1

Conceptual Models of the Human Organism: Towards a New Biomedical Understanding of the Individual

Stephen Lewis
University of Chester
United Kingdom

1. Introduction

Central to the conduct of ethical medical practice is the need to have some conception of what disease and health might be. It is the concept of disease which prompts medical intervention and that of health which either prevents unwarranted intervention in the first place or informs its cessation when the patient is deemed to be well again. As highlighted by Reznek (1987), it is not only those directly involved in clinical activities who are affected by these concepts. The work of scientists in medically-related fields can also be directed by how these concepts are understood. What is and what is not an appropriate project may be affected by how disease and health are understood with the granting of funds and other resources similarly affected.

An individual's legal status and the responsibilities expected of them may also be affected by how they are classified medically. Somebody with a psychiatric disturbance may be excused for an act which, in others, might be deemed wilfully criminal by virtue of their condition. Alternatively, somebody with what is classed as a disability may be provided with financial assistance and/or specialised equipment at public expense. They may even be excused the expectation of work altogether.

How individuals are labelled medically – how their 'condition' is classified – is important. However, defining the terms 'disease' and 'health', upon which much of this has rested, has proven to be extremely difficult and it may well be that an alternative approach is long overdue.

2. The current biomedical model

The prevailing model upon which much of modern Western medicine relies is the so-called 'biomedical model' (Davey & Seale, 1996). Sometimes this may be shortened to simply 'medical model'. Indeed, the terms tend to be used somewhat interchangeably to refer to the same way of thinking about the well-being and ailments of individuals. There is certainly no appreciable difference in the way the terms 'biomedical model' and 'medical model' are used. In addition, the title 'disease model' may also be sometimes used. This title is perhaps more telling. One of the central characteristics of Western medical thinking is its emphasis on disease and with anything else which might be deemed to be 'wrong' with the patient.

As the term implies, the biomedical model is an attempt at combining biological and medical thinking in the clinical setting. There are two inter-linked ways in which the biomedical model can be seen working in practice.

Firstly, scientific knowledge gained from non-clinical research is often used to inform patient treatment. Secondly, clinical practice itself is undertaken in a scientific way by adopting the same methodology and intellectual rigour as found in pure scientific research. This approach became typical of the style of medicine practised in the West particularly during the twentieth century and it has become for us that century's medical legacy. Indeed, it is still the prevailing model by which the medical profession operates and, as a result, it is also the way in which people's ailments are understood and treated. Furthermore, this impacts on the attitude shown to the people affected. Once the medical focus is fixed upon what is wrong with the patient, that patient can very easily become a bystander and less of a participant in their own ailments as their bodies are probed and exposed to various treatments.

Seedhouse (2001) identified in this model the following characteristics:

1. That health is the absence of disease.
2. That health is a commodity with a wide-ranging commercial/business-like dimension.
3. That medical science has produced an accumulation of knowledge which can be applied to bodies as physical objects rather than to bodies as people.
4. That the best way to cure disease is to reduce bodies to their smallest constituent parts.
5. That health can be quantified in relation to norms for populations, particular groups of individuals, and individuals.
6. That medicine is and should be a form of engineering.

In essence, the biomedical model explains a patient's ailments as being the result of some anatomical or physiological cause which, in turn, is deemed to be a fault with the patient's body. Understanding the causal processes leads directly - or so it is assumed - to appropriate treatments: remove the cause and one removes the source of suffering and, subsequently, the suffering itself with the result that the patient is restored to health. The logic seems reasonable enough and, to an extent, this approach seems to have been successful. Arguably, the biomedical model has provided clinicians with exactly what they have needed to do their job: a clear and direct way of approaching the identification and remedying of their patients' problems. However, this apparent success may be somewhat illusory.

The emphasis of the biomedical model is on the patient's body. The psychological, behavioural, social and wider environmental aspects of their ailments are not integrated into this model – certainly not overtly. Whether or not a particular clinician chooses to include these aspects is another matter. If they do, it will tend to be at their own discretion and in their own particular style and manner. Significantly, the biomedical model does not oblige clinicians to make any such consideration.

Furthermore, the biomedical model fails to recognise and take into account the multi-factorial nature of cause. If the cause of a patient's ailment is multi-factorial, then effecting some form of cure is likely to require a multi-factorial approach too. By following this model, health professionals limit themselves to dealing primarily with the patient's physical state when other aspects of their lives might need particular attention for complete well-being to be achieved. For example, a patient may be unwell because of a lifestyle choice such as over-eating, smoking or excessive alcohol consumption. The simplistic biomedical remedy is to prescribe a change in diet, a cessation of smoking and a limitation of alcohol

consumption to safe levels, respectively. While these recommendations, if adopted, may well bring about beneficial physical effects in the patient's body, this approach completely overlooks what might be described as the 'cause of the cause'. The patient's eating, smoking and drinking habits may stem from some non-physical problem or set of problems to do with the wider aspects of their life. Factors which may have led to these habits in the first place are largely ignored. A patient who adopts the recommendation to change their lifestyle habits in the way described may be physically improved but still have what might be described as 'quality of life' problems. These, because they fall outside the biomedical model, are not usually seen as specifically clinical problems and have not become an integral part of medical thinking. Yet they can impact directly on an individual's overall well-being.

In the biomedical model, there is also a tacit separation between the mind and the body. Indeed, a mind-body dualism is arguably central to this model. Exactly why this should be is unclear. As will be noted below, the biomedical model does not seem to have appeared as the result of a specific formulation but seems instead to have evolved over a period of time and while there is a historical and philosophical precedent for a separation of mind and body in the work of René Descartes (1596-1650), the biomedical separation may have a much more prosaic explanation. There is a sense in which each individual feels as if they are a person with or within a body. It is not uncommon for people to use expressions such as 'my hand' or 'my heart' as if they were objects which belonged to them rather than being integral parts of them. The linguistic environment within which people operate is not one conducive to an integration of mind and body but rather one of separation. Thus, to the average individual, mind and body are not continuous; they are not a unity and it is, therefore, very easy for people – including clinicians – to make such a separation.

Consequently, the extent to which a patient's experience of pain and suffering are part of the biomedical model is also a moot point. There is no mention of these in Seedhouse's characterisation above. That a patient is in some form of distress is only implicit in the biomedical model in that it is taken for granted that this is what causes people to seek medical help in the first place. Thereafter, however, once medical help has been procured, attention is focussed primarily on the cause of the ailment and upon its removal or, failing this, on the treatment of symptoms until the individual gets well of their own accord. Pain gets treated quite separately via the provision of analgesia. It does not get considered from a psychological perspective. The prevailing notion is that pain is experienced because of some physical cause within the body. Analgesia is given to take away that experience while the task of removing the physical cause is undertaken. In effect, there is no fully developed theory of suffering in its wider sense within the biomedical model.

Another effect of the mind-body dualism is an assumption that mind and body can be treated separately. The body, it is further assumed, can be treated as a machine and a mechanical metaphor for how it operates can be adopted. Accordingly, the biomedical model assumes that diseases can be characterised as resulting from identifiable physical causes – that is, there must be a mechanical element to disease. As a corollary to this, it is assumed that applying ever more sophisticated technological investigations in determining the mechanical nature of the disease can only be to the increasing benefit of the patient. However, this may not necessarily be the case. Tinetti and Fried (2004) have noted that "(a) primary focus on disease ... inadvertently leads to undertreatment, overtreatment, or mistreatment". Confronted with this, it may well be the clinician who, in fact, benefits most from these technological advances – or at least some of them. Being better informed does not

necessarily lead to better treatment. What an extensive battery of diagnostic tests certainly can do is allow clinicians to guard themselves against liability for misdiagnosis and inappropriate choice of treatment.

Historically, the biomedical model never had a single definitive founding moment. Instead, a series of events in the history of biology and medicine appear to have contributed to its gradual emergence. These include the work of Giovanni Battista Morgagni (1682-1771) in founding the field of pathology in the eighteenth century, the general progress made in establishing physiology as a science in the nineteenth century (with the work of Claude Bernard (1813-1878) occupying a significant and enduring position as a forerunner to the notion of homeostasis developed by Walter Cannon (1871-1945) in the 1920s) and the specific proposals about the nature of medical training made early in the twentieth century in the Flexner Report (1910). However, as Keating and Cambrosio (2003) have noted "… the object of medicine is not the body per se but, rather, models of the body". The emphasis that the biomedical model places on the body is, in fact, an emphasis on a model of the body: an abstraction.

The models we use influence and may even drive our understanding of the object to which those models apply. Here, our models of the human body influence the practice of medicine itself. Until the nineteenth century, the prevailing model of the body in Western medicine was based upon the ancient notion of humoralism. How well or unwell one felt was thought to be the product of the way in which four supposed bodily humors – black bile, yellow bile, phlegm and blood – were in proportion to each other. Therapies and treatments were delivered not in accordance with physical observations about the nature of the body alone but in terms of how these observations were interpreted in terms of humoral theory. For example, if a patient's ailment was deemed to be related to an excess of the humor blood, this excess was alleviated by subjecting them to the process of blood-letting. Any anaemia that may have resulted from this process seems to have gone unnoticed. While we have moved on since then to become more accurately informed about the true physical nature of the body, we still adhere to conceptual models via which to operate, as the example of the biomedical model illustrates. Any model by which we operate is an abstraction from what is currently known. As a result, such models are always in need of refinement as knowledge and understanding develop.

Given this historical background, one might reasonably expect the biomedical model to be something which continues to evolve and to be refined as new knowledge and understanding emerge. While research does produce new findings from which new treatments and therapeutic techniques are developed within the context of the current model, the conceptual basis upon which the biomedical model is founded appears to be somewhat more static. Arguably, the biomedical model has not, strictly speaking, kept pace with wider intellectual developments. In practice, it is now quite clear that the cause-effect relationship does not hold. Frequently, clinicians are confronted with patients whose ailments are without apparent physical cause. Similarly, routine screening can bring to light potentially life-threatening lesions for which there is an absence of any experienced symptoms. Those conditions which cannot be accommodated by the biomedical model often cause clinicians considerable problems in terms of decision making (Marinker, 1975). Yet, the central cause-effect assumption remains. This reflects, in part at least, a too rigid application of the wider scientific expectation that all observable phenomena within the physical universe are explicable in physical terms. It is questionable whether the body, even if seen merely as a set of physical processes, really operates in quite that way.

One is compelled to ask not only to what extent the prevailing biomedical model is useful in contributing to clinical practice but also to what extent this model truly represents the biology of the individuals concerned. Ailing, in the absence of apparent physical cause, and the absence of symptoms, in the presence of life threatening lesions, seem to refute the viability of the biomedical model as currently formulated. Indeed, the conceptual bases upon which much of Western medicine is founded may not be as sound as might be expected.

One of the core problems with the prevailing biomedical model is its focus on disease. Health, it tends to be assumed, is merely the absence of disease. In effect, something that exists because of the absence of something else – some sort of default status. This is in contrast to the constitutional statement of the World Health Organization which holds that '(h)ealth is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (WHO, 1948). While the first part of this statement has its critics, the latter clause tends to receive little criticism. Those whom one might have expected to be most exercised by the problem of defining the notions of health and disease – because they are core to their professional practice – are those who seem least interested in their conceptual foundations. When posing the question 'What is health?' Richard Smith, editor of the British Medical Journal (BMJ) stated that '(f)or most doctors that's an uninteresting question. Doctors are interested in disease, not health. Medical textbooks are a massive catalogue of diseases.' However, when it comes to diseases, defining what these are seems to be equally difficult as surveys published in the BMJ have discovered (Campbell et al., 1979; Smith, 2002). Offered a list of named conditions with which clinicians frequently deal, different groups of people – including medical academics and general practitioners – were asked to say which they thought were diseases and which they thought were not. Noticeably, there was not complete agreement. There were differences of opinion within and between the groups surveyed. Clearly, deciding whether something merits being called a disease is not a simple proposition.

One finds there to be in the philosophy of medicine, however, much more debate about how to define the terms 'disease' and 'health' with two different schools of thought having emerged (Nordenfelt, 1986; 2007a,b). One school of thought, sometimes called 'descriptivism' or 'naturism' because it holds that disease and health can be understood in physical terms, is represented by the work of Christopher Boorse (1975; 1977; 1997). His work has been particularly prominent within this debate and is in some respects a formulation of the biomedical model. There is certainly a pathological and physiological emphasis within Boorse's description of what constitutes disease. The other school, sometimes called 'normativism' because it sees the ascription of the terms 'disease' and 'health' as labels expressing a value-judgement, has come to be associated with the work of Lennart Nordenfelt (Khushf, 2007). While not overlooking the pathological and physiological, Nordenfelt takes a different approach. His emphasis is on health and, using action theory, the individual's ability to achieve various 'vital goals' associated with daily living.

A simple dichotomy between health and disease – or of being well and unwell – seems to pervade biomedical thinking which has become somewhat linear in nature. In various pictorial descriptions, a simple line is used to represent the health-disease (well-unwell) dichotomy (Seedhouse, 2001; Downie et al 1996). This is also, arguably, a tacit assumption within the philosophical debate about the definition of disease and health. Health and disease are largely seen as dichotomous categories into which patients may be placed. By

portraying 'disease' and 'health' in this way, as if at opposite ends of a single axis, the biomedical model has not contributed to the resolution of the philosophical debate and finding philosophically rigorous definitions of these terms remains elusive. Indeed, it may be argued that the biomedical model, at least as currently formulated, has contributed to the apparent obfuscation. At best, the biomedical model can only be said to provide a heuristic by which clinicians work.

Sadegh-Zedah (2000) has strongly criticised this bipartite 'either-or' aspect of thinking about disease and health. This he attributed to an uncritical adherence to another aspect of scientific thinking, Aristotelian logic with its law of the excluded middle. Instead, he suggested, it might be more appropriate to apply Fuzzy Logic recognising a continuity between the two extremes. Adhering to the dichotomy – and even allowing for this continuity – means that those scenarios described above, which cannot be accommodated by the biomedical model, are still simply left in abeyance.

The healthy or 'well' state is also assumed to be the 'normal' state; the diseased or 'unwell' is assumed to be the 'abnormal' state. This attitude, deemed to be currently prevailing in medical schools and textbooks, has been labelled 'Naïve Normalism' (Sadegh-Zedah, 2000). The prescription of normal and abnormal states is typically undertaken by comparison to population means for given anatomical or physiological parameters. Deviations outside prescribed limits either side of these statistical means forms a basis for clinical concern. The individual is constantly compared to others in order to determine what is and what is not 'normal' for them. However, as Sadegh-Zedah (2000) has also pointed out, what 'normal' really is – apart its numerical interpretation – remains unclear.

3. The biopsychosocial model – an attempt at improvement

One of the most prominent critics of the biomedical model and advocate for change was the American psychiatrist, George Engel (1913-1999). Having identified the need for a new model (Engel, 1977), he proposed an alternative: the biopsychosocial model (Engel, 1981; 1997). Engel intended this model to be a "conceptual framework to guide clinicians in their everyday work with patients" (Engel, 1997) as well as a framework for a wider more scientific understanding of what he called the "human domain". That is, a model to act as a general framework to guide theoretical and empirical exploration, not only of processes or states that are called illnesses or diseases but something more inclusive when trying to understand the human condition as a whole. Importantly, Engel's work highlighted how easy it is to forget that it is a person who is central to any understanding of suffering and its causes. It is not only the physical processes involved when an individual is feeling unwell that should command centre stage but a whole range of features at a number of different hierarchical levels of interaction (Figure 1). It is the individual as a whole – as a physical organism and as a person interacting with the world around – that is essential to any understanding of the notions of disease and health.

Despite initial optimism when first proposed, the biopsychosocial model failed to find the key role in clinical medicine for which it was intended. While Engel's ideas still attract followers (see, White, 2005), his proposals have met with limited success and have not fully entered mainstream medical thought. The main legacy of that model appears to be that the term 'biopsychosocial model' has come to be used to mean something akin to 'holistic'. When the term 'biopsychosocial' is used, it is more likely to be as a form of shorthand implying 'widely-inclusive' or 'all-encompassing' rather than offering a way of detailing what is going on at the different levels Engel had envisaged.

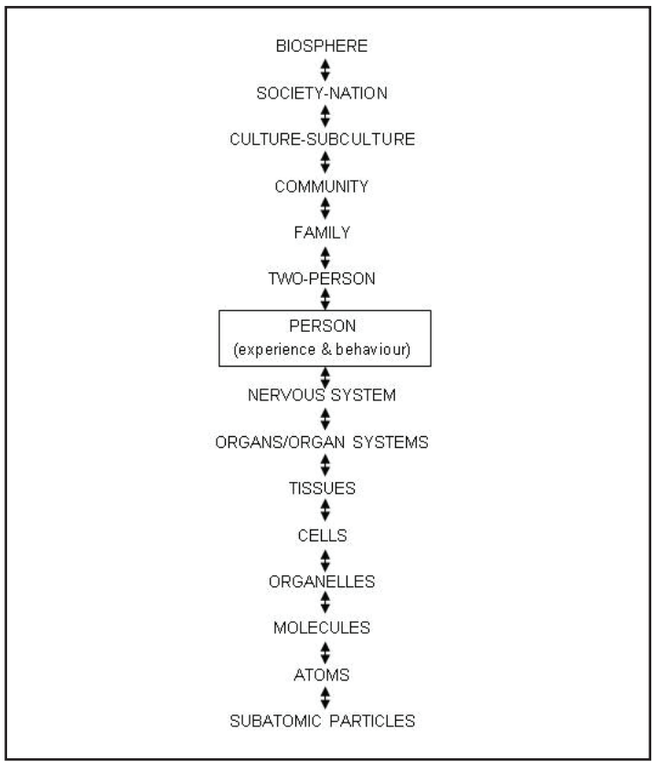

Fig. 1. The Systems Hierarchy (Levels of Organisation) of the Biopsychosocial Model (after Engel, 1981)

The biopsychosocial model does improve upon the standard biomedical model in that it recognises a link between mind and body. The two influence each other but exactly how is unclear. The biopsychosocial model does not set out to explain what the mechanisms involved might be. This is, perhaps, a good thing. To have speculated was not strictly necessary and to have speculated and found to be wrong would have cast a shadow over the rest of his ideas. Instead, the biopsychosocial model recognises there to be a link between mind and body in a somewhat more empirical way.

The biopsychosocial model is not without its critics. It has been criticised for not explaining how the levels Engel highlights interact (Malmgren, 2005). It is true that the biopsychosocial model does lack what might be called a theory of the organism. The list of different levels at which different effects may be observed is left without a detailed explanation of the way in which these levels influence each other being given. The biopsychosocial model is able to accommodate a good deal of information about what occurs at each level as was demonstrated using the clinical example of a myocardial infarction (Engel, 1981). However, its explanatory and predictive capabilities are quite limited. Indeed, Engel's model begs the question of how much detail is necessary in order to understand the organism as a whole.

Instead of a series of hierarchical levels, an alternative is to conceive of a series of nested (or Chinese) boxes (Grobstein, 1965). Where Engel encounters a problem is that his readers require of him an explanation of how the different levels – or nested boxes – influence each other (Malmgren, 2005). It may not be strictly necessary for all the minutiae to be explained before an acceptable picture of the organism emerges. Might one reasonably choose instead to put a lid on one or other of the boxes and to view the operation of each box separately

without going into the finer detail of the workings within? Indeed, the biopsychosocial model owes much to Ludwig von Bertalanffy's (1901-1972) 'General Systems Theory' (Malmgren, 2005). In such an approach, it is usually more informative to explain the behaviour of a system as a whole. Such behaviour is not merely the summation of the behaviour of the parts. Emergent properties may only manifest themselves at certain levels of organisation and might be missed by looking too deeply at fine detail.

In engineering, a black box is a something which can be viewed purely in terms of its input, output and the transfer function that gives the relationship between the two rather than in terms of the details of internal operation. There need be no knowledge of the processes occurring within the black box for it to be understandable in some way (Figure 2). Instead of requiring increasingly precise amounts of information about different levels of organisation, it may be more desirable, in order to understand a system as a whole more clearly, to put a lid on one of the conceptual boxes and deliberately ignore what lies within. This produces a form of black box. More appropriately, perhaps, one might refer to this as a 'closed box'. 'Closed', that is, in the sense that the contents and their various processes are hidden from view and 'closed' in the sense that the lid has been deliberately put on. This is a somewhat counter-reductionist approach. While Engel attempts to look at all levels associated with the individual simultaneously, a way of understanding just the individual as a single whole may prove to be a better starting point.

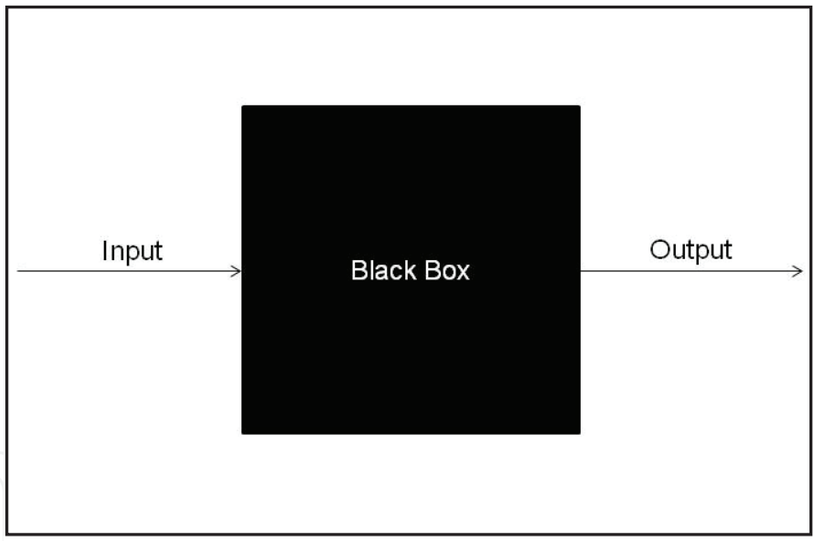

Fig. 2. A Black Box. Only the input and output are known and, as a result, the transformation that has taken place within the black box.

4. Another way ahead

Despite various criticisms, the biomedical model still occupies a prominent place in Western medicine. Indeed, it has proved useful despite its flaws and its complete removal or replacement is likely to prove virtually impossible as Engel's attempts with the biopsychosocial model have demonstrated. The persistence of the biomedical model is, perhaps, not surprising. It has, in many respects, withstood the test of time, having been very successful in acting as a useful - if imperfect - heuristic. However, that is not to say that

the biomedical model cannot be improved. Instead of attempting a complete replacement, a more productive approach might be to build upon its useful features, correct its flaws and expand it as necessary. A revision of the existing biomedical model is needed. Such a revision would need to ensure that there was a firm foundation in biological science such that a range of biomedical and biomechanical disciplines could operate in a more informed manner when dealing with individual patients.

Although the name biomedical model suggests that there is already a strong biological component, not every aspect of biology pertinent to medicine can be said to have been utilised by this model. For example, it is only in recent years that the need for a place for evolutionary biology in medicine has been highlighted with the emergence of the field of evolutionary (Darwinian) medicine - and that well over one hundred years after the publication of Darwin's 'On The Origin of Species' (see, for example, Williams & Nesse 1991; Nesse & Williams, 1995, 1999; Nesse, 2001a,b; Nesse et al., 2006).

Out of a consideration of the range of ideas that evolutionary biology can bring to medicine comes the question of the relationship between the notion of individual 'survival' and a patient's overall state as an integrated physical, experiential and interactive system. 'Survival' should not be seen as simply a matter of whether or not one can stay alive. There is a 'quality of life' element as well which influences whether one merely survives in the sense of just barely staying alive or whether one survives well and flourishes. It is in the latter context that the biological imperative of reproduction can be best performed. For example, those female animals which are required to invest much of themselves in producing and raising offspring would, if experiencing a low quality of life, be less likely to succeed in bringing many to full reproductive maturity. In seeking medical help, an individual is, in effect, seeking help with their quality of life – although not, of course, necessarily with the aim of enhancing reproductive success in mind. Somebody who visits their doctor with an ailment is, in effect, acknowledging a diminution of some perceived aspect of their quality of life. Thus, what biology has to say about this in relation to notions of survival and quality of life is relevant to medical practice.

As a result, one may reasonably propose that one should first seek to understand, in biological terms, what contributes to the individual's quality of life via an examination of the notion of individual survival before going on to try to define the notions of 'disease' and 'health' *per se*.

4.1 On modelling

The need to explain complex systems such as the human body in disease and in health leads to the development of models which in themselves are interpretations of reality. All models are, by their very nature, abstractions. A drawing of a bird that is intended to help bird-watchers identify different species is, in effect, a model, an abstraction. Such a drawing is not an exact likeness of any particular bird that one is likely to see. Rather it is a representation of a whole species. There is, in that drawing, a certain generality.

Similarly, in medicine, it is necessary to identify different types of people. Firstly, there are those who should and those who should not be classified as 'patients'. Secondly, of those who should be classified as patients, it is necessary to differentiate between different types of patient. That is, those who are in need of different kinds of medical attention. A way of distinguishing between these different categories is needed. However, the distinction between 'patient' and 'non-patient' need not mirror the dichotomy between 'disease' and

'health' – which seems to be what the biomedical model seeks to do. Help with enhancing one's quality of life is broader than this.

One must be clear about the purpose of making models. Two major types of model may be identified. These may be described as 'Models of' and 'Models for'. 'Models of' are those models which simply describe an object or process in simplified (although not necessarily simplistic) terms. 'Models for' are those models which have been constructed with a particular purpose in mind. 'Models for' may also share some of the characteristics of 'models of' type models. They may include some form of description of an object or process which then provides something with a practical use. Astrophysical models of star or black hole formation, for example, are models of how something happens but these models may have no immediate practical usefulness on Earth. Models of physiological processes can be models of what occurs within a body and can be of purely theoretical interest – especially if that process occurs in a species quite unlike our own. However, when they are applicable clinically, some physiological models allow for understanding a patient's pathophysiological processes better and may help in remedying their ailments more effectively. It follows that it is of paramount importance in the medically-related fields that the best possible models are devised in order to provide the best possible patient care.

5. Understanding the individual in two biomedical dimensions

In organismal terms, human individuals are not simply physical objects or even sets of physical processes; they are persons – minds as well as bodies. In particular, an individual can be considered as having two concurrent and interwoven characteristics. Firstly, the individual is a materially self-referential system in that there are numerous physiological processes that are monitored and regulated at a physical level via different forms of feedback. Secondly, the individual is experientially self-aware in that conscious and also sub-conscious monitoring and regulation are also being affected at a higher level. If, for example, the body becomes dehydrated, this is not merely a physical change accompanied by concomitant physiological responses. There is also a higher level experience of 'thirst'. Biologically, being 'known' to oneself in these various ways allows the individual to respond accordingly so as to ensure continued survival – in this example, by drinking.

5.1 The physical dimension

At the non-conscious physical level, biochemical and physiological pathways and their regulatory mechanisms are involved. It is with these that the current biomedical model is largely concerned - with much of the emphasis being confined to biochemical and physiological detail. However, if considered from an organismal perspective, these processes have a much greater significance. They can operate in such a way as to ensure organismal survival or they can operate in a way that endangers the survival of the whole organism – or any gradation in between. If these processes work *en masse* so as to ensure survival, we may consider this form of operation to be 'ordered' or 'orderly'. If these processes do not work *en masse* to ensure survival, we may consider this form of operation to be 'disordered' or 'disorderly'. The criteria for conferring these appellations are quite simple, being based on the overall effect on the survival of the individual as an organism. By concentrating on biochemical or physiological detail alone, it is easy to overlook the organism-level role played by the numerous physiological processes occurring within the human body simultaneously. Here one seeks to avoid this by using the black box approach

described above. One is looking primarily at how the whole organism operates, not the sum of its parts. One has closed the box at organism level.

5.2 The experiential dimension

Human beings also have a capacity for self-awareness. They are conscious of how they feel. In particular, the ability to feel unwell or otherwise distressed seems to be especially significant as these experiences are often indicative of some physical disorder. Raised to the conscious attention of the individual, remedial action is possible. While consciousness may be something that concerns the psychologist or the philosopher, the notion of self-awareness is something that has been rather under-represented in biology - especially in relation to the experience of illness (Lewis, 2007a,b) - and, unsurprisingly, is missing from the biomedical model. This is unfortunate as this is an important capacity for an organism to possess. Without the capacity for self-awareness - at conscious and/or sub-conscious levels - one would lack the ability to be aware of any need to respond to disadvantageous changes in one's internal environment. Should this capacity become disturbed, it would impact negatively on individual survival.

Although akin to the separation of mind and body, this division into physical and experiential is subtly different. The notion of 'mind' usually implies consciousness and cognitive self-awareness. Within the experiential dimension as envisaged here, all organismal feedback mechanisms are included whether or not one is aware of them.

5.3 A two-dimensional (biomedical) model

The two dimensions described above may be represented graphically as a plane as depicted in Figure 3 (Lewis, 2009). Importantly, the axes are arranged so that, as one moves along

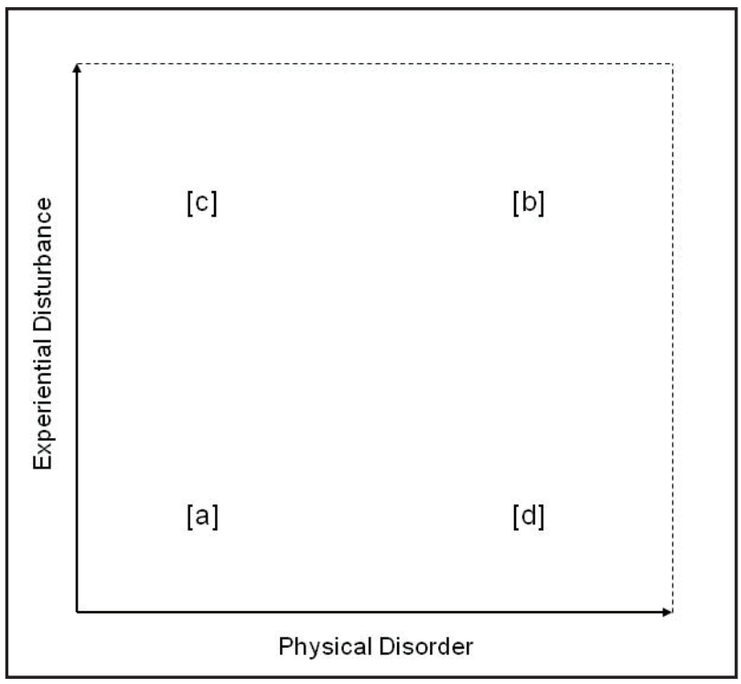

Fig. 3. A new two-dimensional biomedical model

them, there is an increase in physical disorder and experiential disturbance the further one travels away from the origin. With these increasing levels of disorder and disturbance come increasing levels of threat to individual survival. As one moves from left to right along the horizontal axis, the level of physiological disorder increases such that life is increasingly less viable and a point ultimately reached when the individual dies. As one moves up the vertical axis, the level of experiential disturbance increases to a point where the effectiveness of its contribution to survival declines and ultimately ceases.

The intention here is to depict something of the overall state of the individual. They are not being fitted into one or other of the dichotomous states of 'disease' or 'health' at either end of a line, as occurs in the current biomedical model. Instead, they are being given a position on a plane, the different points upon which represent different overall states of the individual and different abilities to survive. Positions on the plane are not static. The position that an individual occupies can vary as their physical and experiential states change. This may occur during the progress of a pathological or psychiatric condition or due to the changes concomitant with the normal course of life.

5.4 Representing clinical cases

An individual who feels well and whose physical processes are operating in an orderly way may be represented somewhere to the lower left of the plane [a]. Likewise, an individual who feels unwell and whose physical processes are not operating in an orderly way may be represented somewhere to the upper right of the plane [b]. Exactly where on the plane one might choose to place a particular individual is a matter of clinical judgement rather than mere physiological measurement. However, in a clinical consultation, what may be more important is using this model as a tool for assessing the patient more informatively. It is not simply a case of the individual being fitted into a category. Rather, it is a matter of assessing the individual and developing a better mental picture of their own particular overall state. By separating out these two dimensions of the individual so that they become available during clinical consultation, the examining clinician is more readily alerted to the need to take not only the physical but the experiential into account.

As noted earlier, not all cases presenting to the clinician can be accommodated by the old biomedical model and these caused clinicians serious problems (Marinker, 1975). These were cases where an individual felt unwell but for which there was no obvious physical cause and cases where the individual felt well yet had a lesion of some sort. While these cannot be fitted into the current biomedical model, they can now be represented by this two-dimensional model quite readily. Position [c] represents the situation when the individual feels unwell but for which there is no obvious physical cause. Here, there is an experience of disturbance but no obvious physical disorder. Position [d] represents the situation where the individual feels well but has a lesion of some sort. Here, there is no feeling of being unwell but there is a degree of physical disorder. Thus, lesion-less symptoms and symptom-less lesions can now be represented alongside the more easily accommodated states.

In a clinical consultation, this would again act as a useful tool. In both cases, there is now a way of characterizing and understanding the patient better. Furthermore, this model also allows phenomena such as the placebo and nocebo effects to be represented. When somebody takes a dummy pill or undergoes a sham operation, they may feel better (placebo effect) or worse (nocebo effect) afterwards. This may be represented by a downward shift from one's previous position on the plane or by an upward shift respectively.

6. Understanding the individual further - a third dimension

While physical and experiential aspects of an individual can be represented using a two-dimensional model, there still remain other aspects which both contribute to individual survival and are potentially of clinical relevance. These concern the behaviours expressed by an individual. It is through behaviour that the individual interacts with the wider world - drawing upon what can prove beneficial or trying to counter that which is disadvantageous, as appropriate. Each can have the express aim of contributing to individual survival. Although humans display a diverse range of behaviours, those primarily directed at survival through such activities as eating, drinking, finding safety, maintaining general hygiene etc. are those that are of particular importance here. Any one or more of these needs (see, for example, Maslow, 1943), if left unattended would impinge negatively upon the survival of the individual.

Thus, to the two axes already considered, a third - behavioural - axis may be added (Figure 4). This is an axis of behaviour in terms of an individual's ability to perform actions conducive to their individual survival; an axis concerned with interaction with the world. In particular, this is an axis which describes the extent to which those abilities are constrained. In keeping with the approach adopted for the first two axes, the further one moves away from the origin, the greater the constraint there is upon those abilities. That is, as one moves away from the origin, the greater the deleterious effects on survival become.

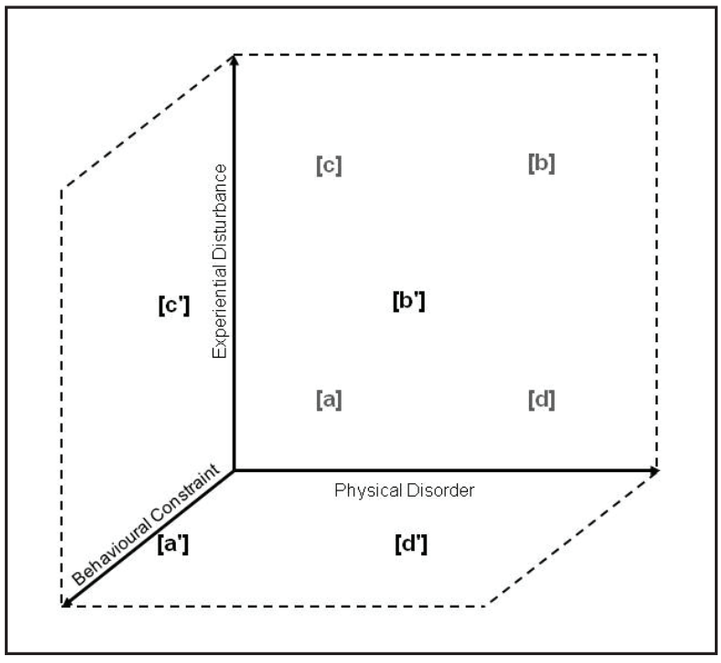

Fig. 4. A new three-dimensional biomedical model

Although it is possible, for clinical purposes, to assess a patient in terms of just the first two dimensions described above, the third is not without clinical relevance. When a patient is discharged from hospital, their ability to look after themselves, or be looked after, is often assessed. Those patients who cannot adequately look after themselves are often discharged into the care of someone who can support them. This assessment is, in effect, an assessment

of the patient's ability to behave in a way conducive to their individual survival. Adding this axis formalises the process.

Taking the four previously considered areas ([a]-[d] on Figure 3) and relating each to what the third axis depicts, position [a'] depicts an individual who feels well and has no physical lesions yet for some reason is constrained in the performance of those tasks conducive to individual survival. Position [b'] depicts an individual who feels unwell and has a lesion and for this, or some other reason, is constrained in performing the necessary survival tasks. Position [c'] depicts an individual who feels unwell but has no physical lesion and because they feel unwell, or some other reason, is constrained in performing the necessary survival tasks while position [d'] depicts an individual who feels well but has a physical lesion and for this, or some other reason, is similarly constrained.

When the constraints on an individual's ability to perform tasks conducive to their survival arise from some internal, physical cause, then there are likely to be medical connotations that need to be considered. When constraints result from some external source - for example, a constraint due to some aspect of the lived environment or habitat in which the individual lives - the issue is more likely to be one needing the auspices of some other agency such as social services. Both, however, may be interpreted as modern out-workings of the notion of biological survival.

6.1 Disability (vs inability)

The addition of a third axis has the effect of separating out the issue of physical disability - formerly known as 'physical handicap' - as a distinct issue for consideration. The question of how people with a physical disability should be considered within the biomedical model is often queried; should they be treated from a medical perspective or in some other way? Based on the current biomedical model, it is sometimes hard for clinicians to afford disabled people the status of being fully healthy. At the same time, neither do they fit neatly into a category equivalent to 'diseased'. Separating out the idea of the ability to behave in ways conducive to individual survival from the dimensions depicted on the first two axes frees disabled people from this dilemma. This model does not necessarily prescribe how behaviours conducive to individual survival ought to be performed or by whom. The precise way one actually ensures one's survival is not dependent on whether or not one has a full range of physical or mental abilities or whether one requires the help of others. This is an axis representing increasing levels of constraint encountered by the individual when interacting with the wider world. An individual without the benefit of modern technological aids would be more constrained in this respect than they would be had they the benefit of them. Using the model described here, it is feasible to envisage a scenario in which a so-called 'disabled person' may be just as successful at ensuring their daily survival as a so-called 'able-bodied' person. Prosthetic devices such as artificial limbs can help reduce the constraints experienced by those individuals who use them and, in some cases, could even allow the so-called 'disabled' person a level of performance which exceeds that of an 'able-bodied' person – as the evidence of the Paralympics is beginning to demonstrate. This model allows for such a distinction whereas the current biomedical model does not.

Instead of being concerned primarily with the physical state of the body, the model presented here provides scope for the individual's experience of their own body and the extent to which the individual is able to interact with the world to be considered. Indeed, for an individual to be located on either of these models, two or three dimensions need to be taken into account simultaneously. It is not enough to assume that a physical change is all

that is needed to effect an improvement in an individual's life. A fuller consideration of their overall state needs to be made.

7. A mental image of biomedical states

The intention of the model described above is to provide a mental image or impression of the overall state of the patient in two or three dimensions as fits the needs of a particular clinical consultation. It is not intended that any clinician should try to draw or plot an exact point representing a patient. The current biomedical model shepherds clinical assessment into thinking in dichotomous terms. The aim of the model described here is to help move thinking on from this single, linear perspective and bring other aspects of a patient's life more fully into consideration. Engel (1981; 1997) was right to want to include the social and psychological factors pertinent to a patient's condition. However, he did not provide a simple way of making an assessment of these factors. Instead, there were numerous potentially interacting levels that needed to be considered simultaneously. The model described here gives a way of assessing the individual as a whole. That does not mean that there should not be detailed and thorough investigation of what makes up that whole where appropriate. The causes and mechanisms involved in any physical disorder, experiential disturbance or behavioural constraint should be explored and the appropriate, specifically directed treatment given. However, that treatment should not be considered in isolation from the effects it may have on the other dimensions considered here. This model is not just for use at the first clinical consultation. It is a tool for continued patient assessment. Having some notion of how a patient's overall state changes, in two or three dimensions, between consultations is important. Furthermore, some treatments aimed at effecting a physical benefit have psychological side-effects which may have, in turn, disadvantageous effects on an individual's ability to look after themselves. In order to bring about the desired overall effect of improving a patient's well-being, some treatments need to be accompanied by assistance in over-coming the effects that may be produced and manifest in the other non-physical dimensions.

7.1 Relevance to other clinical practice – some examples

Not every procedure performed under the auspices of the medical profession is concerned with the cure of ailments. Significant among these is pregnancy. This is a natural phenomenon for which clinical support is typically offered in Western medical settings. However, it is not a medical problem *per se* and the potential medicalisation of this most fundamental of human biological phenomena causes some disquiet. The model described above can be used to represent an individual woman's particular state at any stage during pregnancy without overt medicalisation since it seeks primarily to characterise the individual's overall state.

Physically, the pregnant woman's body undergoes a series of natural changes which have the potential to be hazardous but which may equally be undergone without undue harm. Her conscious self-experience may be, at times, a little more volatile than usual but this is not necessarily to her detriment. Because of her physical changes, the ways in which she is able to interact with the world will change as the pregnancy progresses but again, this is not necessarily to her detriment. Where a particular woman will be represented within the two- or three-dimensional model at any particular stage during pregnancy depends on her particular state. For the uneventful pregnancy, that state will tend to be represented consistently close to the origin. In a condition such as pre-eclampsia, however, her physical

state may become more disorderly and one may imagine a horizontal shift to the right in the representation of her overall state. With increasing severity, a vertical shift may ensue leading, in turn, to a shift in the third dimension if the woman becomes disorientated or loses consciousness.

The model presented here helps visualise what may occur – how a clinical condition may progress – while at the same time also helping one to remember that a pregnant woman can occupy much the same location as a non-pregnant person. Although she is seen in a clinical setting, upon assessment, her closeness to the origin of the plane/space can help all concerned remember that she is not an object for medical concern but a person in need of simple humane assistance. Should her condition prove problematic for her (and her baby) in any way, she would become localised in a different part of the model where medical attention might be deemed necessary.

It does not follow that just because somebody has lived for a long time that they are necessarily diminished in some way by the aging process. It does not follow that the representation of the overall state of an elderly person is necessarily further from the origin of the model than was the case when they were younger or that the older person cannot be represented closer to the origin than a younger person. This model helps prevent jumping to simplistic conclusions based on outward appearances by requiring considered assessment in two or three dimensions, as appropriate.

However, as individuals age, this natural process is often associated with increased medical involvement. Yet, like pregnancy, we choose not to label aging as a disease. However, what the model described here does reveal is the potential for the same location on the two- or three-dimensional model to be occupied by one individual due to the effects of age and by another due to a quite different pathological process. This model helps reveal something that the biomedical model was unable to envisage. This is a particularly interesting scenario for the debate about the definitions of disease and health to consider: a state that can be labelled disease and not disease at the same time, the label being ascribed largely because of the way in which the state came about.

Cosmetic procedures, where an individual's appearance is altered, may be performed for medical or purely aesthetic purposes. For medical reasons, cosmetic surgery may be performed to benefit an individual psychologically. For example, some procedures are performed to relieve the effects of distress due to some facial disfigurement. For aesthetic purposes, some individuals simply want to change their appearance to suit some perceived notion of beauty. Such procedures cannot be accommodated easily by the current biomedical model; the decision whether to perform such procedures is not usually based on a straightforward 'well'-'unwell' assessment. However, the new model presented here does allow such cases to be accommodated.

A disfigured individual may not be physically disordered in that their disfigurement may not threaten their physical survival and their ability to interact with the world may not be constrained but their self-esteem may be so damaged as to cause them significant distress. Some individuals might become deeply depressed, despondent or even suicidal, because of their perception of their appearance. In extreme cases, that individual's survival may even be compromised by the threat of self-harm. Such conscious self experiences are represented on the vertical axes of Figures 3 and 4. One might locate such an individual higher on the vertical axis than might otherwise be the case because their experiential distress is potentially injurious.

An individual who wants cosmetic surgery purely for reasons of vanity is by definition somebody whose survival is not adversely affected in any of the dimensions of the new

model described above. In such cases, it may be possible for the individual to live perfectly well without undergoing the requested procedure. One might locate such an individual near the origin of Figures 3 and 4. The question for the clinician when confronted by either patient is whether to perform the procedure simply as requested or to address what is essentially an issue relating to each individual's experiential state (i.e. their self-perception) via psychological counselling instead of surgery. It is for the clinician, armed with the model described here and their knowledge of the patient, to make that assessment.

It may be argued that some of the assessments that the model described here seeks to foster are already part of clinical practice. This is not disputed. However, these assessments are not necessarily formalised into a discrete model that can be taught or practised consistently. They are not a formal part of the prevailing biomedical model. At the heart of the model described here is the aim of formally representing the individual as a biological whole.

8. A survival triad

Although the emphasis has been on the improvement of the biomedical model and on its clinical use, the model described here may be seen to be much more than this. The three axes, taken together, provide a model of the individual's ability to survive in a wider biological sense. The individual must remain as close as possible to the origin for all three parameters in order to continue to survive in the world. Too great a deviation from the origin in any one or more of the parameters can compromise the individual's survival chances. The three parameters constitute therefore a 'survival triad'. The three-dimensional model considers the individual very much in their lived context being concerned as it is with ability to interact with the world. Should that world – the environment within which the individual lives – change, there will be an effect on the individual the model represents. Thus, the three-dimensional model provides a way of envisaging how external changes have an effect on the well-being of individuals.

It is important to stress here that this relates to individual survival. Much of modern biology tends to focus on population level effects. Indeed, it is in the population related sense and not in an individual sense that fitness is usually understood with that of the individual organism largely ignored. In a clinical setting, it is the other way around; it is the individual and not the population that matters most. In setting out to improve upon the biomedical model, a contribution to biology may also be made: that of bringing together into a triad those features which are crucial to understanding an individual organism's survival.

9. Conclusion

For a long time, the biomedical model has prevailed even though it has been known to be flawed. Yet, at the same time, it has been able to perform its basic task in such a way that its complete abandonment has proved impossible. Indeed, the approach adopted here has assumed that attempts at its abandonment may be unfruitful – even undesirable – and suggestions have been given instead with a view to its improvement. To that end, axes in addition to the purely physical have been added and the notion of an individual's overall biological state developed.

The prevailing biomedical model tries to match the individual to labels such as 'healthy' or 'diseased', 'well' or 'unwell'. The aim of this work has not been to produce a model of labels but a model of that to which those labels are applied: the individual. The model described here seeks to first describe the individual and then, where necessary, allows a label to be

ascribed at the discretion of the clinician. As was noted above (Campbell et al., 1979; Smith, 2002), classifying a particular condition as a disease can vary even between health professionals. Here, need for assistance in personal survival and quality of life has taken precedence over any argument about what is and what is not a disease. Whether a clinician chooses to ascribe a particular disease label to a patient or not is of secondary importance so long as the desired outcome of improving that patient's well-being is attained. Indeed, medically, giving the wrong label but bringing about the desired outcome is preferable to giving the correct label and not bringing about that outcome. In this respect, the model presented here is not prescriptive. Other than those points near the origin where it might be reasonable to suggest that a state of health may be ascribed, no other point on the two- or three-dimensional diagrams has a prescribed label. Indeed, it is possible that under different circumstances, a given state may warrant different labels.

Expressed in two- and three-dimensional forms, the model described here incorporates physiological, experiential and behavioural aspects of the individual into an integrated system which directly relates to an individual's ability to survive in a biological sense. In its two-dimensional form, it extends and improves upon the current biomedical model by integrating the physical and experiential aspects of the individual patient. Instead of a linear 'well'-'unwell' dichotomy, the physical and experiential states of the individual are represented as moveable points upon a plane. This version of the model has particular application to clinical situations. In its three-dimensional form, a third axis is added to allow an individual's ability to interact with the world to be considered. In particular, this allows the question of disability to be accommodated. Disability is not something that has been successfully integrated into the prevailing biomedical model. Indeed, it has largely been ignored. This version of the model particularly suits those dealing with disability issues, for example, those engaged in various branches of bioengineering.

Furthermore, although separate axes have been used, the intention has been to model the individual as a single, integrated biological entity in all lived states and not simply as a 'patient'. Hence, a point combining two- or three-dimensions in a phase space has been used to represent that individual. It has certainly not been the intention to model the individual as a set of distinct physiological processes. As a biological organism, the individual is a single systemic whole: something that has to survive as a unified, albeit changeable, entity within the world in which it finds itself; it does not survive as a series of separate parts or part-functions.

Since the model offers a fuller biological description of the individual, it is conceptually applicable in a wide range of clinical and clinically-related settings. A wider range of states than those traditionally labelled as simply 'diseased' or healthy', 'well' or 'unwell' are discernible and states previously outside the scope of the prevailing biomedical model are now accommodated. The model informs the clinical view of the individual and it informs the application of other technologies in their pursuits of the maintenance and enhancement of well-being and the remedy of ailments and disabilities.

It should not be assumed that all of the criticisms that have been levelled at the biomedical model have been addressed here. Only problems with a biological perspective, in particular those relating to individual survival, have been considered. Shortcomings highlighted by commentators from other fields relevant to human well-being, for example, criticisms by those in the social sciences, have only been touched upon. However, despite the present biological emphasis, it is hoped that commentators from other fields might find the ideas presented to be potentially useful and that they can be built upon within their own particular disciplines.

Originally, these models were developed as part of an exploration into the philosophical problem of defining 'disease' and 'health' and are still intended to contribute to that debate which, after many years, still shows no sign of resolution having been also described as having "ended up in a blind alley" (Sadegh-Zadeh, 2000) and *cul-de-sac* (Khushf, 2007). Care has been taken to avoid entering that debate here but modelling the changeable states of the individual as presented above, if valid, should lead inevitably to new ways of approaching the notions of 'disease' and 'health' (see, for example, Lewis 2007c). Furthermore, a closer conceptual association between the 'biological' and the 'medical' perspectives should also be possible and a more thorough 'bio-medical' understanding be possible by the introduction of the notion of an individual's overall state via a 'biomedical (state) model'. Given the ways in which biology and medicine intersect, it may be timely to reconsider not only the nature of the biomedical model and how its improvement might help the patient but also the place of the individual in biology. While, as already noted, the biomedical model needs a fuller inclusion of biological ideas, biology itself needs a greater appreciation of the individual. This may be especially important if ideas of disease and health - which only properly relate to individuals - are to be understood from both a biological and a medical perspective.

10. Acknowledgements

I would like to thank the trustees and fellows of the Konrad Lorenz Institute, Altenberg, Austria, where, as a Visiting Fellow, I was able to develop many of the ideas outlined here. I would also like to thank Annette Lewis for her help in the preparation of the manuscript of this chapter.

11. References

Boorse, C. (1975). On the distinction between disease and illness. *Philosophy and Public Affairs*, 5, 49-68, ISSN 0048-3915

Boorse, C. (1977). Health as a theoretical concept. *Philosophy of Science*, 44, 542-573, ISSN 0031-8248

Boorse, C. (1997). A Rebuttal on Health. In J. Humber & K. Almeder (Eds.), *What is Disease?* 3-134, Humana Press, ISBN 089603352X, Totowa, New Jersey

Davey, B & Seale, C. (1996). *Experiencing and explaining disease*, (2nd edn.) Open University Press, ISBN 0335192084, Buckingham

Downie, R., Tannahill, C., & Tannhill, A. (1996). *Health Promotion: Models and Values* (2nd ed.). Oxford University Press, ISBN 0192625918, Oxford

Campbell, E., Scadding, J., & Roberts, R. (1979). The concept of disease. *BMJ*, 2, 757-762, ISSN 1759-2151

Engel, G. (1977). The need for a new medical model: a challenge for biomedicine. *Science*, 196, 129-136, ISSN 0036-8075

Engel, G. (1981). The clinical application of the biopsychosocial model. *Journal of Medicine and Philosophy*, 6, 101-123, ISSN 0360-5310

Engel, G. (1997). From Biomedical to Biopsychosocial - being scientific in the human domain. *Psychosomatics*, 38, 521-528, ISSN 0033-3182

Grobstein, C. (1965) *The Strategy of Life*. W.H. Freeman and Co., ISBN 0716706350, San Francisco & London

Keating, P., & Cambrosio, A. (2003). *Biomedical Platforms - Realigning the Normal and the Pathological in Late-Twentieth-Century Medicine*. MIT Press, ISBN 0262112760, Cambridge, Mass.

Lewis, S. (2007). Illness - An Under-Rated Biological Phenomenon. Retrieved 5th September, 2010, from https://sites.google.com/site/sjlewis55/presentations/sshb2007. (Abstract: Annals of Human Biology 34, 688, ISSN 0301-4460)

Lewis, S. (2007b). Putting Illness In Its Place. Retrieved 5th September, 2010, from https://sites.google.com/site/sjlewis55/presentations/temah1

Lewis, S. (2009). Seeking a new biomedical model. How evolutionary biology may contribute. *Journal of Evaluation in Clinical Practice*, 15, 745-748, ISSN 1356-1294

Malmgren, H. (2005). The theoretical basis of the biopsychosocial model, In: *Biopsychosocial Medicine - An integrated approach to understanding illness*, White, P. (Ed.), 21-38, Oxford University Press, ISBN 0198530331, Oxford

Marinker, M. (1975). Why make people patients? *Journal of Medical Ethics*, 1, 81-84, ISSN 0306-6800

Maslow, A. (1943). A Theory of Human Motivation. *Psychological Review*, 50, 370-396, ISSN 0033-295X

Nesse, R. (2001). How is Darwinian medicine useful? *Western Journal of Medicine*, 174, 358-360, ISSN 0093-0415

Nesse, R. (2001). Medicine's missing basic science. *The New Physician* (December 2001), 8-10, ISSN 0028-6451

Nesse, R., Stearns, S., & Omenn, G. (2006). Medicine Needs Evolution. *Science*, 311, 1071-1073, ISSN 0036-8075

Nesse, R., & Williams, G. (1995). *Evolution and Healing - The new science of Darwinian medicine*, Weidenfeld and Nicolson, ISBN 0460861409, London

Nesse, R., & Williams, G. (1999). On Darwinian medicine. *Life Science Research*, 3, 1-17, ISSN 1007-7847

Nordenfelt, L. (1986). Health and disease: two philosophical perspectives. *Journal of Epidemiology and Community Health*, 40, 281-284, ISSN 0141-7681

Nordenfelt, L. (2007). The concepts of health and illness revisited. *Medicine, Health Care and Philosophy*, 10, 5-10, ISSN 1386-7423

Nordenfelt, L. (2007). Establishing a middle-range position in the theory of health: A reply to my critics. *Medicine, Health Care and Philosophy*, 10, 29-32, ISSN 1386-7423

Reznek, L. (1987). *The Nature of Disease*, Routledge and Kegan Paul, ISBN 0710210825, London

Sadegh-Zadeh, K. (2000). Fuzzy health, illness, and disease. *Journal of Medicine and Philosophy*, 25, 605-638, ISSN 0360-5310

Seedhouse, D. (2001). *Health - The Foundations for Achievement* (2nd edn.), John Wiley and Sons, Ltd., ISBN 0471490113, Chichester

Smith, R. (2002). In search of "non-disease". *BMJ*, 324, 883-885, ISSN 1759-2151

Smith, R. (2008). The end of disease and the beginning of health. Retrieved 5th September, 2010, from http://blogs.bmj.com/bmj/2008/07/08/richard-smith-the-end-of-disease-and-the-beginning-of-health/

Tinetti, M.E., & Fried, T. (2004) The end of the disease era. *American Journal of Medicine*, 116, 179-85, ISSN 0002-9343

White, P. (Ed.). (2005). *Biopsychosocial Medicine - An integrated approach to understanding illness*, Oxford University Press, ISBN 0198530331, Oxford

World Health Organization. (1948). WHO Constitution. Retrieved 5th September, 2010, from http://apps.who.int/gb/bd/PDF/bd47/EN/constitution-en.pdf

Williams, G., & Nesse, R. (1991). The dawn of Darwinian medicine. *The Quarterly Review of Biology*, 66, 1-22, ISSN 0033-5770

Biomedical Engineering, Trends, Research and Technologies
Edited by Dr. Sylwia Olsztynska

ISBN 978-953-307-514-3
Hard cover, 644 pages
Publisher InTech
Published online 08, January, 2011
Published in print edition January, 2011

This book is addressed to scientists and professionals working in the wide area of biomedical engineering, from biochemistry and pharmacy to medicine and clinical engineering. The panorama of problems presented in this volume may be of special interest for young scientists, looking for innovative technologies and new trends in biomedical engineering.

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen