

Personalized Medicine and Complementary and Alternative Medicine: In Search of Common Grounds

Chidi Oguamanam, LL.M., Ph.D.

Abstract

Objectives: As complementary and alternative medicine (CAM) continues to assume influence in medical care delivery, biomedical orthodoxy has contemporaneously experienced landmark technoscientific advances, tempting analysts to question the relevance of CAM to 21st century medical provision. This article focuses on one representation of contemporary advances in biomedicine, namely, the phenomenon of personalized medicine (PM) and the technoscientific contexts for its evolution. It examines whether biomedicine's embrace of the PM concept widens the conceptual and philosophical gulf between it and CAM.

Design: Focusing on genomics and its translation into PM, the article finds that presently, the gene–environment dynamic is an important aspect of genomics and PM. However, there is a lopsided emphasis in the gene–environment matrix that focuses on toxicogenomics (i.e., the effect of toxins and chemicals, including drugs on genes and genetic materials). This approach to genomics ignores the role of other environmental stressors, which constitute components of an individual's health experience critical to PM.

Conclusions: If this lopsided approach is addressed, in a counterintuitive way, PM has potential for engendering a confluence between biomedicine and CAM as a part of the paradox of the 21st century medical landscape.

Introduction

HISTORICALLY, THE RELATIONSHIP between orthodox Western biomedicine and other medical traditions conveniently referred to as complementary and alternative medicine (CAM) has remained contentious.¹ For the most part, Western medicine's ascendancy to orthodoxy is the consequence of a complex dynamic. This includes a combination of politics, intrigue, propaganda, appeal to science, and ideological purity.² Despite biomedicine's success in capturing symbols of institutional power in medicine such as hospitals, clinical schools, professional and credentialing bodies, its love-hate relationship with CAM continues to be negotiated. The paradigmatic gulf between biomedicine and CAM, though often exaggerated, compels the continuing search in biomedicine to diversify its conceptual framework.³ In this process, insights and knowledge from CAM remain extremely resourceful and of interest to biomedicine. However, the nature of biomedicine's new engagement with CAM remains open to scrutiny both in terms of CAM's sustainability in this perceived fusion, and especially in regard to suspicion over biomedicine's tendency toward imperialistic domination in the inchoate union.

Major breakthroughs in biomedicine, especially in the 19th and 20th centuries, have been perceived as widening the paradigmatic and conceptual gap between orthodox biomedicine and CAM. Essentially, these landmark accomplishments entrench biomedicine deeper within the technoscientific framework. More recently, attention has been focused on notable scientific and technological advances in biotechnology, genomics, proteomics, pharmacogenomics, bioinformatics, and various complex scientific interventions that have significant ramifications for biomedical care delivery. At a time when biomedicine is renegotiating its relationship with CAM, these recent developments in modern medicine have tempted analysts to ponder or question the relevance of CAM for the future of medicine.^{4,5}

It is tempting to perceive recent technoscientific turns in biomedicine as widening the philosophical and paradigmatic gulf between orthodox medicine and CAM, particularly in the context of the more current phenomena of genomics and personalized medicine. I argue that contrary to general assumptions, the advent of genomics and its translation into personalized medicine, as a real or actual complement of 21st century biomedical care delivery, presents an opportunity

Canadian Institutes of Health Research (Ethics of Health Research and Policy), Law and Technology Institute, and Health Law Institute, Dalhousie University, Halifax, Nova Scotia, Canada.

Aspects of the ideas in this article were presented for the first time in Toronto, Ontario, Canada as part of the 2008 University of Toronto Health Law and Policy Seminar Series on March 6, 2008.

for a reconciliation of the philosophical and paradigmatic dichotomies that undergird these two broad medical traditions.

Indeed, personalized medicine, or the tendency to rely on individual genomic profile as pivotal of biomedical care delivery, has the potential to bridge the epistemic gap between biomedicine and CAM, offering a much-needed opportunity for meaningful conversation across medical paradigms for optimal health care delivery. Specifically, in exploring personalized medicine, I unravel the paradoxical relationship between the themes of individualism and holism that have traditionally characterized the paradigms of biomedicine and CAM.^{6,7,8} Perhaps, there are not many contexts better suited to understanding the individualism–holism paradox than that presented by personalized medicine.

Biomedicine and CAM: Conceptual Polarity and False Absolute

Biomedicine depicts a therapeutic philosophy that emphasizes the application of natural science principles, with particular regard to biology, biochemistry, and biophysics, to clinical medicine. The rise of biomedicine began around the 16th century and is associated with the increasing scientific discoveries of that age. This rise was also contemporaneous with European global exploration and migrations, and subsequent U.S. global expansion and imperialism.^{9,10} These defining experiences in modern history had ramifications not only for the spread or distribution of diseases and inquiry into epidemiology but also for the exchange of ideas and understanding of the role of environmental factors in health and well-being. In addition, they facilitated a focus on biomedical research as critical to the economic and political success of European exploration and entrenchment in the new world.^{9,11} By extension, these same experiences resulted in part in the globalization of the biomedical model ahead of other competing therapeutic ideologies and philosophies of health and healing.

Though the biomedical model took root in the 3 to 4 centuries preceding the 19th and 20th centuries, the latter period represents, arguably, a significant highpoint in the rise of Western biomedicine. To the credit of that period were a number of significant achievements that have shaped modern biomedicine. Notable were Rene Laennec's invention of the stethoscope in 1816; and Pasteur, Lister, and Koch's discovery of the germ theory of disease (1844–1857) and its subsequent role in the development of the science of bacteriology, immunology, and vaccination. Also, the use of anesthesia and antiseptics, even though 13th century medical marvels, came to greater application in the 20th century and constituted major aspects of the biomedical advances of the era.¹² Banting and Best's discovery of insulin in 1921 and Fleming's discovery of penicillin in 1928 are part of the litany of biomedical breakthroughs of this era. Perhaps more towering in significance is the period 1943–1952, which is associated with Avery, Watson, and Crick's discovery of the DNA structure that provided practical insights for encoding genetic information and patterns in the replication of life.¹³ In the late 20th and the early part of the 21st centuries, the technoscientific advancement of biomedicine has been boosted by the significant turn in the direction of genomics and personalized medicine, which I explore below.

Naturally, the foregoing advances in modern biomedicine further entrench the latter deeper within the Western scien-

tific paradigm. This is in sharp contrast to other medical philosophies outside the biomedical framework. While critics and proponents of biomedicine contest the extent or merits of the basic paradigmatic distinctions between biomedicine and CAM, they do not disavow their relevance in understanding biomedicine in relation to a multitude of medical traditions under the CAM umbrella.

In terms of their distinctiveness from the biomedical model, CAM forms are identified with the theme of holism.⁶ Holism is not a medical system in itself.⁷ It is an approach to health, healing, and therapeutic intervention that incorporates as many factors, especially diverse psychosocial factors, including but beyond those emphasized in the biomedical model. Holism is distinct from therapeutic inclusiveness. As a healing approach, it views health as a component of cultural and environmental factors, worldviews, belief systems, lifestyles, sociocultural contexts of lived experiences, etc. which in and of themselves account for individual and subjective (as opposed to objective) experience of illness and the basis for targeted therapeutic intervention.

Pursuant to the holistic thrust, in unorthodox medical systems, unlike in biomedicine, there is an inseparable unity of the mind and body; the body is more than a component of its parts. In CAM, for the most part, sickness and affliction transcend the absence of a pathogenic condition. They are often explained as a disconnection from the psychosocial equilibrium necessary for the optimal and psychophysiological functioning of the individual in her community.^{14,15} Thus, under CAM, health is conceived as transcending the absence of disease to embrace, among other conditions, physical, social, cultural, and environmental harmony and mental well-being, to mention a few.

Notwithstanding attempts by biomedicine to broaden its frequently criticized narrow conceptual framework through the integration phenomenon and other strategies, biomedicine is largely defined by Cartesian reductionism and a therapeutic intervention that is overly individualistic. In contrast, various CAM models lay claim to holism as their defining therapeutic philosophy, especially in regard to the accommodation of psychosocial factors in the understanding and treatment of affliction.^{6,8,16} The paradigmatic divergences between CAM and biomedicine are hardly absolute. However, recent technoscientific developments in biotechnology, especially in regard to genomics, pharmacogenomics, bioinformatics and, consequently, personalized medicine, portend tremendous ramifications for biomedical care delivery. They leave little doubt in regard to the triumph of molecular imperative and the individualistic thrust of modern biomedicine.

Before exploring the potential ramifications of personalized medicine for bridging or widening the gulf between biomedicine and CAM, in the next section, I evaluate the concept of personalized medicine and the technoscientific backdrop for its current evolution in biomedical care delivery.

Personalized Medicine

It must be pointed out from the outset here that the concept of personalized medicine draws not only from the historic strides in biomedicine referred to earlier but also is furthered by contemporary technoscientific advances in modern biomedicine, including *in vitro* fertilization technologies, organ

transplantation, stem cell therapy and complex life support, and life-sustaining and reproductive technologies of our time such as pre-implantation genetic diagnosis and forms of prenatal diagnostic technologies. The point here is that these and related developments not only continue to stretch and “design” life, and to boost life expectancy statistics, especially in advanced countries, but they also pose ethical challenges and support a dichotomous relationship between longevity and quality of life. Above all, they help to sustain the triumph and pre-eminence of biomedicine over its unorthodox rivals, especially in terms of its growing adjunct, namely, the customization of medical care delivery, which is at the basis of personalized medicine.

An important backdrop to understanding the phenomenon of personalized medicine is the famous human genome project (HGP). Started in 1990, at the initiative of the U.S. Department of Energy and National Institutes of Health, the HGP has since assumed a significant global appeal. It was completed in 2003 ahead of its completion date, owing to the rapid pace of technological advancement. The HGP was designed, among other things, to identify all the genes in the human DNA and to sequence the three billion letters (chemical base pairs) of the human DNA code or the human genome. Literally, the HGP was an exercise in auditing the genetic blueprint of the human being. From the HGP, scientists discovered that of the three billion letters of the human genome or the “instruction book,”¹⁷ 99.9% are identical between two individuals. Only 0.1% differentiates for variations among humans and accounts for individual susceptibility to disease.

Toward the completion of the HGP, in 2002, a consortium of six countries (Canada, China, Japan, Nigeria, United Kingdom, and United States) embarked on the Haplotype Mapping (HapMap) Project, which focuses essentially on the 0.1% of the human genome to “identify and catalog genetic similarities and differences in human beings.”¹⁸ This population health-centered research is designed to identify chromosomal regions that are core sites of genetic variation, in order to enable researchers to locate genes associated with disease and their likely responses to therapeutic drugs and overall individual responses to medications and environmental factors. Like the HGP, the HapMap Project is designed to account for ethical, legal, and social issues implicated in the research. Resulting data from the Project are required to be freely available in the public domain pursuant to the Project’s data-release policy.

As complemented by the HapMap Project and many other research endeavors, the HGP is a critical platform initiative that has the potential to define the future of medicine and health care in the 21st century and beyond. Shan and Busia⁴ echo the general sentiments that have trailed the HGP in the medical, research, and general scientific communities “as the single most important project in the biomedical sciences, predicted to have an unprecedented impact and long-lasting value for basic biology, biomedical research, biotechnology and health care.”^{4, p.194}

Already, the HGP is pivotal in the burgeoning of the science of genomics and other practical applications of genetic knowledge and information. Essentially, genomics is the study of the individual gene profile in relation to both gene-to-gene interaction and gene-environment dynamics.¹⁹ While many saw the completion of the HGP as perhaps a

milestone in genomics, Francis Collins, human geneticist and the director of the U.S. National Human Genome Research Institute, insightfully observes that the completion of the HGP is the real beginning of genomics.²⁰ The HGP presents a real opportunity to access, work with, and understand the workings of the human genes in a broad and arguably comprehensive platform and context, far beyond that offered by any previous opportunity.

A significant component of the scientific endeavor in genomics is the phenomenon of pharmacogenomics.²¹ By means of pharmacogenomics, scientists are able to determine or predict the probability of an individual’s response to a drug on the basis of genetic makeup.^{19,21} Research in genomics and pharmacogenomics is not conducted in isolation. In addition to bringing together diverse disciplines including biology, molecular biology, and biotechnology, the translation of research in genomics and pharmacogenomics into downstream biomedical applications is facilitated by hi-tech support in bioinformatics. The latter is an intersection between “bio” and digital technologies and information processing and management. Specifically, bioinformatics involves a combination of computational biology, applied mathematics, computer science and forms of artificial intelligence, chemistry, biochemistry, and so on, in the management of critical information or data for the furtherance of genomics and other applications of biotechnology.

Technoscientific revolutions in genomics, pharmacogenomics, and bioinformatics provide the foundation for personalized medicine. In addition to reservations about its appropriateness, the term means various things to various people and, thus, is often subject to competing impressions.^{e.g., 20,22} Put simply, when genomic information is deployed to facilitate the detection, treatment, prevention or to predict individual susceptibility to disease, that is personalized medicine in practice. This article uses the terms “genomics” and “personalized medicine” interchangeably out of discretion born of convenience, rather than based on rigorous interrogation.

A shared and underlying thrust of personalized medicine is the resurgence of the focus on the individual, and on the genetic, pathogenic, and molecular imperative in biomedicine. A genomic-driven biomedical ideology opens the opportunity for genetic determinism and a host of ethical, social, and legal quagmires that have been identified as ongoing components of the HGP and HapMap Project. These concerns fall outside the scope of this article. However, proponents of personalized medicine have promoted its promises in seductively compelling ways that are often less critical, while eschewing the controversies associated with the concept.^{21,23,24} Their case is supported by successes in the early applications of personalized medicine concepts that have resulted in some new designer drugs such as Gleevec (imatinib, CIPLA) and Iressa (gefitinib, Astra Zeneca) and in the treatment of genetically based forms of cancer, including leukemia, breast, and colorectal cancers, and familial Parkinson’s disease, Crohn’s disease, obesity, asthma, osteoporosis, low-back pain, etc.^{17,20}

In addition to these early successes, there are many other arguments that strengthen the movement toward genetic individualism in biomedical care delivery. Inherent in the same arguments are inescapable counterarguments for caution. This dialectic signposts the limits of personalized

medicine. For instance, the invaluable or pivotal role of genomics and pharmacogenomics in personalized medicine has the potential to change the protocol for drug discovery from trial and error to design, with significant improvement in drug tests and targeting. Ironically, this trend also has the potential to change drug marketing dynamics from blockbuster to designer drugs. That shift has significant cost and access implications.

Similarly, a combination of genomic, pharmacogenomic, and bioinformatic approaches to biomedical care, as they translate into personalized medicine, results in a change in diagnostic landscape and practices. As noted in regard to change in the drug development protocol and drug marketing, this potential change in diagnostic practice raises issues of cost, access, and intellectual-property rights. This is demonstrated, for example, in the Myriad Genetics' exclusive proprietary claims to diagnostic testing method for *BRCA1* and *BRCA2* genes associated with breast cancer.²⁵ Simply put, the advent of personalized medicine has the capacity to pitch pharmaceuticals and hi-tech diagnostics in a competitive, rather than a complementary, relationship in health care delivery.

According to the American Chemical Society, personalized medicine promises a hi-tech-driven efficiency and scientific accuracy in medical care delivery in many respects.²⁶ According to Shan and Busia,⁴ "Drugs designed through knowledge of gene profiling and using powerful supercomputers may be able to 'home in on their targets like well aimed arrows' [or snipers on targets] and may render the use of plant medicines [or CAM] redundant."^{19,25} In addition, therapeutic or diagnostic interventions based on gene profiling may have the capacity to ensure a quantum leap in drug safety statistics, effective discovery of variants of common diseases, and an expedited drug regulatory and approval process.^{17,19} Furthermore, part of the larger picture for personalized medicine or, for that matter, genomics is the entrenchment of a culture of medical surveillance, risk prediction, and focus on disease prevention and emphasis on lifestyle and heredity. Finally, in part, one of the results of the complex technological platforms for personalized medicine is expansion in the scope of available therapeutic choices. For example, gene therapy, which is a technique for correcting, altering, or generally tinkering with defective genes or genes associated with the development of specific disease, is now a vital therapeutic option in this onset era of personalized medicine.

In addition to variegated legal, ethical, and social challenges, personalized medicine poses a host of other concerns for biomedical care delivery at many levels including the professional and institutional, and in terms of broader public policy. The Personalized Medicine Coalition, a pioneering U.S. interest group that aims at advancing "the understanding and adoption of personalized medicine concepts and products for the benefit of patients,"²⁷ has outlined some of these challenges in a diagrammatic representation. First, on a general level, personalized medicine raises a systems-level challenge for biomedicine. This is in regard to the organizational and power dynamics inherent in the convergences of diverse and new professional actors necessary for effective uptake of personalized medicine. Second, professional education and re-education of physicians and allied health care providers and of the patient population is important for

effective realization of personalized medicine. Third, personalized medicine requires strategic research, development, and funding commitment to mobilize the required resources. This raises concerns in regard to the appropriate model of public-private partnership in medical research funding and suitable governance and regulatory mechanism for the entrenchment of personalized medicine. Fourth, related to the issue of regulation and governance is the management of intellectual property, electronic health records, and competing privacy claims over data generated through the coalescence of sophisticated professional knowledge exchange and subject participants in personalized medicine. Fifth, akin to the experience over the abuse of genealogical data, personalized medicine is vulnerable to corporate hijacking, hype, and misrepresentation that have the potential to undermine its overall credibility, public trust, and confidence.^{17,19,24,28}

Notwithstanding its promises and potential benefits, personalized medicine is associated with major public policy and myriad ethical concerns that do not lend themselves to any platitudes and easy resolutions. What is of immediate interest in the present context is how best to understand or explore the relationship between personalized medicine, as the current practical manifestation of the dominant biomedical orthodoxy, in relation to CAM traditions.

Personalized Medicine and CAM: Toward a Confluence of Medical Traditions?

It is necessary to further interrogate the genomics-driven personalized medicine in an attempt to understand its implication for the paradigmatic relationship between biomedicine and CAM. In this regard, it is important to underscore the dual focus of genomics in the evaluation of an individual gene profile, first, in regard to gene-to-gene interaction and, second, in regard to gene-environment interaction.¹⁹ The latter is quite important in assessing the potential dynamic between biomedicine and CAM.

The importance of environmental factors in the dynamics of an individual's gene expression is part of the core of genomics, and by extension, personalized medicine. For some reason, however, there appears to be a narrow construct or perspective of the "environment" in the gene-environment inquiry. Vested interests in the biomedical-industrial complex, especially the pharmaceutical establishments, do not directly benefit from a construction of a gene-environment relationship that does not emphasize toxicity. Also, the emphasis on pathogens in orthodox medicine's construction of sickness does not accommodate an elaborate outlook on social environmental factors that are implicated in the gene-environment inquiry. In contrast to other equally important factors, the emphasis on the gene-environment dynamic is placed unevenly on toxicogenomics (i.e., on the interaction and effect of toxins and chemicals, including drugs on genes or genetic materials).

Certainly, outside of chemicals or toxins, there are other environmental stressors that are components of an individual's lived health experience and potential triggers or actors on genes or genetic materials. These nontoxic stressors are capable of precipitating health crises in as many if not more ways as toxicants. For example, lifestyle alone involves numerous environmental stressors that have impacts on genes and genetic materials akin to toxicants in a toxicogenomics analysis.

When environmental stressors other than toxicants are taken into consideration in terms of their influence on gene expression, personalized medicine presents an unsuspected opportunity for revisiting the extent of the paradigmatic schism between biomedicine and CAM. Apart from toxicants, there is an open-ended list of other environmental stressors that account for individual gene expression. From nutrition, health status, psychologic profile, and belief-driven, ethnic-dependent factors to the individual's lived experience and general lifestyle are an interconnected series of environmental stressors implicated in the dynamics of individual gene expression. Essentially, these factors are a complex mix of genetic and nongenetic, plus a complex build-up of the individual's psychosocial experience.

In a fitting metaphor, Olden and Guthrie²⁹ have conceptually analogized the relationship between genes and the environment to that of a loaded gun and its trigger. They argue that a loaded gun alone does not cause harm, but the potential for harm arises at the pulling of the trigger. Similarly, "one can inherit a predisposition for a devastating disease, and yet never develop the disease unless exposed to the environmental trigger(s)" or stressors.^{p.3-4} At a more practical level, for example, a set of twin sisters may have an equal probability of a genetic predisposition to a psychiatric disorder. One lives a stressed-ridden life experience from childhood to adulthood, including occasional abuse under foster care, an extremely stressful work or career experience, and life with an abusive partner. A culmination of these experiences may trigger a psychiatric disorder or crisis, say, when she turns 39. Assume the other sister's experience to be the converse. Here, it is possible that until her death as a septuagenarian, she may not experience a psychiatric disorder of any kind because of the apparent absence of any environmental triggers or stressors.

From the Olden and Guthrie analogy and the example of the twins, there emerges a potential for personalized medicine to close the paradigmatic and conceptual gap between biomedicine and CAM. A balanced and accurate conceptualization of the gene-environment interaction beyond the current narrow focus on toxicogenomics opens a vital insight into the role of psychosocial factors and an individual's lived experience in personalized medicine. A logical exploration of the gene-environmental dynamics in personalized medicine or genomics demonstrates that by means of personalized medicine, biomedicine may confront the elusive imperative in its framework to take psychosocial factors seriously in its understanding of health. Genomics and personalized medicine will make more urgent the imperative for the much-needed and yet elusive confluence in therapeutic intervention.

Personalized medicine provides a concrete demonstration of the paradoxical and yet the fused nature of the holistic and individualized spectra of both medical traditions. Despite their paradoxical relationship, biomedicine in its genomic translation and CAM are complementary to the ultimate goal of health in regard to the facilitation of the individual's optimum potential. When the gene-environment dynamic is part of the full complement of genomics, it is easy to appreciate how both CAM and personalized medicine highlight different ways in which family, community, society, exposure, lifestyle, and general environmental factors (in gene profiling and psychosocial evaluation) are essential health determinants for the individual. This correlates to the

inherent nexus between holistic and personal order as flip-sides of the same coin.

A thorough scrutiny of genomics or personalized medicine (as part of the biomedical framework) and CAM suggests a common interest between both medical traditions in the paradoxical themes of holism and individuality, and in terms of their respect for subjective factors in the individual's experience of affliction. The interest of biomedicine, potential or real, in a holistic perspective on the individual's health experience, including the accommodation of subjective factors, takes on greater meaning in personalized medicine than in other biomedical contexts, approaches, or models. Instead of widening the gulf between them, genomics hinges the delineation of the two therapeutic traditions (biomedicine and CAM) on a holism-individuality and subjective-objective dichotomy. According to Geller and Francomano,⁵ "[t]he concurrent growth of genetic medicine and complementary medicine raises the question of whether the two fields have more in common than is immediately clear."^{p.344} As demonstrated above, genomics-driven personalized medicine is premised, in part, on the individual's subjective experience in the context of gene-environment interactions. In a counterintuitive way, this premise deflates the traditional criticism of biomedicine to the effect that it ignores subjective and holistic approaches to health. In this sense, it probably makes no significant difference that the enthusiasm over biomedicine's holism may be nuanced, and that its subjectivity is premised on molecular essences and with emphases on the environmental influences on the individual's genomic profile or general gene expression.

When gene-environment dynamic is narrowly construed as evident in the current emphasis on toxicogenomics in the exposition of personalized medicine, the inadequacy of the latter becomes quite obvious. In that construct, personalized medicine is limited to the genetic or molecular imperative by the distillation of genomic data in a manner that undermines diverse environmental factors, excluding drugs and other toxicants. This narrow construct, which has taken hold in the exposition of personalized medicine, entrenches biomedicine deeper within the Cartesian reductionist thinking and fosters the perception of gulf-widening between it and CAM. Clearly, this lopsided account of personalized medicine undermines its potential to re-position biomedicine for meaningful conceptual realignment with CAM. Indeed, when limited to gene-gene dynamics and the molecular imperative, personalized medicine takes on a far more narrow view of health than under the pre-existing framework in biomedicine. In Stephen Fulder's⁷ imagery, such an approach to health is akin to trying to "squeeze an elephant through the doorway. Only little bits get through, and the real thing will be left out in the cold."^{p.776}

The role of environmental or psychosocial factors cannot be overemphasized, whether seen from the lens of personalized medicine or CAM. For example, personalized medicine concepts may be helpful in an organ transplant procedure, but the ultimate success of that procedure may turn on the cultural, emotional, spiritual, religious, and the psychosocial challenges that influence the individual's understanding and associated beliefs about living with a transplanted organ.^{30,31,32}

In CAM, individual health behavior cannot be dissociated from psychosocial and other multifaceted factors,

including the cultural environment.⁷ In the same vein, it is inadequate to evaluate an individual's genetic profile for the purpose of personalized medicine outside environmental factors broadly construed. The role of environmental factors in genomics and personalized medicine, for that matter, cannot be limited to the molecular matrix. By necessity, it involves a combination of molecular, sociocultural, and many other incidences of the individual's lived experience. If conceived, defined, and practiced in this balanced and comprehensive context, then, rather than widen the gulf between biomedicine and CAM, personalized medicine has potential to bridge the conceptual schism between biomedicine and CAM.

For example, an aspect of the personalized medicine concept, namely, pharmacogenomics, can be applied to CAM forms, especially herbal medicine or herbal remedies, in order to target appropriate the persons or population that may be most amenable to specific herbal remedies. The introduction of pharmacogenomic concepts into the practice of herbal medicine will be effective in reducing incidences of drug therapy failures and associated fatalities that have remained the Achilles heel for traditional herbal medicine. Also, the phenomenon of psychosocial genomics, which explores the sophisticated relationship between gene expression, neurogenesis, and healing practices,⁵ has the potential to reconcile the biomedical model with various rationalizations and accounts of experiences of healing in CAM.

Conclusions

Recent technoscientific developments in biomedicine, especially in regard to the fused phenomena of genomics and personalized medicine, warrant a re-evaluation of the checkered and contentious relationship between biomedicine and CAM. On the face of it, technoscientific advances in biomedicine suggest a further deepening of the paradigmatic and conceptual dichotomies between the biomedicine and the multifarious medical philosophies conveniently depicted as CAM. However, a counterintuitive perspective on the unfolding role of genomics and the evolution of personalized medicine within the biomedical framework suggests that personalized medicine has some potential to bridge the normative conceptual divide between biomedicine and CAM.

A careful scrutiny of the genomics and its translation into personalized medicine shows that perhaps, more than any other aspect of biomedicine, personalized medicine confronts biomedical orthodoxy with evidence that psychosocial factors are critical in the construction of sickness and the provision of therapeutic intervention. However, the extent to which genomics and personalized medicine will potentially foster the urgent need to create a much needed confluence with CAM in therapeutic intervention depends on a number of factors. These include the willingness of the biomedical-industrial complex and the pharmaceutical stakeholders to support the gene-environment analyses that emphasize the social environment, as opposed to the present narrow emphasis on toxicogenomics. As genomics and personalized medicine become critical to 21st century medical provisions, their potential to engender this meeting point between biomedicine and CAM will depend, for the most part, on a robust appraisal of the gene-environment relationship. At

present, that is an aspect of genomics, perhaps, in need of much more inquiry than the current emphasis on toxicants.

Acknowledgments

The author thanks Professor Collin Flood for the invitation to participate in the 2008 University of Toronto Health Law and Policy Seminar Series. The author is also grateful to the student and faculty audience for their highly engaging and critical insights from which this article has benefited. Thanks also to the anonymous reviewers and editors of this Journal for their painstaking efforts.

Disclosure Statement

No competing financial interests exist.

References

- Oguamanam C. From rivalry to rapprochement: Biomedicine, complementary and alternative medicine at ethical crossroads. *HEC [HealthCare Ethics Committee Forum]* 2006;18:245–263.
- Wolpe PR. Alternative medicine and the AMA. In: Baker RB, Latham SR, Emmanuel LL, eds. *The American Medical Ethics Revolution: How the AMA's Code of Ethics has Transformed Physician's Relationship to Patients, Professionals and Society*. Baltimore: John Hopkins University Press, 1999:218–239.
- Barrett B. Alternative, complementary and conventional medicine: Is integration upon us? *J Altern Complement Med* 2003;9:417–427.
- Shan Y, Busia K. Medical provisions in the twenty-first century. *J Altern Complement Med* 2002;8:193–196.
- Geller G, Francomano CA. Complementary medicine and genetic medicine: Polar disciplines or dynamic partners? *J Altern Complement Med* 2005;11:343–347.
- Barrett B, Marchard L, Scheder J, et al. Themes of holism, empowerment, access, and legitimacy define complementary, alternative medicine in relation to conventional medicine. *J Altern Complement Med* 2003;9:937–947.
- Fulder S. Remembering the holistic view. *J Altern Complement Med* 2005;11:775–776.
- Shealy CN. Holism in evolution. *J Altern Complement Med* 2003;9:333–334.
- Watts S. *Disease and Medicine in World History*. New York: Routledge, 2003.
- Rothman DJ, Marcus S, Kiceluk SA. *Medicine and Western Civilization*. New Brunswick, NJ: Rutgers University Press, 1995.
- Hays JN. *The Burdens of Disease: Epidemics and Response in Western History*. New Brunswick, NJ: Rutgers University Press, 1998.
- Hardy KJ. A view of the development of intestinal suture: Principles and techniques (part II). *Neurosurgery* 2003;52:3–19.
- Watson JD. *The Double Helix: A Personal Account of the Discovery and of the Structure of the DNA*. New York: W.W. Norton, 1980.
- Hsiao I-HJ. Patent protection for Chinese herbal product invention in Taiwan. *J World Intellect Prop* 2007;10:1–21.
- Oguamanam C. Between reality and rhetoric: The epistemic schism in the recognition of traditional medicine in international law. *St. Thomas Law Rev* 2004;16:59–108.
- Fulder S. The basic concepts of alternative medicine and their impact on our views of health. *J Altern Complement Med* 1998;4:147–158.

17. Collins FS. Personalized medicine: A new approach to staying well. *The Boston Globe*, July 17, 2005. Online document at: www.boston.com/news/globe/editorial_opinion/oped/articles/2005/07/17/personalized_medicine Accessed January 3, 2008.
18. HapMap Project. Online document at: www.hapmap.org/thehapmap.html.en Accessed November 26, 2007.
19. Meadows M. Genomics and personalized medicine. *FDA Consumer Magazine*. Online document at: www.fda.gov/fdac/features/2005/605_genomics.html Accessed December 12, 2007.
20. Collins FS. Personalized medicine: How the human genome era will usher in a health care revolution. Paper presented to the Personalized Medicine Coalition at the National Press Club, February 10, 2005. Online document at: www.genome.gov/Pages/News/webcasts/Personalized_Medicine_files/Default.htm#noproload=1 Accessed December 12, 2007.
21. De Palma A. Pharmacogenomics and the brave new world of personalized medicine. *Pharmaceutical Manufacturing*. Online document at: <http://www.pharmamanufacturing.com/articles/2006/047.html> Accessed March 1, 2008.
22. Mattingly S. Really personalized medicine: The development of genomic makers to help diagnose disease and indicate treatment is ushering a new age. *Techcom National J Technol Commercialization* 2004;Nov-Dec:26–28.
23. ETC Group. Direct-to-consumer DNA testing and the myth of personalized medicine: Spit kits, SNP chips and human genomics. Special Report on Human Genomics, Part I. Online document at: www.etcgroup.org/en/materials/publications.html?pub_id=675 Accessed April 3, 2009.
24. Munroe JB. A coalition to drive personalized medicine. *Personalized Med* 2004;1:9–13.
25. CCS/NCIC (Canadian Cancer Society and National Cancer Institute of Canada) Position on the Patenting of BRCA1 and 2 Genes. Online document at: www.ncic.cancer.ca/vgn/images/portal/cit_86751114/11/12/89486356postionstatements_BRCA1A_en.pdf Accessed March 2, 2008.
26. American Chemical Society. The promise of personalized medicine. *Science Daily*. Online document at: www.sciencedaily.com/releases/2004/09/040908082636.htm Accessed December 12, 2007.
27. Personalized Medicine Coalition. Online document at: www.personalizedmedicinecoalition.org/about/aboutpmc.php Accessed May 17, 2009.
28. Ruaño G. Quo vadis personalized? *Personalized Med* 2004;1:1–7.
29. Olden K, Guthrie J. Genomics: Implication for toxicology: New frontiers. *Mutation Res* 2001;473:3–10.
30. Sharp L. Organ transplantation as a transformative experience: Anthropological insights into the restructuring of self. *Med Anthropol Q (New Series)* 1995;9:357–389.
31. Sylvia C, Novak D. *A Change of Heart*. New York: Little Brown & Co., 1997.
32. Sanner M. Living with stranger's organ: Views of the public and transplant recipients. *Ann Transplant* 2005;10:9–12.

Address correspondence to:
Chidi Oguamanam, LL.M., Ph.D.
Law and Technology Institute
Dalhousie University Law School
6061 University Avenue
Halifax, Nova Scotia B3H 4H9
Canada

E-mail: Chidi@Dal.Ca

