput technologies in -omics (e.g. genomics, proteomics, metabolomic), molecular imaging technologies, computer technologies, and conventional medicine and its research for cancer is leading to the emergence of systems biology as a departure from the decades of the "reductionist approach.". Cancer CAM research has been facing major challenges in the quality of scientific paradigm. With the progress of modern technologies and science, it is time to move CAM cancer research toward functional, quantitative and systems biological approaches.

Applying a CAM modality to cancer care could affect many different systems and their functional interactions. Current CAM research has been mainly conducted using "reductionism approaches" in the application of the CAM methodology itself and /or biology, such as searching for single bioactive compounds from a mixed TCM herbal medicine . An analysis of FY 2006 NCI active CAM research grants portfolio (Figure 1) reveals that current cancer research is still at the cancer biological systems level, with the majority of the research at the cell and tissue level. Currently, there appears to be no systems biology approach applied to this field. A small number of research projects have studied the use of CAM modalities on immune systems, even though many CAM practices are believed to modulate immune function.

It is clear that more CAM research towards applying high-throughput technologies used in systems biology including genomics, transcriptomics, proteomics and metabolomics, as well as modern medical imaging technologies are needed. More cancer CAM research needs to be designed towards at organ and organism level, as well as applying immunomics, physiomics and nutrigenomics approaches. Finally, in order to significantly advance our understanding of the complex cancer CAM modality and its mechanism of action, it is necessary to integrate CAM theory, high-throughput experimental data and computational modeling into systems biology

approach. NCI FY2006 active CAM research grants portfolio analysis of applying -omics and/or non-invasive imaging technologies in CAM research will be presented.

**Reference:**

1. Eisenberg DM, Davis RB, Ettner SL, Appel S, Wilkey S, Rompay MV, et al. Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. *JAMA* 1998;280:1569-75.
2. Herman PM, Craig BM and Caspi O. Is complementary and alternative medicine (CAM) cost-effective? A systematic review. *BMC Complement Altern Med.* 2005; 5:11.
3. NCI's Annual Report on Complementary and Alternative Medicine: Fiscal Year 2005, A report published by the Office of Cancer Complementary and Alternative Medicine.

Figure 1: NCI Fiscal Year 2006 active CAM research grants portfolio analysis. The training grants are not included. Percentage is each CAM therapy funding over total funding.

### FY 2006 NCI CAM Research Grants (Estimated total \$107,362,031)

