Sequencing the Human Lifestyle

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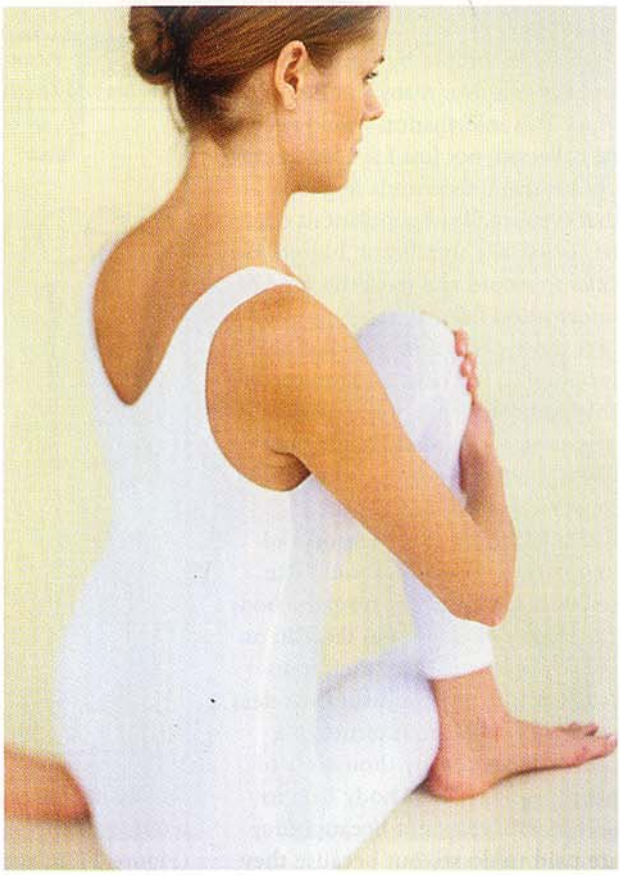
Ever-expanding knowledge of human behaviour, which is being gathered as a side-effect of the increasing use of wearable body monitors, is set to have a huge impact on health care.



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More than genetics

It took mankind about 8000 years to "sequence" the human anatomy. Today, with the exception of the brain's structure and function, this project can largely be declared complete and our knowledge of human anatomy forms the basis of modern medicine. As soon as the structure Deoxyribonucleic acid (DNA) was described 53 years ago, it was clear that the ability to decode and possibly recode DNA would someday form a major new field of medicine. But first, DNA needed to be sequenced and the process went much faster than the industry imagined because technology's exponential improvements over time accelerated the sequencing process. There is a third major element of the human body that has not yet been sequenced and technology is accelerating so fast that it may well be sequenced before we even appreciate the enormous impact it is going to have on the global health-care industry. That third element to be sequenced is the human lifestyle.

It is well understood that the majority of the variability in health-care costs stems from the lifestyles and behaviours of people and only a minority of that variability can be ascribed to their genetics. There are coarse statements that can be made about this variability, for example, "poor exercise and diet lead to obesity, which in turn increases risks of conditions such as diabetes and cardiovascular disease." But these statements are unrefined and take enormous amounts of money and time to make with any confidence, given the complexity of studying statistically significant populations over periods of time.

Mapping behaviour

To sequence the human lifestyle means to create a much more complete map of how people behave over time and how these behaviours relate to their conditions and the success of their therapies. For example, patients suffering from chronic obstructive pulmonary disease are currently given oxygen therapy up to the point of diminishing improvements in their oxygen saturation levels. Imagine instead titrating their oxygen therapy to the point of diminishing improvements in their lifestyle. Or imagine discovering, without the cost of a costly, complex multisite study, a strong relationship between long-term insomnia and risk of falls among the elderly. To know this kind of information would dramatically change the health-care landscape. It could redefine how drugs are prescribed and taken; how medical devices are designed, delivered and measured; and even most basically, how clinicians interact with their patients.

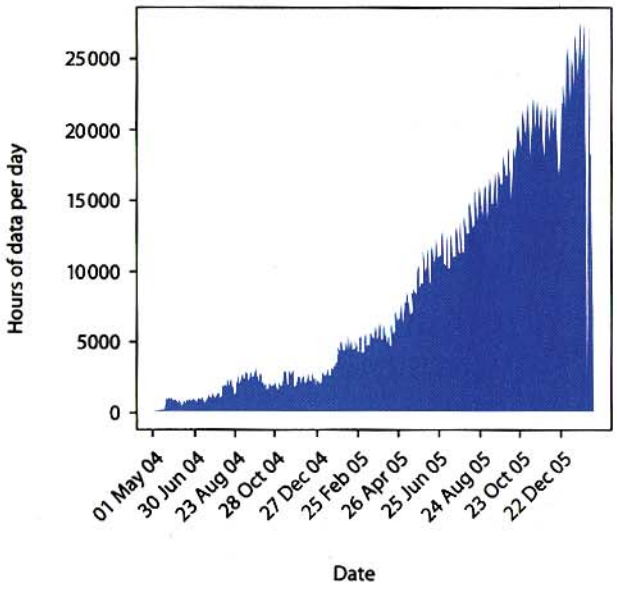
Doing the undoable

On the surface, collecting enough information to be able to say that the human lifestyle is sequenced does not seem doable. It would require knowing many of the basic actions people are →

→ engaged in minute-by-minute, day-in and day-out over many months or years. This information would need to be collected, not just for a few people, but for many thousands of people so that even small subpopulations could be statistically significant. Indeed, the costs to record and track this kind of information from all those people over those periods of time is entirely prohibitive. But new, highly wearable body monitors offer an entirely new perspective on the problem. These products include, for example, SenseWear armbands (Figure 1) that collect lower level sensor readings such as motion, galvanic skin response and heat flux from the body 32 times/s directly from the skin on the wearer's arm. They then transmit that information using wireless technology via the Internet to a central server. Many thousands of people upload their body data to servers everyday, not because they are paid to do so, but because they or their caregivers have paid for the opportunity to have a wearable body monitoring company interpret and summarise their lifestyle. Bioinformatics algorithms have been developed to take the lower level vital signs gathered from wearable monitors and return accurate minute-by-minute body statements on, for example, when a person is sleeping or awake, lying down, sitting or standing; they record precisely how physically active he/she is, what kinds of physical activity he/she is doing, whether walking or in a moving vehicle (Figure 2). In aggregate, this is the sequencing of the human lifestyle in progress. This author's company alone has six million hours of free-living (that is, natural environment, normal daily routine) human lifestyle data in its servers today and that quantity will have more than quadrupled by the end of 2006. Each individual's data, encrypted and heavily protected from physical and cyber theft, can only be accessed via a password by themselves or, with their permission, their designated caregivers. Aggregate statements about cross-sections of this population of individuals (by definition nonprivacy threatening) are extracted and stored separately.

Figure 1: Armband that collects lower-level sensor readings 32 times/s.

Figure 2: Bioinformatics algorithms take lower-level vital signs and return minute-by-minute body statements.



Utilising the known

Today it is known that our behaviours affect what drugs we need and how they work on us. Our behaviours affect what devices will be needed to understand or treat us. They are the major missing element in the interaction between patient and caregiver. Unlike human anatomy or even the human genome, which had to be explicitly sequenced at enormous expense, the human lifestyle is being sequenced as a side-effect of the new applications being offered by wearable multiparameter body monitors. This is a tremendous potential source for progress and benefit to the world health-care community that will take centre stage in the next decade. mdt

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