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Synthesis of Scientific Disciplines in Pursuit of Health:

the Interactive Biopsychosocial Model

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Abstract

Twenty-five years ago, George Engel proposed a challenge to the biomedical model and its limited view of disease as biologically rooted. Building on Engel's work, we present the Interactive Biopsychosocial Model (IBM). The IBM argues for a reorientation in biomedicine where research, education, and clinical practice: (1) address health in addition to illness; (2) aim to decipher interrelated biophysical, psychocognitive, and social processes in health and disease, rather than seek a single root cause; and (3) take into account the social networks of the individual to achieve, maintain, and maximize health and well-being for individuals, their significant others, and society. Based on an interdisciplinary collaboration of medical and social scientists, this paper demonstrates the application of the IBM to understanding and generating hypotheses about the longitudinal relationship between sexuality and health, and sexuality and chronic illness (diabetes mellitus) at older ages. The model provides a dynamic, dyadic, framework for building scientific hypotheses about the etiologies and consequences of health, well-being, and disease throughout the life course.

> The dominant model of disease today is biomedical, and it leaves no room within its framework for the social, psychological, and behavioral dimensions of illness. A biopsychosocial model is proposed that provides a blueprint far research, a framework for teaching, and a design for action in the real world of health care.
>
> —George Engel (1977)
>
> The time for this larger synthesis of scientific disciplines in pursuit of human health has come.
>
> —National Research Council (2001)

In 1977, George engel, professor of psychiatry and medicine at the University of Rochester, proposed integrating psychological and social variables into prevailing models of disease, and created what he called the "biopsychosocial model." Now, a quarter of a century later, the National Research Council and the Institute of Medicine (IOM) are urging scientists to integrate psychosocial and behavioral processes into attempts to decipher pathways of disease, health, and well-being, and to include biological measures in population-based social science research (Finch, Vaupel, and Kinsella 2001: IOM 2001 ; National Research Council 2001). This call for integrative approaches is driven in large measure by the increasing prominence of psychosocial issues in clinical practice and education. For example, physicians are often

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confronted with patients who cannot afford regular checkups or medicines. Older patients experiencing cognitive decline may have difficulty adhering to directions on prescriptions, and patients who have spouses in poor health may be less able to manage their own chronic illness. To promote the cross-disciplinary collaboration necessary for a new approach to the science of health, we need a unified vision of health and disease.

In this paper, we examine the theoretical foundations and limitations of disease-oriented models of biomedicine and propose a new model, the Interactive Biopsychosocial Model of health (IBM). Based on Engel's work, the IBM argues for a reorientation in biomedicine where research, education, and clinical practice: (1) address health in addition to illness; (2) aim to decipher interrelated biophysical, psychocognitive, and social processes in health and disease, rather than seek a single root cause; and (3) take into account the social networks of the individual to achieve, maintain, and maximize health and well-being for individuals, their significant others, and society. The model provides a dynamic framework for building scientific hypotheses about the etiologies and consequences of health, well-being, and disease throughout the life course, and it can be used, in addition, as a teaching tool at the bedside or in the classroom.

This work arises from our research in aging and human sexuality, where the greatest scientific and clinical challenge is as often understanding and maintaining health as it is rectifying dysfunction or disease. Additionally, research in sexuality demands a shift in focus from the individual to the dyad or larger social network. The IBM emerged as a framework for scientific investigation about health and life quality over the life course, when it became apparent that we would need to incorporate psychocognitive and psychosocial variables into traditional disease-oriented models. Below we describe this new model and apply it to the relationship between aging and sexuality.

Historical Context

In proposing the biopsychosocial model of disease, Engel (1977) issued a "challenge for biomedicine" to reconsider the prevailing biomedical model of disease. The biomedical model, still the dominant framework guiding medical research, education, and clinical care today, focuses on the root cause of disease, where disease is "fully accounted for by deviations from the norm of measurable biological (somatic) variables." Engel offered, instead, a model designed to "provide a basis for understanding determinants of disease and arriving at rational treatment patterns of health care." Engel's groundbreaking work grew out of his clinical psychiatric practice, where he found himself often frustrated by "adherence to a model no longer adequate for the scientific tasks and social responsibilities" of medicine. He aimed, therefore, to change the profession's approach to the causes of illness and disease, and to widen the framework for the clinical approach to illness, in general, and mental illness in particular.

General systems theory was emerging in both the biological and social sciences during the formative years of Engel's work, and Engel used this theory to lay the groundwork for his biopsychosocial model (Buckley 1967; Henry and Stephens 1977; Parsons 1951; von Bertalanffy 1968), Engel claimed that "systems theory holds that all levels of organization are linked to each other in a hierarchical relationship so that change in one affects change in the others," and that this theory treats "sets of related events collectively as systems manifesting functions and properties on the specific level of the whole." Engel believed that applying systems theory to medicine could reconcile two fundamental tensions implicit in the traditional biomedical model: mind-body dualism, the belief that the mental and the somatic operate independently; and the reductionist-holistic dichotomy, in which complex phenomena are derived from a single physical aberration from the norm rather than from an integrated system where changes interact at various levels.

While Engel's work consciously shifted away from the primacy of biological etiology, he remained focused on the individual as the embodiment of a disease and its consequences. The treatment of disease was still framed in the clinical setting and conceptualized primarily as an interaction between physician and patient. Social variables, only superficially described, became simply additional characteristics of the diseased individual to be considered in the pursuit of the root cause.

Although Engel's work is widely cited in the medical literature (a citation search in the Web of Science Citation Index found 1,419 citations of the *Science* article as of June 2002), the model remains largely on the margins of biomedicine, particularly as a framework for scientific investigation. Engel's model has failed to replace the biomedical model for two main reasons: clinicians and scientists continue to emphasize the progression from etiology to disease to the exclusion of health as an outcome; and professional and research institutions are often structurally rooted in the biomedical model. These factors motivate us to reconsider the utility of the biopsychosocial model for defining health. In the following sections, we offer a framework for integrating the social factors that influence health, wellness, illness, and disease into the clinic or the science of medicine.

Defining and Measuring Health

Historically, a negative definition of health has prevailed in biomedicine: i.e., health is the absence of disease, dysfunction, or injury, Epidemiologic measures assess population health by rates of morbidity and mortality. Both perspectives rely on normative judgments about the average health of individuals in a given clinical population, community, or society. The primary appeal of these definitions lies in ease of measurement (e.g., measurement of blood pressure, or observation of death certificates), but outcomes in these models are limited to physiological endpoints. Positive outcomes, such as quality of life, well-being, or resilience, typically lie outside these definitions (IOM 2001).

The demographic shift in the age of the U.S. population (Kinsella and Velkoff 2001), combined with medical advances resulting in increased longevity, provides additional impetus for a new, more holistic approach to aging, health, and adult human development. Longer, healthier life in industrialized nations requires a shift in focus from treatment to prevention, from reduction of mortality caused by acute illness to reduction of morbidity due to chronic illness, and from the management of external threats (injury, infection) to the modification of internal threats (negative behaviors such as smoking, poor diet, or sedentary lifestyle). Concepts of successful and productive aging incorporate a positive behavioral orientation and a perspective that encompasses the entire life course (Bass and Caro 2001; Rowe and Kahn 1997). Building on these concepts, the IOM (1998, 2001) proposes "positive health," defined as "a healthy body; high-quality personal relationships; a sense of purpose in life; self-regarded mastery of life's tasks; and resilience to stress, trauma, and change."

Health is a "multi-attribute concept" that depends upon a complex network of physical, biological, environmental, economic, social, cultural, and possibly metaphysical (spiritual and moral) factors (Cutler and Richardson 1998; Thorsen and Harris 2002). The World Health Organization (1958) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." On a population level, the definition of health evolves with social change: "The rising expectations of the past 150 years have led to a shift away from viewing health in terms of survival, through a phase of defining it in terms of freedom from disease, onward to an emphasis on an individual's ability to perform daily activities, and more recently to an emphasis on positive themes of happiness, social and emotional well-being, and quality of life," as well as equity and justice in the distribution of health care across societies (Labonte 2000; McDowell and Newell 1996; Morreim 2000; Riley

1987). For the individual, healthiness changes over the life course and involves not only an internal assessment of health and well-being against one's own prior health and personal expectations, but also an external view of one's health in reference to others and to societal expectations.

Recent debate over the concept of health in the United States has also resulted from health care reform and associated efforts to define coverage and medical necessity or to identify the purpose of health care (Morreim 2000). The debate involves both ethical and philosophical issues and cannot be separated from the pressures of technology or the varying political and economic perspectives of many stakeholders, including, of course, the profession of medicine itself. Labonte (2000), writing for the Hastings Center on the health promotion/disease prevention movement, compares three health "explanatory systems"—medical, behavioral, and socio-environmental—in terms of the compatibility of each with either a libertarian or social justice theory of the common good. This perspective is directly relevant to disputes within the profession of medicine over where responsibility for health lies. Engel recognized this tension 25 years ago in his description of a Rockefeller Foundation seminar on the concept of health, where participants argued that only the organic elements of disease constituted "real" disease and that "the physician should not be saddled with problems that have arisen from the abdication of the theologian and the philosopher" (Engel 1977).

The Interactive Biopsychosocial Model (IBM)

The IBM is based on the IOM concept of health and the following core principles: (1) an orientation toward health rather than illness; (2) analytic capacity for outcomes of health or illness; (3) parity among the three domains of capital (biophysical, psychocognitive, and social) as factors in an individuals health endowment; (4) bi-directional causality and feedback (i.e.. biopsychosocial capital influences the health endowment and the endowment influences access to and use of biopsychosocial resources); (5) primacy of the multi-actor frame (i.e., analysis of individual health or illness embedded in the partner, the family, or other explicitly defined social networks); (6) interdependency of social and life course dynamics; and (7) the potential of capital inputs to act as assets or liabilities. (See Figure 1.)

Creating and using a dynamic, health-centered model requires an explicit vocabulary to describe and explain the relationships between its core components: the biophysical, psychocognitive, and social dimensions of health. We propose a vocabulary that draws on the socioeconomic concept *of capital* to specify biophysical, psychocognitive, and social inputs to health. This vocabulary makes it possible to view the components of health as potential assets or liabilities and reinforces the dynamic function of the model, because stocks of capital change over time (O'Rand 2001).

The application of economic principles to the construction of health models is not new (see, for example, Becker 1964; Cutler and Richardson 1998; Grossman 1972), Grossman proposes that "good health" be viewed as a durable capital stock inherited by individuals. The stock increases with investment and depreciates with age; other factors—such as education, gender, or ethnicity ("human capital")—may positively or negatively affect the rate of health depreciation and efficiency in acquiring good health over time.

Biophysical, psychocognitive, and social capital comprise an individual's *health endowment.* Biophysical capital includes genetic composition, physiology, physique, sensory function, nourishment, strength, and appearance. Investments in biophysical capital affect an individual's physical and physiological capacity for health. Psychocognitive capital includes intelligence, emotions, well-being, personality attributes, self-esteem and self-efficacy, coping, and resilience. Investments of this type determine attitudes, interests, and desires related to health. Social capital refers to the networks of dynamic relationships with others (kin, friends,

neighbors, physicians) who encourage or sanction certain kinds of behavior, and the social connectedness and social constraints that result. Investment in social capital through monitoring, provision and sharing of information, and solidarity (companionship, love, advocacy) with another determines how much access an individual has to the health endowment (Sandefur and Laumann 1998). We distinguish "social capital" from the notion of "sociocultural context," a frequently invoked but vague term. In this model, "sociocultural context" is defined as the broader environment of social locations (ethnic, religious, gender, political, or economic class) and summarizes the set of social expectations and norms as well as socially determined conditions, such as differential access to scarce resources, that influence individuals' health.

The health endowment of the individual is inextricably linked to socially relevant others (partner, kin, friend). This mutual dependency for health involves pooling resources, sharing capital, and negotiating joint resources. In our model, this interdependency allows two healthy individuals acting jointly to generate a surplus greater than each would generate alone. The interdependency occurs through repeated small exchanges and specialization of roles within the relationship, and serves to maximize efficiency and efficacy and to perpetuate the interdependency. If individuals have disparate levels of health (one with a large health endowment, the other with a small endowment) or are both in bad health, they may generate a *net* surplus or a deficit, depending on their relative health, the trajectory of health prior to and within the relationship, and the sociocultural context.

In our model, the health endowment can grow and contract over rime, but at any given time, it is finite and quantifiable. Expansion of an individual's health endowment might occur when an individual begins an intimate partnership. Contraction of the endowment could occur by acquisition of a disease. Individuals may also shift capital resources from one area to another, to stabilize the health endowment and to compensate for specific health challenges. Because the endowment is finite at any given time, investment in biophysical capital, for example through exercise (often a solo activity such as running or biking), could draw resources away from psychocognitive or social capital, although the exchange need not be one-to-one. Alternatively, where physical capital is lowered, social capital may be used to compensate (e.g., a woman with a hip fracture calls on her partner to assist her with dressing and bathing). Alzheimer's disease may erode psychocognitive capital, but reallocating time or energy to physical capital or social support may lessen the impact of dementia on overall health, Reallocation of resources to maximize health depends on an individual's connections to significant others and the constraints imposed by these connections. Partnerships characterized by mutually high social capital are the most efficient and show the greatest resilience to health threats. Sociocultural context heavily influences the value and meaning of different kinds of health capital to the individual and affects the extent to which one kind of capital can be substituted for another.

Consistent with systems theory, the life course developmental perspective views adult development as an ongoing process in which continuity and change interact in complex ways { Baltes 1987; Elder 1992; O'Rand and Krecker 1990). Transitions and continuity in the life course constitute adult development and well-being, and the impact of changes and the negotiation of conflicts depend on the social context in which they occur (Bengston and Allen 1993; Riley, Foner, and Waring 1988). We use the life course perspective with a focus on dyadic intimate partnerships to understand mature adult sexuality as adult human development unfolds.

In Figure 1, the lower triangle represents the focal individual who connects to a partner represented by the upper triangle. In this case (a study of sexuality and health), an intimate partner is the "other," but the framework allows for the other to be defined by any primary

social connection of interest (the family, a religious congregation, a physician, etc.). This social bond occurs through and within a network of social connections that confer three key bi-directional benefits and constraints: information, monitoring through influence and control, and social solidarity (Sandefur and Laumann 1998). An individual's social ties may facilitate acquisition of or limit access to pertinent health information. Social ties also exert positive or negative constraints on the individual's health activities and promote or detract from a person's sense of social support (Youm and Laumann 2002). The triangles link the three forms of capital that comprise the health endowment, and the hourglass shape symbolizes the importance of time in the life course perspective.

A central challenge presented by the theoretical framework presented here is the articulation and application of a common metric for quantifying varying types of capital. In application of the model to research questions involving populations, this can be overcome using relative positioning and rank-ordering of individuals along scales of each component type of capital. This approach has been proposed by Oakes and Rossi (2003) in the measurement of socioeconomic status in health research.

Application of the IBM Using the Study of Sexuality and Health at Older Ages

We define *sexuality* as physical capacity, opportunity for partnership and sexual conduct, and attitude. "Sexual capacity" includes the physiologic mechanisms of the sexual response cycle and relaxation, restoration, or physical release from sexual activity. "Sexual conduct" incorporates the activities undertaken to find and maintain a sexual partner. "Sexual attitude" refers to subjective states of desire or interest, beliefs, willingness, preferences, and satisfaction. Capacity, opportunity, and attitude comprise individual-level attributes of sexuality. *Intimacy*, by contrast, refers to the quality of the dyadic relationship; it describes a quality or condition involving close personal familiarity and feelings of warmth, closeness, and common or shared fate.

A strict biomedical hypothesis relating sexuality to health would propose that illness, disability, or reliance on medication(s) predict compromised sexual function. The medical model would say that good health predicts intact sexual function at older ages; that is, people who maintain or improve their health will maintain or improve their sexual function. Likewise, people who become ill, disabled, or dependent on medication, or who experience progressive illness will experience deterioration of sexual function. The emphasis here is on the physical and physiological aspects of disease and sexuality and on the individual.

Using the interactive biopsychosocial perspective, however, we posit an interaction between an individual's own health and the partner's health as crucial to sexuality, health, and illness. Further, we hypothesize that the expression of sexuality at older ages enhances the beneficial effects and minimizes the detrimental effects of aging on the health of both individuals in the relationship, and also acts as a buffer against chronic illness, physical disability, medication use, cognitive decline, depression, and social isolation at older ages. In socioeconomic terms, sexuality mediates the allocation of resources to the three domains of capital comprising the health endowment. Because health is constructed in relation to another person, the distribution of one individual's resources for the maintenance of health, which may slow the depreciation of health with age, has a direct impact on the other person's capital resources and the couple's joint endowment of health.

The relationship between sexuality and health is bi-directional. We further hypothesize that older adults with chronic illness will experience greater compromise of sexual capacity, desire, and opportunity than otherwise similarly healthy counterparts. We expect that older adults

whose partners are chronically ill will experience greater sexual dysfunction than others, and that this deficit will negatively affect their overall health.

Application of the IBM: The Case of Diabetes Mellitus

To illustrate the application of the IBM to a hypothesis about the relationship between older adult sexuality and the expression of chronic disease, we next explore the relationship between sexuality and type 2 diabetes mellitus.

Previous research on sexuality in diabetics has focused on the relationship between neurovascular changes and physical sexual function problems such as erectile dysfunction in men (Bokhour et al. 2001; Korenman 1998; Rosen 1996). Despite a major international attempt to understand the relationship between sexuality and diabetes in women (Nicolosi et al. 2002), empirical evidence about the physiologic, psychologic, and social mechanisms is lacking. A strict biomedical hypothesis relating sexuality to diabetes would propose that diabetes predicts compromised sexual function (in particular, erectile dysfunction) at older ages. Over time, age itself will affect sexuality, primarily through physiologic mechanisms. The process and experience of aging may impair sexual function (e.g., vaginal dryness due to estrogen loss in women, or prolonged time to erection in men) or enhance it (more leisure time, equalization of need for foreplay, or deeper awareness of partner's desires and needs). We hypothesize that people with diabetes who maintain or improve their health will maintain or improve their sexual function. The model also predicts that people with poor glycemic control, disabling disease, or insulin dependence will experience deterioration of sexual function.

The IBM allows for an expanded set of hypotheses that incorporate a broader range of physical impairments affecting sexual function among diabetics, such as obesity, frailty, or visual impairments. We can also take into account the *partner's* obesity, frailty, or visual impairments as a determinant of the sexual health of individuals with diabetic partners. (See Figure 2.)

Using the IBM, we hypothesize that diabetics with intact sexuality and strong intimate relationships (intact capacity, interest, and opportunity) exhibit better physical and psychocognitive health, glycemic control, and social functioning at older ages than do similar diabetics with compromised sexuality. We also hypothesize that those with diabetic partners with compromised sexuality will show poorer physical and psychocognitive health and social functioning than those with either healthy partners or with diabetic partners with intact sexuality.

Further, if we consider the relationship between sexuality and chronic illness to be bi-directional, we hypothesize that, over time, sexual health protects against or slows the development of Type II diabetes and associated illnesses at older ages by enhancing the beneficial effects and minimizing the detrimental effects of aging on health. In one direction, preservation of sexuality and intimacy lessens the burden of diabetes (e.g., physical activity, feeling of well-being, control, hopefulness, prolongation of independence) and provides biopsychosocial resources for a better quality of life. In the other direction, diabetes diminishes the benefits (e.g more time for enjoying relationships, less inhibition, more physical attunement to partner's needs) and complicates the detrimental effects (e.g., less intense orgasms, heightened self-consciousness about body image, tougher competition for partners) of aging on sexuality. These hypotheses are supported by pilot work on this subject and form the basis for a national longitudinal study to examine the role of sexuality in mitigating or ameliorating the impact of illness on health at older ages.

Conclusion

The 20th century has witnessed astonishing accomplishments in modern medicine. Prevailing models of illness and disease, in combination with technological advances, have transformed our ability to detect and treat disease, and have eradicated many life-shortening illnesses. These successes have significantly extended the human life span and have enhanced the quality of life in industrialized nations. Yet, this unprecedented demographic shift toward longer, healthier life presents an important opportunity to build on traditional, biomedical models of health. The IBM is not meant to detract from the strengths of purely biomedical models, but rather to build on those models and include social and psychological factors affecting diverse biological systems. A strength of the IBM is the explicit incorporation of partners and larger social networks, as well as the social and cultural context in which the individual is embedded. The IBM adds to the repertoire of researchers and practitioners in medicine and health sciences, and gives them a dynamic framework for building scientific or clinical hypotheses about the etiologies and consequences of health, well-being, and disease throughout the life course.

The IBM can be applied to a wide range of questions about health outcomes and the processes that produce them, including, for example, adaptation to and course of disease for those with cancer, heart disease, hearing loss, dementia, or other diseases; the effects of disease in spouse, child, or social other on self; the impact of group beliefs, attitudes, and practices on development of disease and maintenance of health. The model also could be used to address health issues in public policy that include developing individual and group interventions to improve health practices, and establishing a public infrastructure that expects, facilitates, and promotes scientific collaboration between disciplines and institutions, both national and international.

A model for health that expands beyond the biomedical model is not meant to relegate all responsibility to the medical profession. On the contrary, the ideals of interdisciplinary collaboration in research, education, and the provision of health care is a fundamental inspiration of this model and will determine its success. New opportunities and new challenges require an integrated, interdisciplinary approach, drawing on the impressive advances in biology, medicine, psychology, sociology, economics, and many other disciplines. We will move forward fastest and most efficiently if we link arms, model jointly, and build together.

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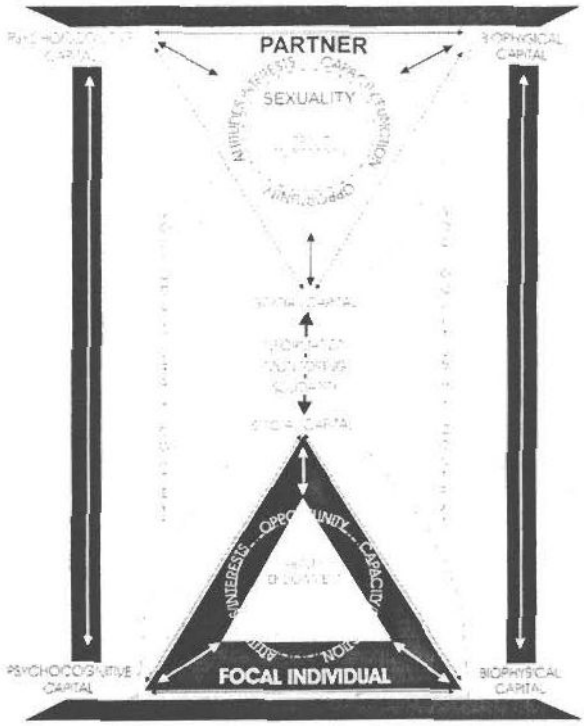

Figure 1.
The Interactive Biopsychosocial Model (IBM).

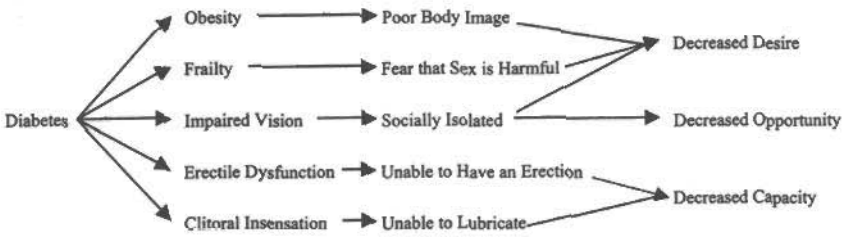

Figure 2.
Effects of diabetes on sexual health.