# Dudley Strategic Needs Analysis

## Part 3

## Horizon Scanning
## Technologies in Healthcare

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# 1. General background

Horizon scanning is:

> *The systematic examination of potential threats, opportunities and likely future developments which are at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems or trends. Overall, horizon scanning is intended to improve the robustness of [the organisation's] policies and evidence base."* [1]

In addition the Office for Science and Innovation's Horizon Scanning Centre adds:

> *The purpose of horizon scanning is not to predict the future, but to explore ranges of possible futures in order to challenge and inform strategy. [HSC] includes the whole of the research base in its definition of science – so economics, social sciences and relevant aspects of arts and humanities are included.* [2]

Horizon scanning therefore aims to help planning activities today by anticipating the options for the future. It also aim to identify the opportunities for influencing the future.

Horizon scanning in the above sense is relatively limited. Organisations such as the NHS Horizon Scanning Centre in Birmingham focus on assessing individual treatments and technologies that are nearing their marketing launch. Foresight is the main body which looks into these. This organisation produced a report on health in 2000.[3] The Wanless Report was also a major document aiming to describe and shape the long term future of healthcare. [4]

In the USA, however, there is one organisation which specialises in this area. The Institute for the Future has produced a number of very useful documents. This paper will draw directly from two of these:

1. Health and Healthcare 2010 (Second Edition 2003) [5] which takes a very broad view of the forces that will impact on health care.

2. Mapping Transformations in Health Technology (2002) [6] which specifically focuses on some of the major technical advances expected to transform healthcare.

# 2. Overview

Expanding knowledge and technological capabilities in all areas of science will lead to both significant improvements to existing healthcare and major new advances. Although it is suggested that many of these will lead to a reduction in health care costs, the overall effects will be additive for the foreseeable future. This is for a number of reasons:

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[1] DEFRA website http://horizonscanning.defra.gov.uk/

[2] http://217.33.105.254/HORIZON_SCANNING_CENTRE/FANclub/NewsletterJuly05/Newsletter.html (linked to the Office for Science and Innovation)

[3] http://www.foresight.gov.uk/Previous_Rounds/Foresight_1999__2002/Healthcare/Reports/Healthcare_2020/index.html

[4] http://www.hm-treasury.gov.uk/consultations_and_legislation/wanless/consult_wanless_final.cfm

[5] Institute for the Future: Health and Healthcare 2010 http://www.iftf.org/docs/SR-794_Health_&_Health_Care_2010.pdf 2003

[6] Institute for the Future: Mapping Transformations in Health Technology http://www.iftf.org/docs/SR-776_Mapping_Trans_in_Health_Tech.pdf 2002

- As researchers find out more about normal and pathological processes they are 'discovering' new diseases and illness categories to treat and more points at which to intervene. This in turn will lead to a demand for more diagnostic testing and monitoring of individuals.

- Many new treatments are targeted at previously untreatable conditions.

- Although there is a move to ambulatory and home based care, the existing hospital activity is likely to be replaced with other high tech activity.

- The private sector will continue to seek high levels of return for their investment. As a result new developments are likely to be priced higher than existing treatments.

- Many new high cost treatments are not one off interventions, but are treatments which a patient might need to take for years, if not life long.

- There is a time lag between a new treatment or technology is introduced and the benefit that is realised.

The above will be compounded by an ageing population and a more demanding public.

What technologies are developed and how they spread very much depend on a range of social factors. These include: how research is funded (and therefore directed), how healthcare services are funded, the regulatory framework for bringing new technologies to market and the behaviors of consumers and healthcare professionals. There are a number of particularly important factors that will influence what technologies will be adopted by the NHS.

- The level of funding constraints. Although a public debate about the increasing costs of healthcare is desperately needed most experts generally feel that is will not happen. Any means to change the method of funding healthcare is unlikely to lead to any real impact on the problem and may well have unexpected inflationary effects.

- Demand for proof of cost-effectiveness. Most commentators believe that one of the major changes in the future will be increased demand for better information on the effectiveness of treatments using more relevant health outcomes. However, despite the fact that most Western countries have created institutions such as the National Institute of Health and Clinical Excellence – these institutions have not yet made any real impact on the nature of the evidence available. Furthermore, it would appear that there is a trend for trials being stopped early, and for media and public demand to drive decision making – regardless of the evidence. Issues of access, cost-effectiveness and reimbursement can be expected to remain highly political.

- New technologies frequently demand new care-delivery processes and professional skill sets. The need for greater flexibility in how healthcare is delivered remains a major challenge.

- How healthcare is regulated. The orphan drug legislation is a good example of how regulation has led to an unexpected explosion in 'orphan' treatments. The legislation has also probably led to overpricing in some instances and this, on the other hand, will restrict access.

In addition to changes that are anticipated within traditional healthcare there are two other interesting trends in the field of healthcare:

- The private provision of ***boutique medicine*** (preventative services, individual diagnostics, home diagnostics and health information) and ***complementary medicine*** is expected to increase.

- ***Health tourism*** is expected to increase both through private and public funding mechanisms. The recent Watts case in the European Court of Justice is evidence of the potential risks of health tourism to the NHS [7].

## 3. Specific developments

### Molecular biology

All areas of the biological sciences are advancing our knowledge of health and disease and thereby contribute to medical advances. However it is the study of the molecules of the body which are expected to have the greatest impact. There are four areas of particular interest:

- ***Genetics*** – the study of how human characteristics are inherited from one's parents.
- ***Genomics*** – the analysis of all the genes involved in the risk or causation of a disease or a trait.
- ***Proteomics*** – the analysis of al the proteins involved in risk or causation of the disease or trait. Genes make proteins and our understanding of their classification and function is being transformed, particularly since the mapping of the Human Genome.
- ***Nutrigenomics*** – the analysis of how and what we eat interacts with our genes.

In the past, searching for a drug was a drawn out process in which thousands of compounds were tested in the hope of finding an active substance of interest. Drug development has been transformed as a result of better understanding at the molecular level, advances in computer technology and better production techniques for complex molecules. This has ushered in the era of ***rational drug design***. Scientists can now predict the type of molecule that will interfere with disease processes, model the effectiveness of many thousand hypothetical molecules on the computer and then select and construct the most promising ones.

Drugs that are being developed are increasingly targeted at smaller patient populations. Herceptin, a drug for breast cancer, is an example of a drug targeted at a specific group of women with a genetic variant of the cancer.

Technological advances are leading to previously fatal conditions becoming chronic illnesses. Examples include some cancers and HIV. Technological developments are also making it possible for treatment in many instances to be more ambulatory. For example, in the area of cancer a large number of the new treatments in development are oral formulations.

The above contribute to the forces which are pushing healthcare to ever more ***personalised healthcare*** (the others being consumerism, the philosophy of a more patient focused service and approaches to the management strategies that are being adopted for long term conditions).

[7] http://www.curia.europa.eu/en/actu/communiques/cp06/aff/cp060042en.pdf

As well as more individualised treatment, it is anticipated that a new specialty of medicine will emerge, that of ***predictive or prospective medicine***. Increasingly it will be possible to give a probabilistic health history for the individual based on their genetic makeup. This will lead to specific primary prevention strategies designed to influence the emergence of illness and disease. Although it is recognised that our genetic profile is not deterministic it is quite clear that this development will have profound impact both on the impact, the concept of self and the interaction between the individual and Society.[8]

## Gene therapy

***Gene therapy*** is a therapeutic technique in which a functioning gene is inserted into targeted cells of a patient to correct genetic faults or to provide the cell with a new function. Much has been expected of gene therapy and although a great deal of effort has gone into research into this area, clinical advances have been limited. A major problem is delivering the right amount of genetic material to the right cells. There have been some limited clinical applications to date. It cannot be predicted at what stage the clinical applications of this technology will really take off.

## Vaccines

Historically vaccines have been used to prevent infectious diseases***.*** ***Therapeutic vaccines*** are increasingly being used for non-infectious diseases, particularly in the area of cancer therapy. Vaccines may be used to prevent the emergence of spread of cancer or to boost the response to other treatments. Therapeutic vaccines may also be developed for infectious diseases such as HIV and TB.

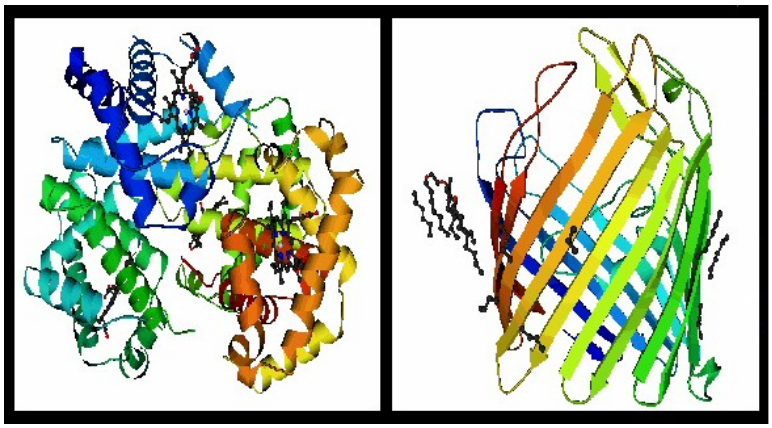
## Bioinformatics

Reference has already been made to how developments in information technology are transforming the search for new drugs, as result of a greater ability to model and measure biological phenomena. IBM has developed a series of supercomputers, the first being 'Blue Gene'. This spent a year predicting how one protein might fold. A protein's shape is intimately linked to its function and once this is understood rational drug design in greatly improved.

**Figure 1: Diagram of the folding of a protein [9]**

[8] There is an early example of this. There are a number of serious single gene disorders (e.g. Gaucher's disease) which have a very high prevalence in subsections of the Jewish population. A rabbi in the USA has taken the brave and extraordinary effect of encouraging couples in his local communities to have genetic testing before marriage. A number of couples have broken off their engagements as a result. http://www.newscientist.com/opinion/opinterview.jsp;jsessionid=GFGKKKLIOIPA?id=ns24341

[9] http://www.research.ibm.com/bluegene/sciapp.html



Bioinformatics not only helps with primary research but has also helped in developing a means to replicate molecules. This has practical and commercial benefits. This technology was adopted early in the identification of microorganisms – such as the test to identify which type of meningitis an individual has. These tests were the forerunners of the ***biochips*** which increasingly enable ever more rapid testing. It is expected, for example, that ***genechips*** will allow affordable near patient testing for specific genetic abnormalities in the future.

Equally revolutionary will be the development of wireless sensors which will enable ***continuous health monitoring*** of patients in their home environments. This is a form of ***telemedicine***. An example is ***intelligent clothing*** which is already in commercial use. For example a company in the USA has developed intelligent clothing to monitor babies breathing, oxygen, heart rate and temperature for special care baby units and for home use. [10]

## Health information and communications

***Cyberchondriacs*** are adults who have searched online for health information in the past year. Health information is changing. Increased access and exposure to more sophisticated health information is also influencing the interaction between the individual and healthcare services, and the patient and the healthcare professional. This is considered to be potentially one of the highest impact developments as the power dynamics alter. The Internet is the single main contributing technology. In 2002 one third of all searches on PUBMED the USA's National Library of Medicines Clinical Database was done by the public.

As well as general health information – patient information will also be increasingly more widely available to both the individual themselves and to healthcare professionals. Improved access to and the sharing of patient information should be possible although with this will come concern and controversy regarding issues of patient confidentially and individual privacy.

***Cybermedicine*** is also likely to increase – both through telemedicine and email communications.

The ever increasing information that is available presents two related challenges. The first is what is the scientific and health community going to do with all this data that we are only just learning to interpret? How will it be translated into meaningful information for the

[10] http://www.intelligentclothing.com/introduction.html

consulting room and for the individual patient? The second is how are we to improve the health literacy of the consumer? As healthcare becomes ever more consumer driven – the need for an informed population is urgent.

## Diagnostics

Some important developments in diagnostics have already been touched on. The impact of diagnostics equals that of treatment. Below are some others:

***Genetic testing*** – is the process of testing for the purpose of detecting genetic susceptibility or predisposition to, or determination of a condition or a disease.

***A biomarker*** – is an objective measure and evaluated as an indicator of normal biological processes, pathogenic processes or pharmacological responses to a therapeutic intervention.

***Pharmocogenomics*** – is the study of variability of patient responses to drugs and using human genetics variations to optimise drug discovery and development and patient treatment.

### *Imaging*

Advances are developing in all aspects of imaging:

- Energy source technology is improving which allows ever greater focus, thereby protecting adjacent tissues.

- Detector technology is developing both in terms of digital imaging and contrast media.

- Analysis of the images is increasingly using more sophisticated computer technology.

- Display technologies are getting bigger, faster and cheaper.

Some examples of developments in this area include:

- Electron-beam CT in combination with new contrast agents will lead to more rapid imaging, reducing discomfort for patients and enable ever greater visual detail. It will be possible for example to see narrowing in individual vessels.

- Harmonic imaging will overcome some of the current problems of undertaking ultrasound in some individuals as well as produce better images. Ultrasound may form the basis of cancer treatment in future by exploding 'loaded microbubbles' which have been added to contrast medium.

- Functional imaging will be developed further which will includes high resolution PET scans and functional MRI.

As imaging becomes ever more sophisticated there will be further advances in minimally invasive surgery or procedures.

## Tissue engineering

Tissue engineering combines the principles of life sciences and engineering in an effort to develop biological substitutes for damaged tissues and organs. This is a rapidly

developing field driven by the changing concepts of biocompatibility because replacing body parts or tissues requires inserting foreign material into the body. In recent years there has been a move from using inert substances to those interacting and integrating into the body.

***Tissue scaffolding*** is a three dimensional skeleton built out of a biodegradable polymer to which ***stem cells*** have been added and from which new tissue grows. Stem cells are pluripotent cells whose daughter cells have the potential to develop into any type of cell. An example is the use of bone scaffolding, embedded with either donor stem cells or the patient's own cells, to repair some broken bones.

Biocompatible polymers are also being used to improve drug delivery to the body.

Stem cell technology itself is finding wider applications – both as a research tool and as a treatment. This importance of this for the future is reflected by the fact that Sir Richard Branson is establishing a major stem cell storage facility. Treatment has already been established for blood disorders, diabetes (replacement of the pancreas) and burns victims.

### Artificial blood

The development of artificial blood reduces the risks of inadequate supply and disease transmission. Hemoglobin-free fluids carrying dissolved oxygen have been developed but they cannot as yet provide sufficient oxygenation. However, recombinant haemoglobin can now be produced and good blood substitutes may be produced in the near future.

## 4. Implications

1. New developments will be overwhelmingly additive in terms of healthcare costs. Some will be major beneficial advances but many others will provide only incremental benefits at the margins. We are also likely to see increasingly useful technologies, however cost-effective, being unaffordable. There is a risk that health technologies will squeeze out care services and primary prevention. This is already starting to happen. It is absolutely vital that the PCT establishes extremely robust, confident, fair and open priority setting in order to ensure that resources are used in the best way and enable balanced healthcare to be provided. The challenges of providing a public funded healthcare service in the context of an ever increasing consumer model of healthcare is already in evidence.

2. More and more life threatening diseases will become treatable. This may reduce the burden of disease by curing the condition. In other instances it will increase morbidity as a life threatening disease becomes a chronic condition. A really big challenge is the number of individuals who are now surviving health crisis and serious illness with major disabilities.

3. Ambulatory, community and home based services will increase. The belief that this will dramatically reduce demand for inpatient capacity is probably overstating the case.

4. The major areas of technological growth will be new drugs, diagnostics and increased monitoring requirements. The latter two – particularly – have not always undergone the same scrutiny as new treatments in terms of assessing their benefits. This needs to change.

5. One of the major challenges is going to be the creation of more flexible healthcare services. There is an ever increasing need for more rapid transfer of knowledge, more

consistent adoption of good practice and changes in both what individuals do, the skill mix and the location of work. Interests and personal and organisational resistance to change, however, remain a feature of the NHS landscape.

6. The interaction between the public and individuals and the healthcare system will also have a dramatic effect. Much of this will be positive but unless we are able to increase the health literacy of the public – it is likely to have negative effects – such as demand for expensive treatments of low efficacy. In addition there will be an increasing drive to medicalise health and well being.

7. Many of the new advances will present Society with new ethical challenges that both local and national decision makers will need to be confident to manage.

## 5. Final comment

This document has focused on specific technological developments which will have an impact on healthcare in the future. The eventual impact cannot be predicted and depends as much as anything on capacity in the system to comprehensively plan and deliver changes, the ability to introduce major new information systems into healthcare, the ability of health and social economies to rationally plan and implement change and the capability for increased flexibility within healthcare provision. The sustainability of healthcare services depends heavily on a healthy economy and a society which promotes health rather than illness.

History would suggest that the potential of health technology to transform healthcare and health as described in Foresight's *Healthcare 2020* is profoundly optimistic. Some dramatic changes can be envisaged – but it is unlikely that this change will occur in the planned, systematic and cooperative way needed. Furthermore, despite all the technological advances that we might expect in the next 10 -15 years, the really big health challenges will remain, the 'technologically mundane': obesity, smoking, alcohol and mental and social wellbeing.

## Appendix

The following diagram is presented which maps out the Institute of the Future's view of the timing of certain technological developments, as viewed in 2003.

### Forecast Timeline for a Range of Genetic Technologies