TECHNOLOGY IN THE NHS

Transforming the patient's experience of care

Alasdair Liddell, Stephen Adshead and Ellen Burgess

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For the last 10 years NHS Direct has delivered 24-hour health advice and information through a range of innovative technologies. NHS Direct has developed a national ICT infrastructure from which to deliver its 0845 4647 telephone advice and information service. Its website receives over 3 million visits each month. NHS Direct was the first public sector or health care service to embrace interactive digital TV technology with services now available on both Sky and Freeview.

Summary

Despite the potential benefits of technology, it is generally acknowledged that its adoption within the health care sector is slow and disparate. The Healthcare Industries Task Force, for example, described the National Health Service (NHS) as 'a late and slow adopter of technology' (Healthcare Industries Task Force 2004).

The NHS Next Stage Review interim report in 2007 emphasised the importance of technology in the NHS and highlighted the role that technology can play in improving health outcomes (Department of Health 2007b), but much remains to be done to give effect to the aspirations set out in the final report, *High Quality Care For All* (Department of Health 2008a), and the associated regional plans.

The study we have undertaken builds on current work in this area, and aims to improve the uptake of useful consumer-facing technology in health care by analysing the main barriers to adoption and suggesting measures to overcome them.

We begin (Chapter 2) by describing an ideal scenario for the adoption of technology in health care, looking ahead over the forthcoming decade to illustrate its potential to contribute to better clinical outcomes, to improve the patient experience and to provide economic benefits.

We give examples of the kind of technologies that might be available (although few of these are actually dependent on all the features of the ideal scenario).

The main part of our report, Chapter 4, analyses the principal factors, both positive and negative, that influence decisions to adopt technology, including the following.

- **The ability of the vendors of technology to build an investment case and attract funding** Core to this is the perceived market opportunity within the NHS. This is often seen as being unattractive due to the complex selling process and the diversity of buying points.
- **The level of engagement between technology suppliers and the NHS** The commissioning process within the NHS is seen as fragmented and complex, and varies between commissioning groups. Every commissioning group has a different set of requirements against which it assesses new business cases for technologies.
- **The availability of agreed technology standards** These are essential, especially where interoperability is important.
- **Consumer awareness of technology and understanding of the benefits that it can bring** Consumer demand is an important driver for the adoption of technology as consumers become more empowered and more demanding about the kinds of treatment they want.
- **Consumer concerns about confidentiality and usability** This concern might be greater than the real level of risk, but it remains a significant barrier to uptake.

- **Government policy** Policy can have an impact on the adoption of technology either directly, by setting guidance or targets, or indirectly, by setting objectives that could be met via technology.
- **Management leadership and direction** Strong leadership is required at national and local level to create a climate in which local managers feel encouraged to participate in the testing of technology solutions, and to adopt them where positive outcomes have been demonstrated**.**
- **Structures to assess and trial technology and encourage adoption, such as the National Institute for Health and Clinical Excellence (NICE), the NHS National Innovation Centre (NIC), and the innovation hubs** If working well, these mechanisms act as filters for new technology and then as catalysts for adoption.
- **Efficiency of information sharing within the health service** Technological innovations will spread most effectively within the health service if the flow of information about them is free and efficient, so that potential buyers and users know about the technologies, their potential benefits and how to implement them.
- **Effectiveness of procurement and decision-making** The procurement process within the NHS is highly complex, presenting many barriers to the adoption of technology. These include multiple points of sale, extended and complex procurement processes, and a tendency to focus on 'least cost' rather than 'best value'.
- **Resources: funding and people** The availability of resources, both financial and organisational, affects the ability of the health service to change across the range of its activities, including the use of technology.

Chapter 4 reviews the various models for the adoption and dissemination of technology, from the 'top-down', centrally mandated approach, through local management-driven initiatives and uptake by professionals, to uptake by consumers. The main barriers to adoption across these models are identified as:

- lack of resources (people, management and funding)
- lack of leadership from the centre (potentially remedied by the new commitments to innovation in *High Quality Care For All* [Department of Health 2008a])
- a tendency to assess new technologies on a 'least cost' rather than 'best value' basis
- the requirement to manage a change in service strategy that may be enabled or necessitated by a new technology
- the complexity of the decision-making process, the diversity of buying points, and the inability of commissioners to take a sufficiently long-term view.

Chapter 5 sets out our recommendations. These are as follows.

Recommendations

National leadership

- The Department of Health should provide clear, consistent and sustained Ministerial and Board level leadership on the use of technology in health care. In this regard, the main leadership roles of the department include:
  - supporting the recently established Health Innovation Council, which brings together key health sector technology interests, and ensuring its recommendations are implemented

- co-ordinating the activities of the various national bodies and agencies that have a technology remit, including the NHS Institute for Innovation and Improvement, the NIC, NHS Connecting for Health, the National Programme for IT (NPfIT), the NHS research and development (R&D) programme, and the local innovation hubs
- ensuring that the appropriate use of technology is considered an integral part of all policy development within the department
- ensuring that active steps are taken to increase and accelerate the technology assessments carried out by NICE, to implement the results, and to roll out technologies from successful trials
- reviewing national procurement processes to ensure they are structured to facilitate the uptake of innovation and the adoption of appropriate technology, based on a 'best value' approach
- consolidating access to central pump-priming, R&D and innovation funding to provide a 'one-stop shop' for the funding of new technology
- developing a 'manifesto' for the use of technology in the NHS, perhaps including a list of '10 high-impact changes' for technology, as proposed by the NHS Modernisation Agency (2004).

Local performance

- There is a number of mechanisms for ensuring that the adoption of innovation and technology remains high on the agenda for local NHS organisations, not the least of these being the new legal duty on strategic health authorities to promote innovation, announced in *High Quality Care For All* (Department of Health 2008a), and the annual NHS Operating Framework, which sets out the national priorities for the coming year (Department of Health 2007c).
- Convenience and access are important outcomes. The extent to which local public services use innovation and technology to improve the customer experience and provide more convenient access to services should be routinely measured and reported.
- The new Comprehensive Area Assessment (CAA) process seeks to provide an annual, holistic, independent assessment of the prospects for local areas and the quality of life of people living there. The answer to the central question posed by the CAA – 'what is it like to live in my area?' – must, of course, deal with key requirements such as safety, access to employment, education, housing and fresh food; but it could also look at how technology and innovation is improving the quality of life by providing better and more convenient access to public services, enabling and supporting healthy living, and enabling treatment and care to be delivered at or closer to home, especially for older people and those living with long-term conditions who otherwise might have to be cared for in an institutional setting.

Funding mechanisms

- Commissioners and providers should recognise that investment in technology might have relatively long timescales for payback, and must manage the investment funding accordingly.
- Transition funding for the adoption of new technologies should be made available at national, regional and local levels in order to cover short-term implementation and

double running costs. Funding could be in the form of a loan, repayable on the basis of an agreed schedule.

- Commissioners should take the lead in ensuring that the effects of 'silo budgeting' (where the costs and benefits of implementing technology fall to different budgets) do not inhibit the adoption of appropriate technology. This would normally take the form of adjusting provider contracts to shift resources from a provider making savings to one incurring costs as a result of the adoption of technology.
- The Department should consider steps to limit the adverse effects of silo budgeting on the adoption of technology as part of its regular review of Payment by Results.

Better management of the trial process

- NICE's technology assessment programme can address only a limited number of new technologies (although we have recommended an increase in its capacity to undertake assessment of technology). There need to be more informal mechanisms for assessing the costs, benefits and risks of new technologies, which could then be subject to post-implementation evaluation to confirm or revise the initial assessment.
- Before a trial of technology is undertaken, there should be a mechanism that ensures that the trial adds value to the existing technology landscape. This could be overseen by the regional innovation hubs.
- The trial manager should provide commitment that the trial will both contribute towards the evidence base and be appropriately acted on.

Better communication with consumers

- NHS trusts, primary care trusts (PCTs), managers and clinicians should actively communicate the benefits of and promote the use of technologies that can improve patient outcomes and patient experience (including those that offer more convenient access to and transactions with the health system).
- Clinicians – in hospitals and community settings – should encourage patients to make full use of the technology available, for information, transactions and monitoring where this is appropriate to their condition.
- Technology (especially consumer-facing technology) should be targeted appropriately to ensure maximum uptake. This will mean initially targeting those most likely to embrace the service (for example, as a result of information technology literacy, value or convenience). The aim should be to develop a critical mass of users sufficient to generate a 'viral marketing' effect to drive uptake on a wider basis.

Strengthening the NHS/industry partnership

- The NHS Institute and NIC should provide industry with accurate and up-to-date advice about how and where to present its business case for new technology in order to maximise the adoption of technologies that can benefit patients and the public.
- Those seeking to sell their technologies to the NHS should develop an evidence-based business case that demonstrates value in terms that are relevant to the purchasing decision-maker.
- The NIC should run a series of 'showcase events' on a rolling basis, targeting not just those interested in technology and innovation, but a wider range of potential clinical and management decision-makers.

1 Introduction

Context

Demographic changes are placing an increasing burden on the health service. An ageing population and an increase in chronic disease and in behaviours that are detrimental to health mean that there is an increasing demand for health care services. In his first review of future spending, Sir Derek Wanless concluded that over the next 20 years the United Kingdom (UK) would need to devote substantially more resources to its health care system in order to ensure high-quality services that meet public expectations (Wanless 2002).

In a more recent report, Sir Derek concluded that technology and medical advances had contributed around two percentage points to the annual rate of growth of health spending over the previous 20 years, and suggested that over the next two decades spending on technology would need to grow at an even faster rate to catch up – and keep up – with that of other countries (Wanless 2007). The European Commission has also called for a 'new health care delivery model [which] can only be achieved through the proper use of [information and communication technologies], in combination with appropriate organisational changes and skills' (European Commission 2006).

The importance of technology and information technology (IT) systems in meeting the challenges placed on the health care system is becoming increasingly apparent. In 1998, recognising the changing nature of technology – and its increasing potential for interconnectivity – the then National Health Service (NHS) Executive published *Information for Health: An information strategy for the modern NHS 1998–2005* (Department of Health 1998a). This strategy laid the groundwork for more recent initiatives, and set out a commitment to develop the following:

- **electronic health records**, providing round-the-clock access to summary information about the care of individual patients
- **electronic patient records**, built to common standards, recording more detailed information about the treatment and care of patients within hospitals
- **a technical infrastructure**, including an NHS-wide network, a dictionary of clinical terms and a strategic messaging service
- improved clinician and public access to **evidence-based health and health care information**, through the National Electronic Library for Health and NHS Direct
- guidelines to promote the greater use of **telemedicine and telecare**.

The National Programme for IT (now called Connecting for Health) was formally established in 2002, with a renewed commitment to replacing the fragmented approach to NHS IT with standardised interconnecting systems. The main elements of the programme are:

- **The NHS Care Records Service:** a system of individual electronic health records for patients linked to a national spine through which summary records can be accessed by authorised professionals and consumers through HealthSpace. Since spring 2007,

early adopter sites have been testing the linking of electronic patient records enabled by the NHS Care Records Service.

- **Choose and Book:** an electronic appointments booking service, allowing a choice of hospital and appointment dates and times. More than 97 per cent of general practitioner (GP) practices can now use Choose and Book to make referrals, and approximately 40 per cent of all referrals to specialist care go through the Choose and Book system.
- **Electronic Prescription Service (EPS):** a system to streamline the issuing, dispensing and reimbursement of prescriptions. Progress so far has been slow: where the EPS has been implemented, only 10 per cent of prescriptions are being sent through the EPS, and only 2 per cent of those are being dispensed via the EPS.
- **N3:** a national broadband IT network for the NHS that is in the process of roll-out.
- **Picture Archiving and Communications Systems (PACS):** a storage database for digital images such as magnetic resonance imaging (MRI) scans and x-rays. The roll-out of PACS to all NHS trusts was completed in late 2007.
- **NHSmail:** an email system for NHS staff. The system currently has 153,000 active users (12 per cent of the 1.3 million NHS workforce).

The National Programme for IT has experienced issues with implementation, interoperability, costs and timescales. In 2007, a report from The King's Fund, led by Sir Derek Wanless, called for 'detailed external scrutiny [of Connecting for Health] so that forecasting of long-term costs and benefits [of IT within the NHS] can be made with more confidence' (Wanless 2007).

Moreover, the programme's focus on infrastructure services – though a necessary pre-condition for an 'e-enabled' NHS – has tended to eclipse the development of more consumer-facing technologies, such as telemedicine and telecare, the full potential of which has yet to be realised. This, and the delays to the major infrastructure projects, has contributed to the general perception that the adoption of technology within the health care sector is slow and disparate. The Healthcare Industries Task Force, for example, described the NHS as 'a late and slow adopter of technology' (Healthcare Industries Task Force 2004).

In the interim report of his Next Stage Review of the NHS, Lord Darzi emphasised the importance of technology in the NHS and highlighted the role that technology can play in improving health outcomes (Department of Health 2007b). In the review's final report, Lord Darzi examined how to overcome the 'NHS reluctance' to adopt new technologies and how to achieve better use of IT (Department of Health 2008a). Key commitments include:

- extension of the **NHS Choices website** to provide more information about services, to support informed choice
- development of **NHS Evidence**, a new portal through which anyone will be able to access clinical and non-clinical evidence and best practice
- the continued role of the **Health Innovation Council** to champion innovation for the NHS
- a new **legal duty** on strategic health authorities (SHAs) to promote innovation, with new innovation funds to be held by SHAs, and new prizes for innovations that directly benefit patients and the public

- the creation of **health innovation and education clusters** to set strategic goals across organisations and to run joint innovation programmes.

Objectives and structure of the report

This review builds on current work in this area and aims to improve the uptake of useful consumer-facing technology in health care by analysing the main barriers to adoption and suggesting measures to overcome them.

We begin by describing an 'ideal scenario' for the use of health care technology and reviewing the conditions likely to be most favourable for the adoption of technology, to illustrate the potential benefits that might accrue to patients and the public.

Chapter 3 of the report analyses the factors that influence the adoption of technology, and Chapter 4 goes on to identify the most important barriers to adoption. Chapter 5 sets out our recommendations for overcoming these barriers and improving the adoption of technology.

Our approach

We undertook a dialogue with key stakeholders to identify the important issues that determine whether and how technology is adopted. Given the broad scope of the review and the complexity of the issues involved, we did not attempt to conduct a detailed literature review or a comprehensive survey of the use of technology within the health service. We used the following approaches to inform our thinking:

- desk research: high-level review of key literature, search of press reports
- interviews with health, technology and futures experts
- workshop with representative stakeholders: suppliers, clinicians and patient groups.

We are grateful for the support of all those who took part in interviews and the workshop. See Appendix 3 for a list of interviewees and workshop participants. We expect the report to be of interest to commissioners and providers of health services, suppliers of technology and to policy-makers. Our recommendations refer to the health sector in England.

Scope and definitions

We have defined 'technology' as any device, product, service or application with an IT element. This review includes all health care technologies, both wired and wireless, that occur at the consumer interface. We have defined technologies at the consumer interface as business-to-consumer (B2C) and consumer-to-consumer (C2C) technologies. Business-to-business (B2B) technologies, such as IT infrastructures, and advanced medical equipment that does not directly interface with the consumer, such as operating theatre equipment, is not included within our scope.

We have considered technologies that interface with consumers at all stages of their health care experience: maintaining health, receiving care, and managing a condition. In this review, 'e-health' is defined as health care practice supported by electronic processes and information communication systems. 'Telecare' is the continuous, automatic and remote monitoring of real-time emergencies and lifestyle changes over time in order to manage the risks associated with independent living. 'Telemedicine' is the practice of medical care using interactive audiovisual and data communications. 'Telehealth' monitoring is the remote exchange of physiological data between a patient at home and medical staff at a hospital or clinic to assist in diagnosis and monitoring.

We have defined 'health' widely as all activities related to health and well-being. It therefore includes all formal provision of health care (by both the NHS and independent-sector providers), as well as informal or individual preventive care, self-care and discretionary health care. Where health care and social care intersect (such as in the provision of telecare services to older people) we have included this in our scope.

2 The ideal scenario

Technology can help to respond to the burden of current demographic changes as well as serve a range of consumer health care needs. This chapter describes how technology could be used to benefit consumers in an ideal scenario in 2018. We have chosen a 10-year timeframe to provide a forward-looking view over a period that is sufficiently long to make change on a large scale feasible. We set out the benefits that technology can bring to health care consumers, the health sector and society more generally. Where specific medical conditions are mentioned, we have focused on:

- chronic obstructive pulmonary disease (COPD)
- diabetes
- elderly people with multiple chronic diseases
- emergency care.

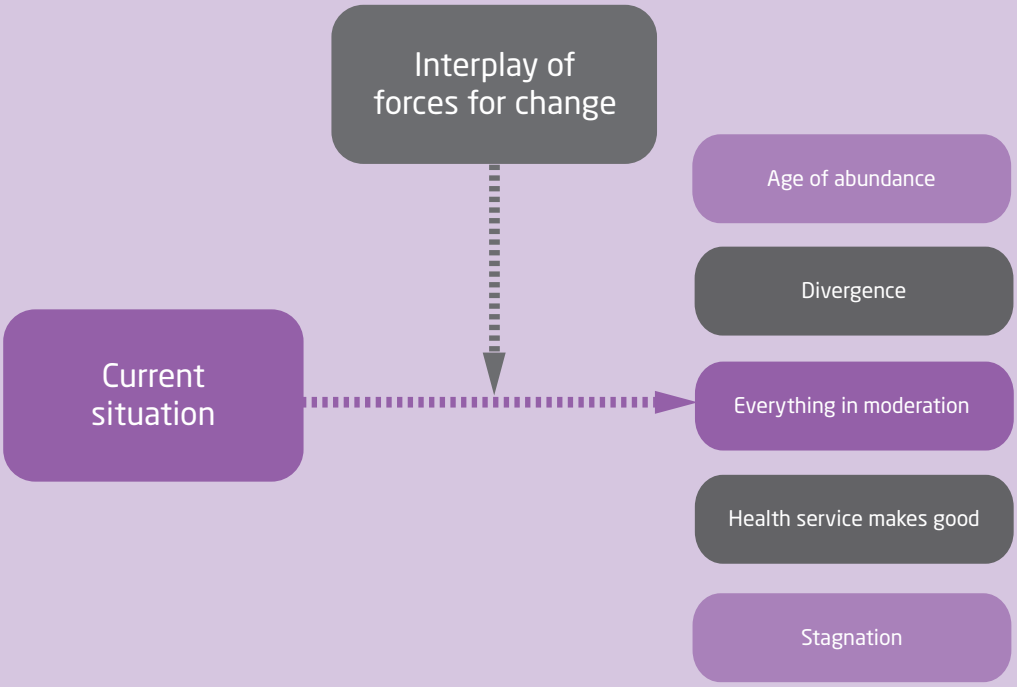
This work builds on the Office of Communications (Ofcom) health and socio-economic and technology scenarios development study (Ofcom 2008), which was designed to inform Ofcom's estimates of the likely future wireless spectrum requirements of the UK's health sector. In order to determine what these requirements might be, the review team generated five plausible scenarios depicting alternative futures for the use of technology by the health system over the next 10–20 years (*see* Figure 1 overleaf). Each scenario was self-contained and plausible, but based on different assumptions about the impact of a number of key variables, which were termed 'super forces'. The super forces were:

- economic growth and funding
- technological progress and rate of uptake
- structure of the health care system
- personal engagement
- use of information
- level of morbidity.

Some of the super forces, such as economic growth, are outside the control the health care sectors. The focus of this report is on issues that can be controlled and acted on within the sector.

In this study we use the scenario that was judged to be the most positive in enabling the productive use of health technology (described as the 'age of abundance' in the Ofcom study) as the basis for identifying what needs to be done to enable the health sector to achieve the most effective use of technology to support the delivery of better health and health care for patients and the public.

Figure 1 Scenario development methodology (Ofcom study)



The 'age of abundance' scenario

The 'age of abundance' scenario paints a picture of a world in which the conditions for the adoption of technology in health care are optimal.

- Economic growth and health service funding are high, filtering through to the funding of technology.
- Technological progress is fast due to high levels of research and development (R&D).
- NHS staff and patients not only accept technology but have come to expect it to be used within all stages of health care delivery.
- Interfaces have become highly intuitive, and clinical and administrative staff and consumers are able to use a wide number of new technologies with minimal formal training.
- Large-scale, secure and safe information sharing has been enabled by the implementation and success of information systems, such as the National Programme for Information Technology (NPfIT), and communication systems, such as the fibreoptic N3 project.
- It is commonplace for health information to be collected in real time, collated and analysed, transforming it from information to actionable knowledge (both at the level of an individual patient and at the aggregated level, where information provides evidence of the effectiveness of alternative interventions to promote health, prevent illness and tackle ill health).
- People have a high level of disposable income, which they can spend on discretionary health care products.

The ideal scenario for the adoption of technology in the health sector in 2018 is one that assumes that the benefits of technology are fully optimised given the resources available. From a consumer perspective the ideal scenario could be described as follows.

Technology is widely adopted in the health sector. Where there is a consumer need that could be better met using technology than using other solutions, the technological solution is implemented. The level of adoption of technology is comparable with that of other industry sectors. When consumers interface with the health service they feel that the experience is as good as or better than it is in the financial services or travel sectors, for example. Consumers are able to choose the technology that is right for them individually, and the provision of technology is sufficiently flexible to cater for the wide range of needs, abilities, and use of existing technologies seen in the population.

The health sector is technologically innovative. There is substantial investment in R&D to fund development of innovative health technologies, and technology is used in innovative ways to improve the consumer experience of health care. Providers of health services are able to respond to new technological developments swiftly, and build upon existing technologies (such as developing new applications on existing platforms) in order continuously to improve the adoption of technology.

The benefits of adopting technology are fully harnessed; clinicians and other staff within the sector, as well as consumers, are comfortable using technology and do make full use of it. The use of technology enables improvements in the quality of care received by patients, in addition to offering an improvement in their overall experience of contact with the health service.

The use of technology allows the resources of the health service to stretch further, enabling it to keep pace with the increasing demands placed upon it (for example, ageing population, increased morbidity).

The consumer experience of technology in the ideal scenario will vary from individual to individual as we believe that consumers should have the choice to adopt the technology (or other solution) that best suits their situation and needs.

Consumer health care needs

Consumers have several health care needs that could be supported or enabled by the use of technology. These are:

- information and advice
- administration and transactions
- consultations and clinical care
- diagnosis
- monitoring
- relationships.

Information and advice

In managing their care, consumers need information and advice from clinical professionals and other consumers or third parties. Such information may be on general

Table 1 Consumer needs

Need	Examples of technological needs	Examples of the application of technology
Information and advice	■ Access to health information ■ Storage of and access to personal health information ■ Managing self-care	■ NHS Direct Online, NHS Choices ■ Google Health Records (Google Health website) ■ Microsoft HealthVault
Administration and transactions	■ Making and managing appointments ■ Managing prescriptions	■ Choose and Book service ■ Managing prescriptions online
Diagnosis	■ Remote diagnosis ■ Self-diagnosis	■ 'Walk in' cholesterol testing service at pharmacies ■ Plasma glucose test
Consultations and clinical care	■ Communicating with clinicians remotely ■ Providing more services in the home ■ Providing therapy remotely	■ Instant messenger-web chat ■ Videoconferencing with clinician, eg, Health Presence (Cisco Systems website)
Monitoring	■ Monitoring of vital signs ■ Lifestyle monitoring ■ Safety and security monitoring ■ Communicating and responding to monitors ■ Public health monitoring	■ Motion sensors to monitor activities of daily living ■ Sensors to monitor vital signs or other parameters, eg, oxygen levels, blood glucose
Relationships	■ Relationship with carers/clinicians ■ Relationship with family	■ Hub enables communication with carer and family

or specific health care issues, supporting self-treatment or self-care, or allowing access or contribution to personal health records.

Administration and transactions

Consumers may need to perform administrative tasks to manage their care, such as making appointments, receiving referrals and ordering prescriptions. Such administrative tasks are often similar in nature to those commonly performed by consumers in other sectors.

Consultations and clinical care

Consultations traditionally take place face to face in a hospital, a general practitioner's (GP) surgery, the home, or in an emergency context. Technology can allow the clinician to consult with the patient remotely, and could improve communication in emergency situations, such as between an ambulance and a hospital.

Diagnosis

The diagnosis of a condition is a crucial part of the care pathway. It is a complex process, based on clinical experience and research, signs, symptoms and context. Diagnostic technologies are traditionally used by the clinician in a hospital or clinical setting. There are, however, an increasing number of diagnostic technologies available directly to the consumer.

Monitoring

An ageing population, an increase in morbidity, a shortage of care workers and an emphasis on care in the community present a need for patient monitoring. The nature

of this monitoring, and the parameters actually monitored, are directly dependent on the individual context and condition of a patient.

Relationships

An important patient need – and one that is often omitted in the context of technology – is that of the patient's relationships with carers, clinicians, peers and family.

The patient–clinician relationship is central to the practice of medicine and is essential for the delivery of high-quality health care in the diagnosis and treatment of disease, and recovery from it (General Medical Council 2006).

It is also generally agreed in the literature that the relationship between the patient and the family/other supportive people has a positive effect on general health and patient recovery (Iles 2003).

As technology can enable better communication between patients, their carers and their families, it could be argued that technology should play an increasingly important role in patients' relationships with their carers and families in the future.

Table 1 opposite summarises consumer health care needs, and gives examples of technological applications that meet those needs.

Table 2 Examples of health care technologies in the ideal scenario, 2018

Need	Technology	Description
Information and advice	Nutritional content scanner	The barcode on food items is scanned using a reader on a mobile telephone (or other device). Nutritional information is then displayed on the reader, alongside advice from a health practitioner, when appropriate. For example, if the patient is diabetic, more in-depth information could be displayed about the sugar content.
Administration and transactions	Electronic prescription services	The Electronic Prescription Service enables prescribers to send prescriptions electronically to a dispenser (such as a pharmacy) of the patient's choice.
Consultations and clinical care	Doctor's e-bag	Portable computers specifically designed for health care professionals include basic diagnostic testing equipment as well as decision support systems and access to online medical records, etc. They also include technology for video and imagery.
Diagnosis	MMS* photos to health services	Consumers send MMS messages to health services (eg, NHS Direct) to help with the diagnosis of conditions.
Monitoring	Fall detectors and alarms	Alarms can be triggered either by patients themselves after they have fallen, or by an accelerometer or other technology that can detect a fall. The alarm includes a microphone and speaker that allows the wearer to talk to someone in a call centre. This technology would usually be found in the home, but could be deployed in care homes, hospitals at night, etc.
Relationships	Videoconferencing with family	The patient communicates with family and friends using video. The device could be a computer, mobile telephone, telecare hub or other device. Videoconferencing provides a richer experience than using the telephone.

**MMS, multimedia messaging service*

How technology would impact on the primary care experience of a health care consumer under the ideal scenario

- A home hub enables all forms of communication to and from a consumer's home. The hub may be a dedicated health care device, or may take the form of a more generic communication device. The hub supports various communication protocols and interface devices, including mobile devices. Sensors and health care devices, such as blood glucose monitors, can be permanently connected to the appropriate monitoring service through the hub.
- The home hub provides access to information and advice, and facilitates transactional services. For example, consumers may access their electronic health records or health information through the home hub's internet connection.
- If required, the consumer can communicate with a clinician, carer or monitoring service through the home hub, which supports video telephony and email.
- Peripheral devices can be attached to the home hub. For example, a home diagnostic centre can perform a range of diagnostic tests. The test data and other contextual information are sent to a monitoring centre. Once authenticated, the centre provides suggestions on appropriate next steps. It is linked to both automatic and managed decision support and triage services.
- A hand-held communicator is a hand-held mobile health care device that can be used in the home or any situation. It has similar functionality to the home hub. For example, it can deliver health and social care information.
- Smart medication ensures that medication is delivered as prescribed and measures relevant parameters. For example, a smart inhaler could check and record that it is being used correctly, simultaneously measuring the respiratory function. Smart medication may communicate with a monitoring centre via the home hub. The centre is alerted if the medication is not administered correctly.
- Surgically implanted sensors are small biocompatible devices powered by miniature cells that are designed to monitor the state of a medical device, transplanted organ or joint. They communicate with the monitoring service via a receiver worn outside the body and the hand-held communicator.
- Medical bracelets contain digital information on a patient's identity and a summary of his or her medical information, including allergies, medication and other facts that might influence a clinical decision. The bracelets can take the form of jewellery or be incorporated into a watch. More advanced versions can monitor vital signs.

The supply of health care technologies

There are many technologies available or in the pipeline that have potential applications in health care (*see* Appendix B). Table 2 (below) presents a few examples to illustrate how health care consumers might be using technology by 2018.

The box above looks at what the consumer experience of primary care might be like in the ideal scenario.

The impact of the use of technology in health care

Technology can bring many benefits to consumers directly and indirectly through improvements in service and outcome. Technology has the ability to support clinical staff (for example, by making records available instantly, and providing access to searchable knowledge bases), and to meet patient needs (for example, by enabling online appointment booking, and providing easier access to information about health and health care). At the same time, technology can bring economic benefits, freeing up resources for use elsewhere in the health system.

These benefits can be broadly divided into three areas:

- a contribution to better clinical outcomes
- an improved patient experience
- economic benefits.

Better clinical outcomes

Technology can contribute to better clinical outcomes by:

- facilitating better continuity of care
- providing clinicians with access to knowledge about effective interventions
- providing patients and carers with access to information to support choice, self-management and self-care
- encouraging patient engagement
- placing an emphasis on prevention, rather than cure.

The electronic health record 'follows the patient' and enables staff treating or caring for patients to have access to information about them, improving diagnosis and care. For clinicians, online access to research outcomes, guidelines and protocols on searchable databases allows easier reference to the current knowledge base. Technology also facilitates preventive care. For example, monitoring an individual's vital signs (such as weight, blood sugar or respiratory function) can prevent unnecessary hospital admissions.

Technology can also help patients to understand more about their condition and encourages patient engagement, which can lead to better clinical outcomes. Preventive care matters because if the NHS can support people to make healthier choices, they can avoid ill health (Department of Health 2007b). The benefits of a population with increased knowledge about health and increased understanding of disease are well recognised (Royal Society 2006). The use of modern electronic media to deliver information, mould attitudes and change behaviour is a significant new means of managing health care and is an example of how technology can be used in way that has a lasting impact (World Health Organization 2003). Furthermore, the role of health care professionals is changing to incorporate this: many doctors refer their patients to online health information websites, which enable patients to be better informed.

The overuse of technology can, however, have some adverse effects, such as in the case of home diagnostic testing technologies. There is a danger that too much testing within a population can result in a level of 'false positives' that may outweigh the benefits of a testing programme. Furthermore, information from many home testing kits and full body scans is usually not clinically useful and is not designed for use by people with no symptoms or elevated risk. Many doctors and scientists agree that well people do not need to be tested for disease (Sense about Science 2008).

Improved patient experience

Technology can improve patients' experience of health care at all stages of the care pathway. This is mainly due to the fact that technology enables improved communication between consumers and the health care system. Perhaps one of the major benefits is greater convenience in accessing information, transacting administrative tasks, and reducing the need for routine visits to the doctor's surgery, clinic or hospital.

Technology provides channels through which consumers can access health information about their local area, such as the NHS Choices mobile directory (NHS Choices website). Feedback services, such as those provided by Patient Opinion (see website), provide consumers with a voice and empower patients to change the way health care is delivered. Online booking services and touch-screen patient check-in systems give patients more control of the consultation process and thus empower them (Technology in Action 2008).

Monitoring and alarm devices can help sustain an independent life at home for people who otherwise might have to be cared for in an institution, while devices to measure blood glucose or monitor the use of anticoagulants may save unnecessary visits to the clinic or surgery.

Technology may have an impact on the relationship between patients and their carers or clinicians in ways that may sometimes be perceived as counterproductive. For example, some doctors view the availability of online information to patients as a threat to the delicate balance of the patient–clinician relationship (Royal Society 2006). Patients, on the other hand, may be concerned that the relationship with their carers could be replaced by one with a machine.

Economic benefits

Technology can also bring economic benefits to both the health care system and to the broader economic context. Several technologies have been proven to provide cost savings, yet the economic benefits of other technologies are contested. However, health is a global economic issue. Economic growth, stability, human dignity and the fulfilment of human rights will be achieved only when people are given the opportunity to lead healthy lives (World Health Organization 2003). A healthy society is an economically productive society – absence from work, for example, costs the British economy around £12 billion annually (Health and Safety Executive 2006).

Economic benefits can be realised by enabling health care resources to be used more effectively. The interim report on the NHS Next Stage Review (Department of Health 2007b) recognised that better use of information technology can improve the effectiveness and safety of care. For instance, technology can facilitate preventive care (for example, telecare), more efficient administration, and travel savings for patients and carers. The NPfIT promises to bring financial and efficiency savings through improvements to technology systems and health services. The recurrent savings brought to the NHS by this programme are expected to be almost £120 million per year (Department of Health 2007a).

Technology enables administration within the health service to be more streamlined. For example, online appointment booking services reduce administrative loads (Technology in Action 2008), and automated appointment reminders also have potential to provide huge cost savings to the health service. Trials have shown that text message (short message service, SMS) reminders lead to a 30–50 per cent decline in missed hospital and doctor's appointments. If extrapolated, this could save the NHS in England £240–370 million a year (Vodafone Group 2006). The Electronic Prescription Service helps pharmacies to manage stock more effectively (Department of Health 2007a).

Preventive technologies can avoid costly hospital admissions. Telecare can help reduce hospital admissions by preventing minor incidents such as falls. In 1999, there were 648,000 fall-related injuries in people aged 60 and older, which cost £981 million (Audit Commission 2004).

People with chronic conditions, who account for the majority of hospital admissions, also take up time in GP clinics for routine checks, which, if they could be carried out at home, could spare the time of doctors and nurses in practices and help cut down on the number of times ill patients have to travel to a clinic.

However, technology can cause unanticipated costs and create new demands. For example, home-based monitoring of patients may generate a higher demand for clinical intervention (rather than the opposite, desired effect) either because it might expose genuinely unmet needs or because it might lead the 'worried well' to seek medical attention for reassurance (Royal Society 2006).

Furthermore, there is a tipping point at which the cost of collecting information from patients outweighs the benefits it provides, a point at which technology is no longer cost effective. Too much information can be disconcerting for both clinicians and patients – there can be too much to cope with and if the information cannot be acted on, there is little value in collecting it.

3 The adoption of technology in health care

This chapter reports on our analysis of the main factors that influence the decision to adopt technology. Our starting point is to identify the key decision-making events that determine whether a technology will be adopted: 'How does a good idea become a technology in widespread use by the health care consumer?'

The pathway from the laboratory to the general practitioner's (GP) surgery or patient's home is complex and differs for each kind of technology. However, at its most basic level it involves key decisions about whether to:

- develop and market a technology (made by technology suppliers)
- buy a technology (made by managers or users)
- use a technology (made by users – clinicians, consumers or both).

In practice, the situation is more complex: the technology adoption pathway is an iterative, non-linear process that involves multiple stages and stakeholders. Figure 2 below is a simplified model of the decision process, illustrating the key points that a technology must pass through before it is adopted by health care consumers.

The framework of factors influencing the adoption of technology

The key decisions in this process are influenced directly or indirectly by multiple factors. We have separately identified the factors within the National Health Service (NHS) (internal) and outside it (external on both the supply and demand side). The factors are complex, may be iterative, and may affect one another. Figure 3 overleaf illustrates how these various internal and external factors influence different stages of the decision pathway towards the adoption of technology.

Figure 2 Simplified model of the adoption of technology

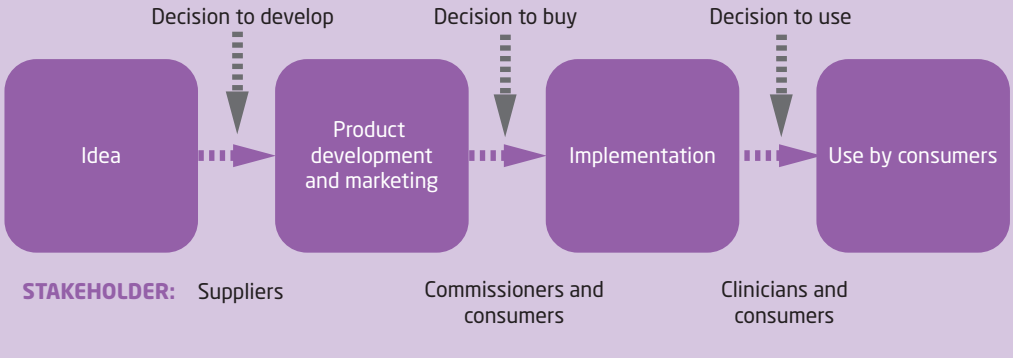
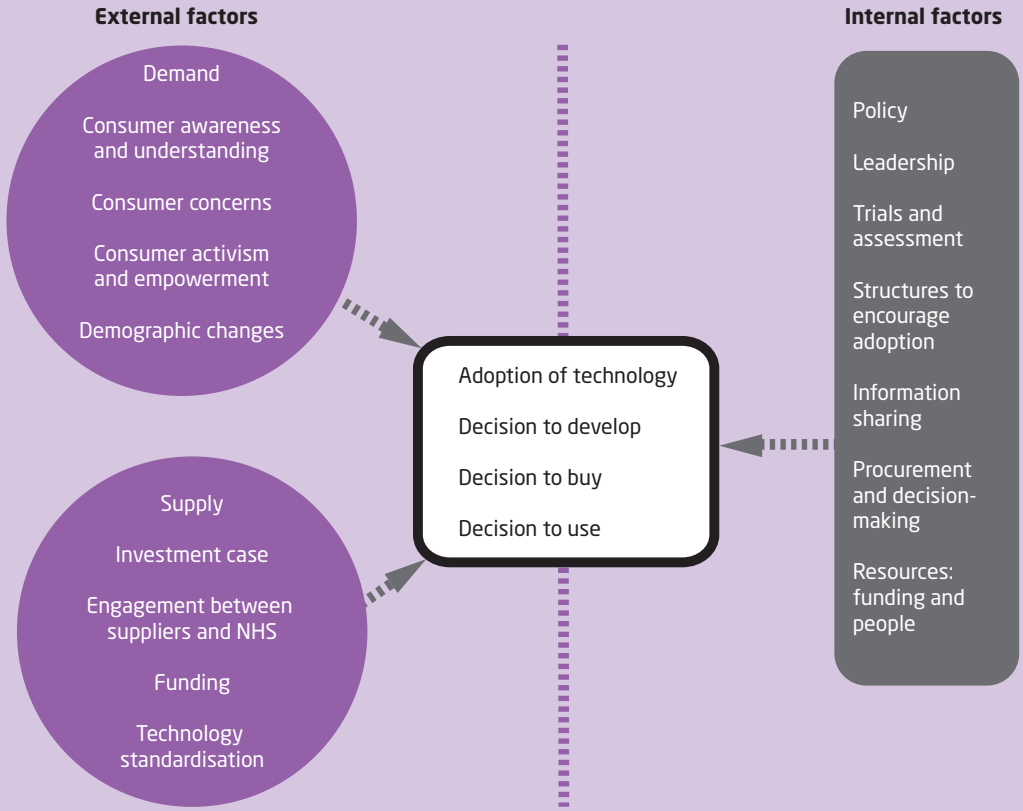


Figure 3 Factors affecting the adoption of technology in health care



External supply-side factors

On the supply-side are technology vendors (for example, device manufacturers, software developers and telecommunications companies) and some public organisations (for example, universities) involved in research. These organisations create a level of 'supply push': effective development and marketing of technology. The level of this push is determined by factors such as the investment case (risk:reward ratio) and the nature of the relationship between these organisations and health care buyers.

The ability to build an investment case and obtain funding

Making an investment case for technology development and marketing is important to get ideas off the drawing board and into the market. Broadly, two main types of investment are required:

- investment in fundamental research or the development of concepts with a speculative or long-term market opportunity – typically publicly funded or supported by large technology companies with a long-term view
- investment in product development and marketing for technologies with commercial potential – often privately funded.

The investment climate in each case strongly influences the likelihood of technology development.

Some public funds are dedicated to the development of ideas within health care. For example, NHS Innovation London's (NHSIL) Xpedite Innovation Fund gives grants for

'proof of concept' pre-commercialisation activities for NHS ideas and innovations with strong commercial potential, so that inventors and researchers have the opportunity to demonstrate the commercial applications and viability of their innovations to attract further investments from external sources. Since the launch of this fund in August 2005, more than 20 projects from London trusts have been allocated some £500,000 (NHS Innovations London website).

The Technology Strategy Board's Assisted Living Innovation Platform has made initial funding of about £12 million available to collaborative research and development (R&D) and small and medium-sized enterprise (SME) R&D work in standards, business models and projects in user-centred design (Care Services Improvement Partnership 2007).

In the commercial sector, funding of product development and marketing depends on the investment case for a technology. Core to this is the perceived market opportunity within the NHS. Feedback from some suppliers indicates that the opportunity is often seen as being unattractive because of the complex selling process and the diversity of buying points within the NHS.

Nevertheless, large suppliers (for example, Intel, Microsoft and BT) are investing in development. Smaller companies, however, are not represented: the interviewees drew attention to a funding gap among SME suppliers. Specifically, some SMEs believe that venture capital firms are too cautious to invest in early stage health care technologies (Flowerday 2007). This could be a missed opportunity as SMEs can be innovative and quick to respond to consumer demand.

The level of engagement between suppliers and the NHS

The ability of suppliers to develop appropriate products and sell them successfully is crucial to the adoption of technology, particularly the buying decision. Suppliers need to market in an appropriate way (for example, provide a business case in terms relevant to an NHS purchaser), and the NHS needs to provide suppliers with information about how it wants to be sold to. Given the complexity of the NHS, the quality of engagement at its interface with suppliers is important in influencing the adoption of technology.

Some suppliers have indicated that they find it difficult to sell their products to the health service. The commissioning process within the NHS is fragmented, complex and varies between commissioning groups. Every commissioning group has a different set of requirements against which it assesses new business cases for technologies. There is no standardisation of this process within the NHS.

A business case for a particular technology may satisfy the requirements of one buyer, but not another. For example, the use of telemedicine for electrocardiogram analysis in GP surgeries in Cumbria and Lancashire demonstrated clear clinical and financial benefits (Rafferty *et al* 2007). However, the same business case was insufficient for some commissioners in other primary care trusts (PCTs).

Technology companies find this diversity of commissioning requirements difficult and, as a result, are unsure about how best to present the business case. In addition, sellers are often uncertain about who within the organisation has the power of decision, and how to reach him or her. This landscape is difficult to navigate for technology companies. They receive little guidance on how best to meet the requirements of commissioners. Furthermore, commissioners do not always communicate their requirements to sellers:

> *I don't think that's up to me, it's not my job. It's up to the supplier, the provider, to show me that a piece of kit works, does what it's supposed to do, and what a saving I'll make. That always does it for me, if it's going to cost less, if they can really show*

> *me that it will reduce costs, people turning up at [Accident and Emergency], bed and waiting times.*
>
> (NHS Institute for Innovation and Improvement 2007)

This confusion and misunderstanding between buyers and sellers represents a significant barrier to the decision-making process, and some organisations have been set up to help overcome it. For example, the NHS Technology Adoption Centre (TAC) aims to 'promote greater cooperation between all organisations involved in the development and use of healthcare technologies in the NHS' (NHS Technology Adoption Centre website). The TAC is working to help the technology industry understand the processes and requirements necessary to sell technological products to the NHS. One of its initiatives is the production of a 'how to/why to' guide, which will provide more guidance to technology companies on how best to sell their products to the NHS.

Efforts have been made to improve links between suppliers and the NHS: the Healthcare Industries Task Force (HITF) on the supply-side produced recommendations that led to the establishment of the TAC within the NHS. The TAC is relatively new, so it remains to be seen how effective it will be.

Launched in October 2003, the HITF was a year-long joint initiative between the Association of British Healthcare Industries and the British government, and came about because of the health care industry's wish to develop a strategic dialogue with government (Healthcare Industries Task Force 2004). It claimed to make good progress in the following areas:

- device evaluation to inform procurement decisions
- stimulating more innovation and encouraging a more entrepreneurial culture in industry and the NHS (for example, the establishment of an NHS National Innovation Centre [NIC])
- building R&D capacity via the UK Clinical Research Collaboration
- the creation of Healthcare Technology Co-operatives, pilots to pioneer specialist techniques in patient treatments and to inform future development.

The standardisation of technology

It is important for technology standards to be agreed on in order to facilitate competitive multivendor markets, particularly where different technologies need to interface (for example, devices that input data into telecare home hubs). In the telehealth area, the Continua Health Alliance is 'working to identify and resolve gaps in some standards bodies so that personal telehealth solutions are interoperable and contribute toward improved health management' (Continua Health Alliance website). Continua is working closely with NHS Connecting For Health to develop a set of universal standards within the National Programme for IT (NPfIT).

Despite this activity, some technology companies have expressed the view that there is a lack of guidance from the Department of Health on technology standards and that this is stultifying technology development.

External demand-side factors

Consumer demand is driven by the perceived utility of a technology relative to consumers' concerns about it (for example, usability, complexity, privacy). Having consumers on-side is beneficial at all stages of the adoption process, and 'demand pull' can be significant in encouraging adoption.

Demand can manifest directly, for example, through consumers buying technology or asking their GPs to provide them with a technology. It can also be indirect: consumers demanding care, but clinicians and managers making judgements about whether technology is the appropriate solution.

Awareness and understanding of the utility of technology

Direct consumer demand for technology is driven first by awareness of the technology and an understanding of the benefits that it can bring. Awareness and understanding result from a range of mechanisms including:

- media coverage
- planned dissemination of information by the NHS or suppliers
- word of mouth/experience-sharing
- experience of technology in other sectors.

The last is important as consumers' expectations of the use of technology are often set by their experiences in other sectors.

Consumer concerns

For a technology to become widely adopted, consumers' concerns about technologies must be overcome. The main issues are with confidentiality and usability.

Consumer fear of a lack of confidentiality/poor data protection is a major problem in relation to technology in general, but particularly in the health sector as data is so sensitive (Royal Society 2006). The issue of confidentiality has also been raised by some clinicians, with regard, for example, to the risk of breaches of privacy with computerised patient records. One clinician wrote thus in the *British Medical Journal*:

> *Workers in hospitals or general practice surgeries might seek inappropriate access to medical records because of curiosity or malice, commercial gain, or simple error. If screens are left on in open areas or passwords compromised, tracing of access for disciplinary purposes would be difficult. If challenged after a breach of security one could argue that data were requested accidentally. I occasionally enter a wrong number into the radiology viewing system and see unwanted images. Such errors are inevitable.*
>
> (Foley 2006)

However, the level of concern displayed by consumers could be in excess of the real level of risk as a result of the huge amount of media coverage given to the risk to patient confidentiality caused by electronic health records. A survey by the Health and Social Campaigners' Network International – a global network of patient groups – revealed that 64 per cent of patient groups were worried they would suffer a loss of confidentiality and privacy (Health and Social Campaigners' News International 2005). In practice, however, access to records will be controlled by the use of various security devices or mechanisms, such as smartcards that use chip and PIN (personal identification number) technology and have to be inserted into a card-reader attached to a computer before the user is allowed access to patient records. Smartcards would be issued only after stringent identity checks. Although an element of risk would remain, it would most likely be less than is commonly thought.

The uptake and usage of technology by consumers will depend on the consumer's ability to use or learn to use the technology. For example, partially sighted individuals struggle

to use screen-based technologies. Consumers may favour applications delivered over familiar technologies, such as the mobile telephone, rather than a new device.

Consumers also have concerns about the changes that a technology will bring to their experience of health services. For example, they may be resistant to technology that changes their relationship with their carer or clinician.

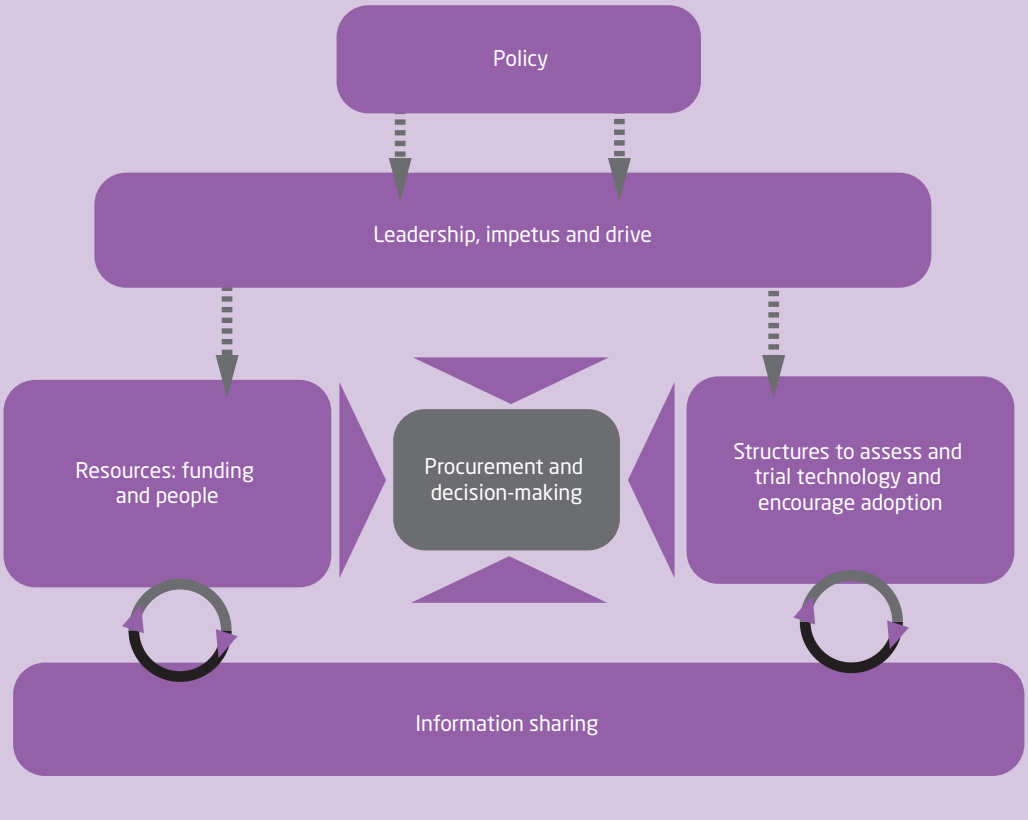
Consumer activism and empowerment

If consumer awareness and understanding is to lead to real demand, consumers need to be proactive, whether this is by asking a clinician to provide a particular technology or by taking the decision to buy a technology themselves (in cases where it is adopted by individuals).

Possibly as a result of increased awareness of the different treatment options available, consumers are becoming more demanding in asking clinicians for specific treatments, whether via active campaigning by patient groups or an individual requesting a specific treatment from his or her GP.

The Medical Technology Group is an active coalition of patients, clinicians, patient groups and medical device innovators that campaigns for broader patient access to medical innovations, including the latest treatments for heart conditions, diabetes, stroke prevention and incontinence. The group has played a role in increasing the use of technologies such as pacemakers, drug-eluting stents and implantable cardioverter defibrillators in the NHS (Medical Technology Group website).

Figure 4 Simplified model of key factors within the NHS that influence the adoption of technology



Factors internal to the health service

The adoption of technology by the NHS is also affected by a range of internal factors, as illustrated by Figure 4 below.

Policy

Naturally, government policy has a significant impact on the adoption of technology, even if it does not make its implementation mandatory, policy decisions can act to motivate commissioners. Policy can affect the adoption of technology directly, through setting guidance or targets, or indirectly, through setting objectives that could be met via technology.

Technology and information technology (IT) systems are becoming increasingly more central to health care policy. The recent review of the NHS conducted by Lord Darzi emphasised the importance of technology in the health service, and placed a legal duty on strategic health authorities to promote innovation (Department of Health 2008a). Our review highlights the role that technology can play in improving health outcomes, and makes recommendations for ways in which the NHS could improve its adoption and use of new technologies (see pp 33–8 of this report).

The NPfIT was formally established in 2002 with the aim of developing electronic health records for patients and connecting GPs to hospitals. The intention is to replace the fragmented approach to IT in the NHS with standardised interconnecting systems.

The 2006 Department of Health White Paper *Our Health, Our Care, Our Say: A new direction for community services* (Department of Health 2006b) set out a vision for preventive care services and established the Whole System Demonstrator programme. The Whole System Demonstrators will gather evidence in a UK context by deploying telecare and telehealth services covering a resident population of more than 1 million across three areas of the country, and with funding of £31 million is reputed to be the world's largest pilot project of its kind (Department of Health 2008c).

In addition, at least a dozen major policy reports have highlighted the potential of telecare. These date back at least to *Information for Health: An information strategy for the modern NHS 1998–2005* (Department of Health 1998a), *Modernising Social Services: Promoting independence, improving protection, raising standards* (Department of Health 1998b), and the *With Respect to Old Age: Long term care – rights and responsibilities* (Royal Commission on Long Term Care 1999). Together, these recognised the potential contribution of future developments in telecare and assistive technology.

Management leadership, impetus and drive

Given the complexity of the adoption process, strong leadership and direction is important to make the adoption of technology actually happen. Our review found few signs of strong leadership from the centre, and, until recently, little evidence of real impetus and drive for technology adoption in the NHS.

Given the large number of other initiatives and changes competing for health care managers' time, the level of prioritisation for the adoption of technology relative to other matters is also an important consideration. Technology initiatives, such as the NPfIT, have been prioritised nationally, but at a local level the use of technology is less often seen as a priority. In practice, prioritisation can be achieved by setting targets and guidance for managers, but in a more devolved NHS perhaps a more appropriate role for the Department of Health is setting a climate in which local managers feel encouraged

to participate in the testing of technological solutions and to adopt them where positive outcomes have been demonstrated.

Structures to assess and trial technology and encourage adoption

The effectiveness of the specific structures and management in place to assess, trial and encourage the spread of new technologies affects the ease with which technology can be adopted by the NHS. If they are working well, these mechanisms act as filters for new technology and then as catalysts for adoption.

Although the primary remit of the National Institute for Health and Clinical Excellence (NICE) is the assessment of new drugs and treatments, its role also extends to the assessment of new technologies used in the delivery of care, and it uses its assessments to provide national guidance on technology purchasing. In theory, NICE enables commissioners to make decisions about approved technologies – the NHS is legally obliged to fund and resource medicines and treatments recommended by NICE's technology appraisals (NICE website). The Single Technology Appraisal process was set up by NICE in 2004 to speed up the evaluation process.

However, some interviewees drew attention to the limitations of the NICE assessment process, and the House of Commons Select Committee on Health (House of Commons Select Committee on Health 2006) identified problems including the following.

- Topic selection: only a few selected medical technologies are chosen as suitable for assessment as technology appraisals. For products not recommended by NICE, the purchasing decision is taken at a more local level. NHS bodies must 'determine local policies for the managed entry of the new intervention' (Department of Health 2006a).
- The wider benefits to society, for example to carers, are not included in NICE's economic evaluations.
- Even a successful approval by NICE does not necessarily lead to implementation because of a lack of clarity about which body, if any, is responsible for ensuring implementation.

The NHS Purchasing and Supply Agency (PASA) acts to ensure that the NHS in England makes the most effective use of its resources by getting the best possible value for money when purchasing goods and services (NHS PASA 2007). PASA provides national support for bulk buying and logistical services. PASA is responsible for procuring approximately 80 per cent of the products and services bought in to the NHS (Craven *et al* 2007). Before a product or technology can be procured, it must undergo a health economic assessment process in which value for money is assessed against patient outcomes. Interviewees indicated that the PASA approval process was complex and represented a significant barrier to enabling technology companies to sell their products to the NHS.

Technology trials and pilots are also an important stage of assessment and/or early stage implementation. Trials can aim (among other things) to:

- demonstrate the benefits of technology, contributing to the evidence base
- provide guidance for implementation of best practice
- raise the profile of the technology among clinicians, patients and managers.

However, trials and pilots may act as a barrier to adoption of a technology. Some specific problems that we identified together with examples relating to telecare include the following.

- Trials can hold up national roll-out: at its worst the NHS can find itself in a state of permanent trial, with each new trial delaying a larger-scale roll-out. For example, the Whole System Demonstrator programme is a two-year telecare pilot that will establish an evidence base for telecare in a UK context. Although this is a highly valuable and important piece of work, local services are to a certain extent holding back until its results are published.
- Misalignment of expectations of standards of evidence: some stakeholders may not accept the evidence collected by trials as few meet the accepted clinical standard of a randomised controlled trial (RCT) (often for good practical reasons). For example, a systematic literature review conducted by a team from Imperial College, London found that of almost 9,000 papers reporting on outcomes of telecare trials, only 100 met the quality thresholds established by the authors (RCT plus other conditions) (Care Services Improvement Partnership 2006). However, despite this, technology, particularly telecare, is often adopted without meeting this standard of evidence.

The effectiveness of the structures and management in place to encourage the adoption of technology are an important consideration. In response to the Healthcare Industries Task Force, supporting organisations have been set up within the health service to encourage the adoption of technology. These structures are relatively new, so there is currently limited evidence as to their effectiveness: the jury is out.

The NHS National Innovation Centre (NIC), founded in December 2006, aims to speed up the development of precommercial technologies likely to benefit the health sector. The NIC co-ordinates the activities of the NHS TAC (*see* p 17), which promotes the increased uptake of innovative technology in the NHS, and the innovation hubs, which offer legal and commercial support to NHS staff with a premarket product.

Efficiency of information-sharing within the health service

Technological innovations will spread most effectively within the NHS if the flow of information about them is free and efficient so that potential buyers and users know about technologies, their potential benefits and how to implement them. Considerations include:

- the spread of information through **networks**, both organised and informal
- the role of **champions** for new technology.

Both informal and formal networks can support the spread of information within the NHS. For example, external organisations such as the British Medical Association (BMA) support networking and information exchange (for example, the BMA Medical Technology Group, see its website).

Individuals within the health care system, such as clinicians or commissioners, who champion a technology can play a key role in educating patients and clinicians/commissioners about it. Furthermore, these champions have experience of how to navigate the 'system' in order to implement a technology.

Effectiveness of procurement and decision-making

For a technology to be adopted within the NHS it needs to pass a procurement process (unless adopted directly by the consumer). The ease with which a technology can pass through this process therefore affects the likelihood of its adoption. The procurement process within the NHS is highly complex (we have not attempted to describe it in full here), presenting many barriers to the adoption of technology, including:

- multiple points of sale (individual GP practices and trusts, regional collaborations, central purchasing)
- extended and complex procurement processes (which prove difficult, especially for smaller companies)
- a tendency to focus on 'least cost' rather than 'best value'.

The number of buying points within the NHS affects the ease with which technology is adopted. Too many, and the cost of sale is high, deterring suppliers; but too low, and only the largest suppliers are able to compete, meaning that the opportunity for the market to support a more diverse and innovative range of suppliers is lost. Currently, the health sector is characterised by a diversity of buying points such as at the primary care level, where commissioning is divided geographically. Furthermore, each commissioning group may have different business case requirements, creating confusion for suppliers. However, PASA does overcome this issue within the NHS to a certain extent. Most NHS trusts are now partners in 'collaborative procurement organisations' where, normally on a regional basis, they can share information and resources to achieve economies of scale.

The structure of the market is related to the level of decentralisation of decision-making within the NHS. Some decentralisation has been achieved as a result of two main initiatives.

- **NHS foundation trusts** have more financial and operational freedom than do other NHS trusts. Ministers expect this to stimulate a wave of local entrepreneurship and innovation (Robinson 2002). Foundation trusts have shown evidence of improvements in services and innovation, but it is argued that this has been a general trend across all hospital trusts and is not unique to foundation trusts (Eaton 2005).
- **Practice-based commissioning** (PBC) enables GPs to deliver new services within which technology may play a role. For example, GPs may purchase equipment that enables them to treat more patients at the surgery, rather than referring them to a hospital specialist. However, there are limited sources of information about what impact PBC is having on the NHS. A survey of GP practices across England conducted by the Department of Health suggested that 59 per cent of practices had not commissioned any new services as a result of PBC, and that 46 per cent believed it to be 'too early to tell' if PBC had improved patient care (Department of Health 2008b).

In order to make good decisions about technology procurement, commissioners need to be able to make (or be provided with) a clear business case. For example, they need access to relevant information about health outcomes, value for money, and the impact on the patient experience.

Furthermore, commissioners find it difficult to compare different technological options. There is a lack of health economic and modelling skills to identify and compare the benefits of different technological solutions and the extent to which they could be future-proofed. This challenge is particularly pertinent in the case of assistive technologies (NHS Institute for Innovation and Improvement 2007).

Decision-makers find it difficult to assess the value and potential contribution of technological solutions to service improvement initiatives because they do not know where to access information about the performance of the different technologies that relate to outcome, patient experience, cost-effectiveness and patient safety information.

Current incentives do not encourage commissioners to take decisions on this longer-term and wider basis. The ability of commissioners to take long-sighted macro-level decisions is important as:

- the benefits of health care technologies are often realised over long timescales (for example, four to five years or longer), compared with PCT financial planning, which occurs on a one-year timescale
- the costs and benefits associated with health care technologies are often disconnected: health care technologies are often preventive interventions that reduce patient referrals across the health delivery system, meaning that an investment in a technology at one stage of the delivery system could result in cost savings at a different stage. The system of 'silo budgeting' in the NHS means that wider cost and patient benefits are not always considered in procurement decisions (Mayor 2005).

Currently, value-for-money evaluations are based on this definition: 'the optimum combination of whole-life cost and quality (or fitness for purpose) to meet the user's requirement, having due regard to propriety and regularity' (NHS PASA 2007).

Resources: funding and people

The availability of resources, both financial and organisational, affects the ability of the NHS to change across the range of its activities, including the use of technology.

Securing funding to invest in technology is a necessity for the adoption of technology to occur. There is evidence that funding has been difficult to secure for some technologies. For example, in many acute trusts the budgets for new medical equipment have been reduced, regardless of the merits of individual business cases.

The availability of management resources will affect the pace of adoption of technology. In order for a technology to be adopted, it requires organisational resources to manage the implementation. This is particularly pertinent where technology is part of a larger innovation or requires a change in service delivery (for example, by disrupting established care pathways). Telecare is the classic example that has been described as 10 per cent technological change, 90 per cent service change. It requires a range of public and voluntary services from social care, health care and housing services (Care Services Improvement Partnership 2006). Telecare can change the roles and responsibilities of care delivery teams, so understanding how it affects different stakeholders is critical before implementation.

At a more general level, the capacity for change of the NHS will limit the rate of adoption of technology. For example, staff have a limited capacity to adapt to new modes of working, restricting the number of changes that can be implemented at any one time. Similarly, the ability to train practitioners and consumers to use new technologies limits the rate of change. The Training Hub for Operative Technologies in Healthcare (part of the NIC) works alongside universities and industry to identify and develop advanced training tools for emerging technologies.

This chapter has highlighted the complexity of the NHS and the factors influencing the adoption of technology. Some of these factors are unique to the health service (for example, clinical considerations), but many are common to any large organisation or system looking to adopt technology (for example, resource constraints). Appendix A describes the experience of the adoption of technology in the financial services and travel sectors, which, despite their obvious differences from health care, offer some insights relevant to overcoming the barriers to adoption in the health sector.

4 Technology adoption models

One of the difficulties of analysing the process of the adoption of technology in health care is the sheer number of different influencing factors that affect adoption. To identify the most important barriers to adoption, we have assessed how the influencing factors weigh up in different models of adopting technology.

We have identified four broad models for the adoption of technology in the health sector that describe four different ways in which decisions to implement technology can be made and the means by which technology can be disseminated to reach the end-user. These broadly reflect the four different levels at which the decision to implement a technology can be taken:

- the Department of Health
- local management
- clinician
- consumer.

Although particular technologies are not restricted to any one adoption model, in practice they tend to align to a particular model.

Figure 2 (*see* p 14) offered a simplified model of the key decision points in the adoption of technology. In this chapter, we focus in particular on the second and third decision points – that is, the decisions to buy and to use.

In addition, there are further models in which technology is provided by the private sector and adopted by the consumer (for example, the use of medical information websites). We have not considered these further as the barriers to adoption of these services are typically less significant than for technologies adopted within the National Health Service (NHS).

This chapter highlights the key barriers that act on each technology adoption model and, where relevant, gives practical examples of the barriers.

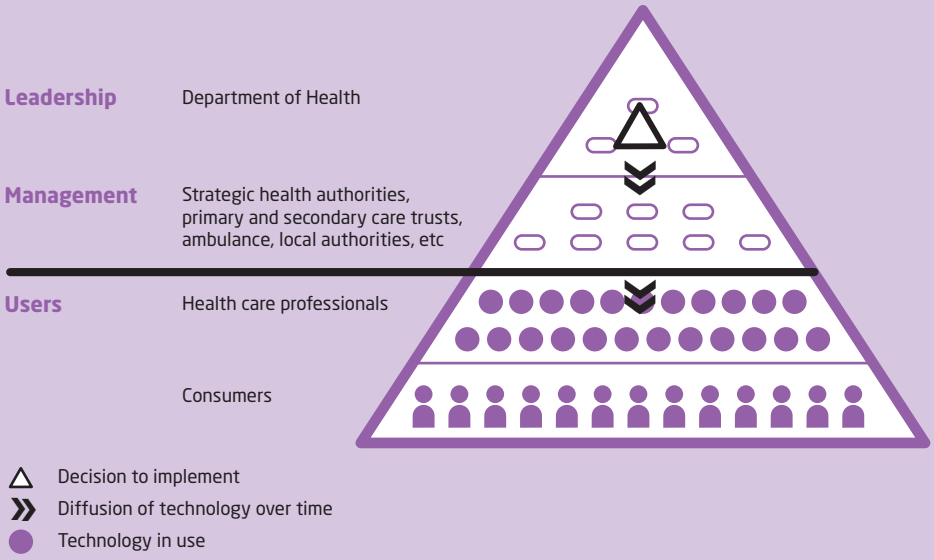
Top-down, policy-led uptake

In this model, technology adoption is driven from the top down (*see* Figure 5 overleaf). The decision to implement the technology is made centrally by government. Technology is disseminated on a national level in order to achieve widespread usage.

Implementation is large scale, and thus represents significant investment and risk to the government or NHS. The funding requirement is normally large, and the decision-making process may be lengthy, requiring a detailed business case for procurement.

This model is relevant to large information technology (IT) projects, and to smaller decisions where guidance is issued by the National Institute for Health and Clinical

Figure 5 Technology adoption model 1 – top-down, policy-led uptake



Excellence (NICE) mandating the use of technology for specific conditions (for example, the use of insulin pumps in the treatment of diabetes).

At a more general level, the key barriers to the adoption of technology in this model include the following.

Example: the National Programme for Information Technology (NPfIT)

The NPfIT is a national health care IT project mandated by the government. Delivery of the programme is the responsibility of NHS Connecting for Health, an agency of the Department of Health. The programme experienced several barriers in getting off the ground, including the following.

- **Building a case:** this is illustrated by the long time it took to take the project from inception to implementation. The government's information strategy was set out in 1998 (Department of Health 1998a), but the national programme was formally established only in 2002.
- **Gaining funding:** the national programme is funded by the taxpayer. The cost of the programme has increased more than fivefold from its original estimate and has been widely criticised in the media.
- **Engaging with suppliers:** Accenture, which was the second biggest of four main suppliers to the national programme, pulled out of the project in September 2006 because the firm was unable to reach an agreement with NHS Connecting for Health on renegotiation of its contracts. More recently, a second main supplier, Fujitsu, has also withdrawn from the project. These moves raised questions over the viability of the programme for the other prime contractors.

The programme is now experiencing significant challenges and barriers to usage: for example, winning the support of NHS staff and the public in making the best use of the systems to improve services and ensure that NHS organisations can and do fully play their part in implementing the programme's systems.

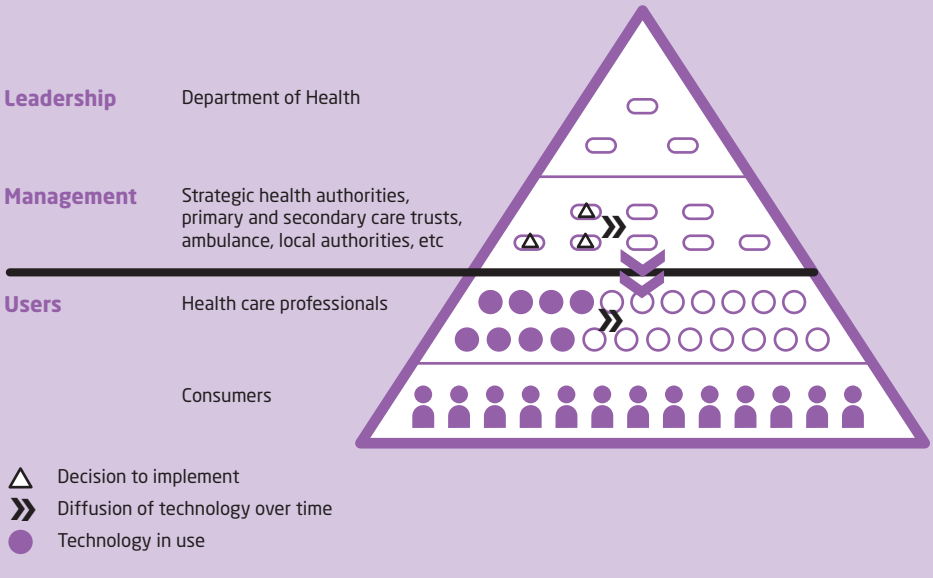
- **Difficulty in gaining funding**. It is challenging to gain funding for major top-down mandated technological projects because of the high costs involved – often many billions of pounds. For example, the National Programme for IT (NPfIT) was initially costed at an estimated £2.3 billion, but this has since been revised by the National Audit Office to £12.4 billion (National Audit Office 2006) over the 10-year life of the contracts to 2014.
- **Lack of strong leadership and direction.** Within the NHS, there is little evidence of real impetus and drive for the adoption of technology. This can lead to slow implementation of top-down mandated technologies. Connecting for Health has recently had a number of rapid changes in its most senior IT and informatics leaders.
- **The limitations of the assessments of technology** performed by NICE mean that there is a compromise in the number and variation of technologies that are recommended for implementation at a national level.
- **Consumer fears about lack of confidentiality/poor data protection**. This is a particular barrier because of the media attention that the large-scale projects receive compared with smaller technological innovations.
- The desire to **devolve centrally procured processes** within the NHS means that centrally mandated initiatives might not, in fact, work in practice. Primary care trusts (PCTs) can act as 'gatekeepers' to centrally mandated initiatives becoming adopted at a local level. In order for such initiatives to become adopted in the PCT, there may need to be further negotiations at PCT level.

Uptake within local management

In this model, decision-making about the adoption of technology is devolved from the centre and resides with commissioners in health and social care trusts (*see* Figure 6 below). This is the model by which most technology is adopted within the health sector.

In this adoption model, the decision to purchase a technology is made at local management level and disseminated to users locally. Guidance for decision-makers may be provided through national frameworks and policy. At a local level, the decision to purchase a particular technology may represent a significant investment, and therefore

Figure 6 Technology adoption model 2 – uptake within local management



Example: telecare

Telecare is an example of a technology that can be implemented at a local level by social services, private providers or NHS care trusts. Despite government guidance as set out in *Building Telecare in England* (Department of Health 2005) and funding being available (the Preventative Technology Grant, for example), telecare has not currently become widely adopted. The main barriers that have prevented widespread adoption are as follows.

- **Lack of resources to deal with the changes in service delivery that telecare may necessitate:** for instance, a telecare programme requires back-end service support, such as call-monitoring centres and carers to respond to patient call-outs.
- **Silo budgeting:** for example, social services may commission and deliver the telecare service but the financial benefits may be realised by the local primary care or hospital trust.
- **Lack of incentives to take a long-term view in decision-making:** benefits may be realised on a longer timescale than the financial planning horizon and thus there are few incentives for commissioners to invest in such technologies.
- **Inefficient use of trials and pilots:** many pilots do not meet the requirements of clinicians to justify a broader roll-out of the technology. Furthermore, pilots such as the large-scale multisite Whole System Demonstrator programme may preclude further roll-outs of telecare services before its outcomes are published in two years' time.
- **Decentralisation of the market:** in addition, as telecare provision differs within each local context, it is very difficult for commissioners to achieve economies of scale through a diversity of buying points.

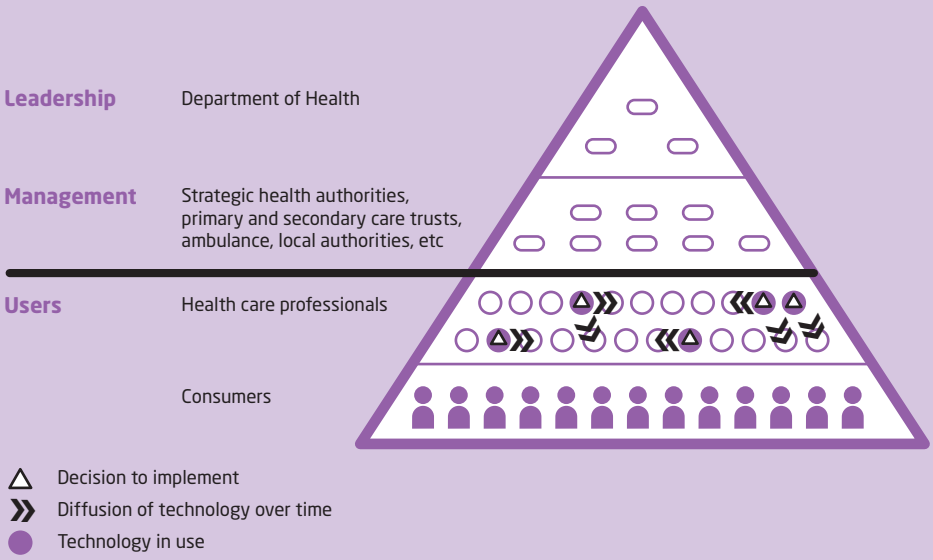
risk, to decision-makers. The decision-making process is slow and business case requirements vary between different decision-makers.

This model is relevant to decisions that are made at a local level by commissioners and care managers within PCTs, NHS trusts and strategic health authorities (SHAs). For example, the decision to implement patient video displays in hospitals is made by hospital or ward managers. The decision to commission in-house diagnostic technologies is made by managers of polyclinics and large general practitioner (GP) surgeries.

At a more general level, the key barriers to the adoption of technology in this model are as follows.

- **Lack of availability of resources:** this may be financial, such as a lack of funds to invest in the equipment, or organisational, such as inefficient resources to deliver the support services.
- **Narrow decision-making process:** silo budgeting, short-term financial planning and a diversity of different requirements across commissioning groups impede local uptake.
- **Lack of awareness of the benefits** of technologies among decision-makers and **few incentives** to encourage commissioners to invest in new technologies.
- **Diversity of buying points** prevents the health service from achieving economies of scale in purchasing technologies at a local level. This means that the technologies are more expensive to local buyers than they could be.

Figure 7 Technology adoption model 3 – uptake by professionals within the NHS



- **Pilots may hinder the rapid implementation of technology** on a wider scale, as the outcomes need to be proven before wider roll-out can occur.

Uptake by professionals within the NHS

In this model, adoption occurs via individuals or unconnected professionals in the NHS taking up a technology, with dissemination to the consumer occurring very locally, through clinicians (*see* Figure 7 above).

In this adoption model, the decision to purchase or use a technology resides with (or very close to) the technology user, usually a clinician. The adoption of the technology occurs without any mandate, but possibly with some guidance from local or national frameworks. The decision-making process is reasonably removed from management level. The decision to purchase a technology is dependent on both proof of concept and proof of business case.

As implementation occurs on a small scale, the value of the investment is typically quite small. As a result, in monetary terms, the level of risk involved in implementation of the technology is relatively low. However, for new or unproven technologies, the clinician may need to manage a certain level of clinical risk.

This model is relevant to technologies that are implemented by health care professionals. It could be a clinician who purchases a personal digital assistant (PDA, also known as a palmtop computer), or a GP who performs telephone and email consultations.

At a more general level, the key barriers to the adoption of technology in this model are as follows.

- Clinicians receive little guidance on **how best to present the business case** to managers in order to purchase the technology. This is especially pertinent in practice-based commissioning.
- **Lack of incentives** in place to encourage clinicians to adopt technologies.

Example: implementation of GP IT patient booking systems

Some GP IT systems allow patients to book and change their appointments online, although of the more than 10,000 GP surgeries in the UK (British Medical Association 2005), only around 10 per cent allow patients to book and change appointments online (Bellingham 2007). The main barriers to implementation of this service are as follows.

- **Business case:** clinicians do not always see the benefit of booking systems, because the main beneficiaries are the patients themselves, through greater convenience.
- **Funding:** GPs need to get approval for their spending plans from PCTs. This creates a barrier in terms of proving the case for booking systems: GPs do not always know how best to present their plans.
- **Lack of incentives:** there are no specific incentives to encourage GPs to adopt these services.
- **Acceptance by patients:** patients without internet access might not be able to use the system.

- **Lack of standards:** there is little integration and interoperability by private providers within the health technology sector.
- **Acceptance by the patient:** patient acceptance of the technology may limit its dissemination into broader use.

Uptake by consumers

In this model, it is individual consumers who decide to adopt the technology, acting as both the purchasers and the users of it (*see* Figure 8 opposite).

In this case, the consumer buys direct from private suppliers, and market forces determine the adoption of technology: it is a matter of supply and demand. Therefore, there are many fewer barriers to adoption than in other models. On the other hand, there is less opportunity for intervention to stimulate the adoption of technology. There is also currently only a limited number of technologies that reach the consumer via this route (for example, diagnostics and healthy living technologies, such as mobile telephone applications), as regulation and/or the need for the involvement of clinicians requires that most technologies are adopted within the NHS.

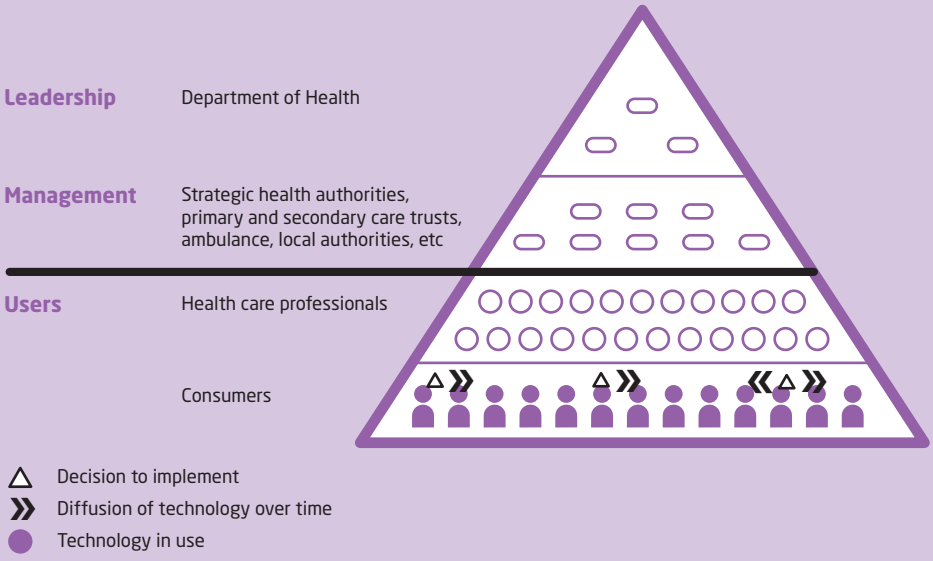
The general barriers to adoption of technology in this model are:

- **limitations on consumer demand** due to, for example:
  - consumer resistance to new technology
  - high prices relative to consumers' spending power
  - lack of integration with the patient care record.

These issues are exaggerated for those most in need: typically, they have the most resistance to technology and the least disposable income.

- **limitations on supply**, such as:
  - lack of product development for the consumer market due to perceived small market opportunity

Figure 8 Technology adoption model 4 – uptake by consumers



- regulatory barriers
- lack of support from the NHS (for example, in promoting technology).

Conclusion – the key barriers to adoption

The most significant barriers to the adoption of technology are listed below. This prioritisation bears in mind that the majority of technologies within the NHS are adopted through Model 2, technology uptake by local management.

There are some universal barriers to technology uptake.

- Lack of availability of resources. This manifests as a barrier to the adoption of technology in three broad ways:
  - a lack of funding to invest in new technology
  - a lack of organisational resource (people) necessary for the implementation of the new technology
  - a lack of time to invest in adopting the technology.
- Lack of strategic leadership by the Department of Heath, and a somewhat fragmented approach reflected in the number of national organisations and structures with an innovation or technology remit. Furthermore, there is also a lack of local leadership in PCTs and SHAs.
- Lack of incentives for clinicians: clinicians sometimes do not see the benefit of technology when it is fulfilling an administrative, rather than clinical, function. Some of the administrative technologies discussed in this review improve the experience of health care for the patients, but these benefits are not inherently obvious to clinicians.
- The commissioning process is geared towards assessing new technologies on a 'least cost' basis. There exist few incentives for commissioners to invest in technologies that represent any form of risk such as a longer-term return on investment or those that require change in the care pathway.

- The inability of the NHS to accommodate the change in service delivery that may be necessitated by new technology. This is due both to resource constraints and inertia within the NHS to alter patient pathways and patterns of care delivery.

The barriers that are specific to adoption by local management are:

- the complexity of the decision-making process itself
- the inability of commissioners to make long-sighted, macro-level decisions
- the diversity of buying points, which precludes achievement of economies of scale by local commissioners within the NHS.

5 Recommendations – how to achieve the ideal vision

Introduction

Achieving the ideal vision for health care technology will depend on addressing the barriers to its adoption. We recognise that this is not a straightforward matter given the multiplicity of other initiatives, objectives and targets, as well as the extensive programme of change already facing managers and clinicians in the National Health Service (NHS). However, we have noted that the NHS seems to be 'behind the curve' in the adoption of technology compared with other industries (*see* Appendix A), and we have identified some important areas of potential benefit (*see* pp 10–13). We make no general assertion that the benefits of technology always outweigh the costs and risks, but we do believe that very significant benefits could be achieved for patients and the public – and for the operation of the NHS itself – if the potential of technology to support the objectives of the NHS was more fully realised.

Harnessing the full potential of technology in health care will require the active involvement of the whole health care system – consumers, clinicians, health authorities and trusts, the regulators, the Department of Health, and the health technology industry. All have a part to play, but the role of the centre is particularly important. Although in a devolved system the Department of Health cannot make the use of technology mandatory, it does have an important leadership role in creating a culture and climate that actively encourages, supports and enables the adoption of technologies that could provide benefits to patients and the public.

In this context, the commitment to innovation and technology in *High Quality Care For All: NHS next stage review final report* (Department of Health 2008a) is particularly welcome, but much remains to be done to give real effect to the intentions stated in that document, especially in the light of the pervasive barriers to the adoption of technology that we have identified in this report.

National leadership

- The Department of Health should provide clear, consistent and sustained ministerial and board level leadership on the use of technology in health care.
- In this regard, the main leadership roles of the Department of Health include:
  - supporting the recently established Health Innovation Council, which brings together key health sector technology interests, and ensuring its recommendations are implemented
  - co-ordinating the activities of the various national bodies and agencies that have a technology remit, including the NHS Institute for Innovation and Improvement, the NHS National Innovation Centre, NHS Connecting for Health, the National Programme for Information Technology (NPfIT), the NHS research and development (R&D) programme, and the local innovation hubs

- ensuring that the appropriate use of technology is considered as an integral part of all policy development within the Department
- ensuring that active steps are taken to increase and accelerate the assessments of technology carried out by the National Institute for Health and Clinical Excellence (NICE), to implement the results, and to roll out the technologies from successful trials
- reviewing national procurement processes to ensure that they are structured to facilitate the uptake of innovation and the adoption of appropriate technology based on a 'best value' approach
- consolidating access to central pump-priming, R&D, and innovation funding to provide a 'one-stop shop' for the funding of new technology
- developing a 'manifesto' for the use of technology in the NHS, perhaps including a list of '10 high-impact changes' for technology, as proposed by the NHS Modernisation Agency (2004).

Local performance

- There is a number of mechanisms for ensuring that the adoption of innovation and technology remains high on the agenda for local NHS organisations, not the least of these being the new legal duty on strategic health authorities to promote innovation that was announced in *High Quality Care For All: NHS next stage review final report* (Department of Health 2008a), and the annual NHS Operating Framework, which sets out the national priorities for the coming year.
- Convenience and access are important outcomes. The extent to which local public services use innovation and technology to improve the customer experience and provide more convenient access to services should be routinely measured and reported.
- The new Comprehensive Area Assessment (CAA) process seeks to provide an annual, holistic, independent assessment of the prospects for local areas and the quality of life of the people living in them. The answer to the central question posed by the CAA – 'What is it like to live in my area?' – must, of course, deal with key requirements such as safety, access to employment, education, housing and fresh food, but it could also look at how technology and innovation are improving the quality of life by providing better and more convenient access to public services, enabling and supporting healthy living, and enabling treatment and care to be delivered at or closer to home, especially for older people and those living with long-term conditions, who might otherwise have to be cared for in an institutional setting.

Funding mechanisms

- Commissioners and providers should recognise that investment in technology might require relatively long timescales for payback, and manage investment funding accordingly.
- Transition funding for the adoption of new technologies should be made available at national, regional and local level, to cover short-term implementation and double running costs. Funding could be in the form of a loan, repayable on the basis of an agreed schedule.
- Commissioners should take the lead role in ensuring that the effects of 'silo budgeting' (where the costs and benefits of implementing technology fall to different

budgets) do not inhibit the adoption of appropriate technology. This would normally take the form of adjusting provider contracts to shift resources from a provider making savings to one incurring costs as a result of the adoption of a technology.

- The Department of Health should consider steps to limit the adverse effects of silo budgeting on the adoption of technology as part of its regular review of Payment by Results.

Better management of the trial process

- NICE's technology assessment programme can address only a limited number of new technologies (although we have recommended an increase in its capacity to undertake technological assessments). There need to be more informal mechanisms for assessing the costs, benefits and risks of new technologies, which could then be subject to post-implementation evaluation to confirm or revise the initial assessment.
- Before a trial of technology is undertaken, there should be a mechanism that ensures that the trial adds value to the existing technological landscape. This could be overseen by the regional innovation hubs.
- The trial manager should provide a commitment that:
  - the trial will contribute towards the evidence base
  - the trial will be appropriately acted on.

Better communication with consumers

- NHS trusts, primary care trusts, managers and clinicians should actively communicate the benefits of and promote the use of technologies that can improve patient outcomes and patients' experiences (including those that offer more convenient access to and transactions with the health system).
- Clinicians – in both hospitals and general practice – should encourage patients to make full use of the technology services available, for information, transactions and monitoring, as and when appropriate to their condition.
- Technology, especially consumer-facing technology, should be targeted appropriately to ensure maximum uptake. Initially, this will mean targeting those most likely to embrace the service, such as those who are confident users of information technology or who most value any additional convenience offered. The aim should be to develop a critical mass of users sufficient to generate a 'viral marketing' effect to drive uptake on a wider basis.

Strengthening the NHS/industry partnership

- The NHS Institute for Innovation and Improvement and the National Innovation Centre should provide industry with accurate and up-to-date advice about how and where to present their business case for new technology, in order to maximise the adoption of technologies that can benefit patients and the public.
- Those seeking to sell their technologies to the NHS should develop an evidence-based business case that demonstrates value in terms that are relevant to the purchasing decision-maker.
- The National Innovation Centre should run a series of 'showcase events' on a rolling basis, targeting not just those interested in technology and innovation, but also a wider range of potential clinical and management decision-makers.

Appendix A

Learning from other sectors

The barriers experienced by the health sector in the adoption of technology at the consumer interface are not unique. Other industries have experienced, and successfully overcome, similar obstacles. This section analyses the experience of the adoption of technology in the financial services and travel industries, and draws top-level implications for the health sector.

The authors acknowledge that direct comparisons of this nature across different sectors are difficult to draw. However, we believe they do offer some insights that could help address some of the barriers to adoption we have identified in the health sector.

The adoption of technology in other sectors

Compared with other sectors, health care has been relatively slow to adopt technologies that are already in widespread use elsewhere. Where such technologies have been adopted, it is relatively recent. Moreover, there are examples of technologies known to be beneficial and affordable that have not yet reached the health care consumer.

Table A1 overleaf illustrates how technology is currently employed to meet consumer needs in the health sector, and compares it with the use of similar technologies in the financial services and travel sectors. Although we have not attempted a full gap-analysis, this section intends to demonstrate that the adoption of technologies within health care lags behind other industry sectors such as travel and financial services.

Financial services sector: the story of online banking

The UK financial services sector has been transformed as a result of the use of technology at the consumer interface.

Adoption of technology in the financial services sector was rapid: more than 75 per cent of all internet users in the UK (27.5 million people) make purchases online, and 17 million adults now bank online, compared with only 6.2 million in 2001 (APACS website). Equally, when consumers visit a branch, technology plays a key role in service delivery, for example, automating the credit scoring system for mortgages/other risk assessment and using systems and analytics to replace multiple teams, making decisions fast and accurate. The financial services sector shares some barriers to the adoption of technology adoption with the health care sector as both are highly regulated.

Looking at the specific example of online banking, two main barriers had to be overcome before the technology was widely deployed by banks and used by consumers:

- the risk of fraud, and consumer concerns surrounding this
- the requirement for significant investment and information technology (IT) resources to implement the technology.

The largest barrier to the adoption of online banking was the risk of fraud. This had the potential to limit consumer acceptance of the technology, and, on the supply side,

Table A1 Comparison of technology uptake across sectors

Need	Current level of technology adoption by sector		
	Health	Financial services	Travel
Information and advice	**Comparison tools**  NHS Choices scorecard, launched in April 2008, enables patients to compare hospital performance for different procedures.	**Comparison tools**  Online banking features comparison tools, such as interest rate comparison tools for different banking services.	**Comparison tools**  Several online tools enable consumers to compare features of holidays, for example Sky Scanner shows the flights available and their prices by destination from all airlines.
Transactions	**Choose and Book**  Approximately 40 per cent of all referrals to specialist care go through Choose and Book (Choose and Book website).	**Transactions**  More than 75 per cent of all internet users in the UK make purchases online (APACS website).	**Holiday bookings**  About 55 per cent of internet users book their holidays online (Nielsen 2006).
	E-prescription services  About 10 per cent of prescriptions are sent via the Electronic Prescription Service (EPS), and only 2 per cent of those are being dispensed via it (within the five primary care trusts where the EPS has been implemented) (Connecting for Health website).	**Chip and PIN**  The adoption of some technologies is ubiquitous: since January 2006, at least 99 per cent of British cardholders have at least one chip and PIN (personal identification number) card in their wallet (Chip and PIN website).	
Service specific to the sector	**Consultations**  In 1995, 3 per cent of GP consultations were on the telephone; in 2006, 10 per cent were on the telephone.	**Online banking**  Approximately 50 per cent of adults in the UK were banking online in 2007 (APACS website).	**e-Tickets**  From 1 June 2008, all Independent Air Transport Association (IATA) tickets are e-tickets (IATA website). IATA flights represent more than 90 per cent of international scheduled air traffic.

to inhibit the range of services offered. Every failure, flaw and breakdown experienced by a bank immediately became common knowledge, and was usually mercilessly and accurately exploited by competitors (Pilawski 2001).

The second barrier to the adoption of technology was the high level of investment required. Furthermore, to become operational, further investment was required in consumer acquisition (for stand-alone online banking services). The return on investment would be seen only once a critical mass of consumers had signed up to the new service (for stand-alone banking services), or when costs were reduced in the branch infrastructure (for banks developing a multichannel strategy).

Over time, banks developed successful, and relatively simple, approaches to overcome these barriers. The key features of their approaches included:

- creating a clear value proposition for the consumer
- effectively communicating to the consumer the benefits versus the risks
- building a strong business case.

Online banking offers a clear value to consumers as it is convenient, easy to use and accessible. In the case of online-only propositions, it also offered more attractive rates. For example, Egg Banking plc is the world's largest internet bank. Egg attracted customers by offering a proposition with clear value: in 2004, Egg became the first British card

company to offer an additional 0 per cent 'anniversary' balance transfer to both new and existing customers (Brand Republic 2004). This perceived utility and value played a key role in driving end-user uptake. Banks were effective in communicating this proposition through their marketing, which was particularly important given the perceived risks (for example, fraud).

Effective communication of the perceived value versus risk ratio was fundamental to driving consumer uptake of online banking: 'the diffusion of online banking is more determined by customer acceptance than by seller offerings' (Mols *et al* 1999, cited by Alsajjan and Dennis 2006). Banks achieved this by effectively communicating and explaining the benefits of online banking to their customers. For example, Nationwide tellers helped customers sign up to online banking services while they were in the branch.

Banks were also able to create clear business cases for online banking services. In addition to the strategic imperative of keeping up with competitors, they were able to construct cases relating to savings in traditional channels (branches). Given the ability of banks to take a relatively long-term macro-view they were able to justify the large investments required.

Travel sector: the story of online booking

The travel sector has also seen a significant increase in the use of technology at the consumer interface over the past 10 years. The internet is now widely employed as a tool for interfacing with consumers. For example, online booking is now the default method of booking a holiday, be it flight or hotel, with 55 per cent of internet users booking their holidays online (Nielsen 2006).

Extensive video, community, social network, and recommendation features allow travellers to find out in great detail about potential journeys and destinations, from Transport for London's journey planner to tripadvisor.com (Trip Advisor website). The use of the internet has meant that would-be travellers have access to a massive amount of information and a large choice of products and services.

Technology has also been used to improve the consumer experience of travel. For example, Transport for London's website offers live online underground train departure boards, Oyster cards have helped speed up journeys and reduce passenger congestion at barriers and ticket machines, and online check-in for flights is altering the set-up of airports.

With online travel booking, as with online banking, a number of obstacles needed to be overcome to reach widespread adoption and usage. Two of the main barriers to adoption by suppliers and consumers were:

- inertia in the industry as a result of embedded working practices and business models
- the challenge for unknown online-only providers, with no established reputation or track record, of gaining consumer acceptance.

The traditional travel industry, structured around sales through travel agents, was resistant to the development of a new channel that threatened its margins. As travel agents controlled a large share of industry sales, this had a significant effect.

The challenge of reputation was also significant in the early stages, when online travel providers were mainly new entrants. Consumers were naturally hesitant to buy high-price items (for example, flights and holidays) from providers with a limited track record or reputation.

The success of online travel is due largely to the strong value of the proposition: in many ways consumers are much better off booking through the internet. Some of the key ways in which the barriers were overcome included:

- building a proposition with strong value for online booking
- harnessing competition within the industry to stimulate innovative use of technology
- the existence of pre-existing systems that enabled online booking
- improved consumer experience.

The uptake of the use of online booking in the travel sector has been driven by the strong consumer value proposition compared with traditional channels. Online booking services (for example, lastminute.com) were able to offer cheaper holidays than high street travel agents because of cost savings resulting from cutting out the travel agent and attendant overheads. Furthermore, online services were able to offer the consumer more visibility and choice (for example, holiday websites can act as super-aggregators for a multitude of travel providers and agents).

The competitive environment led to an increased supply of online booking services. New entrants to the travel market, such as lastminute.com, raised the bar in the use of technology. This stimulated incumbents to innovate and launch their own online booking services. As the incumbents brought their trusted brands online, this helped to overcome consumer fears relating to the reputation of online suppliers.

From a technology point of view, the travel sector had the advantage of pre-existing IT systems (for example, Sabre, Galileo, Amadeus). Many of the services put in place by the online travel agencies made use of these pre-existing systems, making the incremental cost of development more affordable.

The good customer experience offered online also helped to drive the use of online booking services. Online travel booking can now be a better experience than traditional channels as a result of the provision of comparison tools (for example, tripadvisor.com) and video content of destinations (for example, Thomas Cook's website).

Conclusions

In the financial services and travel sectors, technology uptake has been successful despite barriers to adoption that mirror some of those seen in the health sector.

- Creating and communicating a clear value proposition is crucial: consumers need to see tangible benefits from using a technology, especially if risks are involved.
- A competitive environment stimulates the use of technology by service providers. This is particularly the case if new entrants, differentiated through technology use, are able to prompt incumbents into action.
- The ability to make investment decisions over the longer term with regard to the whole business increases the likelihood of implementation.

Appendix B

Technologies in the ideal scenario, 2018

In order to describe the ideal scenario for health care in 2018, we have drawn up a list of technologies that could potentially be in use in the 'age of abundance' scenario. As we have focused on the benefits rather than the underlying technologies themselves, this list is intended to be illustrative rather than comprehensive.

The work focused on those technologies that act at the consumer interface. This includes both direct-to-consumer (D2C) and consumer-to-consumer (C2C) but not business-to-business (B2B) technologies. This report provides examples from all specific consumer segments (maintaining health, receiving care and managing a condition).

The technology behind the application can be simple or cutting-edge. The nature and complexity of the technology is independent of the benefit it can bring. In fact, it may be the case that the simplest technologies bring the largest benefits to consumers. For this reason, future technologies still in development (nanotechnology, robotics) were not within the scope of this work.

We have divided the technologies into where they occur (home, hospital, and so on), the type of function they carry out (clinical, administrative, and so on) and the need area that they address.

Information and advice

Table B1 opposite shows applications that could meet the consumer need for information and advice in the ideal scenario.

Administration and transactions

Table B2 opposite shows applications that could meet the consumer need for administration and transactions in the ideal scenario.

Diagnosis

Table B3 (*see* p 42) shows applications that could meet the consumer need for diagnosis in the ideal scenario.

Consultations and clinical care

Table B4 (*see* pp 42–4) shows applications that could meet the consumer need for consultations and clinical care in the ideal scenario.

Monitoring

Table B5 (*see* pp 44–5) shows applications that could meet the consumer need for monitoring in the ideal scenario.

Table B1 Technology to provide information and advice in the ideal scenario

Application	Description	Location
Text message about pharmacy location	Text message pharmacy and drug finder – a service that would allow users to text a short code number with a specific question such as 'Where is my nearest pharmacy with migraine medication in stock?'.	Individual applications located anywhere
Nutritional content scanning	In future, it might be possible to scan all food items in a supermarket using a reader, on a mobile telephone, perhaps. Nutritional information could be displayed on the mobile device alongside advice from a health practitioner where necessary.	Individual applications located anywhere
Remote personal trainer	Mobile devices could collate your vital signs as well as, for example, the number of paces taken in a day. A personal trainer could access this data remotely and send users messages of encouragement or advice about the individual's fitness regime. It could also include warnings, such as the need for fluids, or glucose if the patient were diabetic.	Individual applications located anywhere
Digital health information including peer-to-peer networks	This would involve the online provision and sharing between patients of health information and support, for example, forums and social networking sites.	Individual applications located anywhere
National Health Service (NHS) care records	There would be one central repository of health care records, including a summary care record.	Hospital or general practice (GP) surgery (medical environment)
Patient information displays	Patient information displays would provide information about appointment waiting times and other relevant information.	Hospital or GP surgery (medical environment)

Table B2 Technology to cater for administration and transactions in the ideal scenario

Application	Description	Location
Appointment reminders via mobile telephone	Patients would automatically be sent reminders about their appointment a week in advance. It would include the appointment day and time as well as the cancellation number. Patients could also be sent text message notifications when their prescriptions were ready, for example.	Individual applications located anywhere
Text messaging payment for prescription charges	Premium rate text messaging (or another mobile telephone-based payment system) could be used to allow cashless payment for prescription charges.	Individual applications located anywhere
Electronic Prescription Service	The Electronic Prescription Service will enable prescribers, such as GPs and practice nurses, to send prescriptions electronically to a dispenser (such as a pharmacy) of the patient's choice. This will make the prescribing and dispensing process safer and more convenient for patients and staff.	Individual applications located anywhere
Equipment status monitoring	This system would enable equipment to be monitored remotely. Thus, if a piece of equipment stopped working or had a problem, it would notify the correct member of staff. Because equipment in hospitals is often mobile, it would need to move with the piece of equipment.	Hospital or GP surgery (medical environment)

Table B3 Technology to meet the need for diagnosis in the ideal scenario

Application	Description	Location
Multimedia messaging service (MMS) photographs to NHS Direct or similar	As the quality of cameras on mobile telephones gets better, there is potential to use them to send MMS messages of rashes, for example, to help with diagnosis.	Individual applications located anywhere
Diagnostic body area networks	As nanotechnology is developed, sensors can be made small enough to be swallowed by the patient. These could then perform diagnostic functions, from temperature and biochemical measurements to endoscopy. Data would be sent wirelessly to sensors on or close to the body.	Hospital or GP surgery (medical environment)

Table B4 Technology to meet the need for consultations and clinical care in the ideal scenario

Application	Description	Location
Medication alerts: intelligent pill dispensers	Patients would automatically be reminded if they had not taken their medication at the appropriate time. The pill box or bottle would be able to sense whether it had been opened each day at the appropriate time. If it had not been, it would be able to sound an alarm. Alternatively, it would send a message to the patient's home hub to notify a relative, a friend or the patient.	Individual applications located anywhere
Medication alerts: text messages	Patients would automatically be reminded to take their medication via a simple text message alert sent to them at the appropriate time(s) of the day.	Individual applications located anywhere
Medication alerts: intelligent medication	Patients would automatically be reminded if they had not taken their medication at the appropriate time. Sensors within the medication itself would be able to recognise whether it had been administered or not. If it had not, the medication would wirelessly send a message to the home hub to notify the relevant person.	Individual applications located anywhere
Mobile interpretation services	There would be two potentially different mobile interpretation services, one in which devices would automatically translate using voice-recognition technology, and another in which translators would be located in a call centre and the clinician would make a voice call using a wireless device such as a mobile telephone. Furthermore, for deaf people, the technology could include a screen displaying a person using sign language.	Individual applications located anywhere
Videoconferencing	There could be two uses of videoconferencing in the home in this context. The first would be between a patient and clinician for appointments/checkups: video could be particularly relevant if the clinician needed to see something, for example, how a wound was healing. The second use of videoconferencing could be between a patient and his or her family and friends, to allow 'visiting', of an elderly or disabled patient, for instance, without having to be physically present. Video would be better than traditional telephony as it would give relatives more peace of mind – they would actually be able to see that their family members were fit and well rather than just taking their word for it.	In the home
Interactive computerised therapy	Interactive computerised therapy could be used by patients in a home setting using any internet-enabled personal computer. There is the potential for the service to be extended to mobile wireless devices used out of the home.	In the home

Application	Description	Location
Visiting doctor's bag/personal digital assistant (PDA, palmtop computer)	These would be portable computers, specifically designed for health care professionals, that would include basic diagnostic testing equipment as well as decision support systems and access to online medical records, etc. They would also include technology for video and imagery.	In the home
Radio frequency identification (RFID) to track patients	The traditional hand-written tags that are currently used to identify a patient in a hospital would be replaced by RFID tags. RFID can hold a larger amount of information about patients, such as allergies, medication and long-term conditions. Additionally, RFID tags not only present a more robust way of identifying patients, but they can also be used to identify where patients are within the hospital.	Hospital or GP surgery (medical environment)
Diagnostic tests at the bedside	This system would facilitate the testing and instant analysis of blood or urine at the bedside. The results of these tests could then be uploaded wirelessly to the central system via the hospital wireless local area network.	Hospital or GP surgery (medical environment)
Picture archiving and communications system (PACS)	PACS, which is already in use in the NHS, enables images such as x-rays and scans to be stored electronically and viewed on screens, creating a near filmless process and improving diagnostics. Doctors and other health professionals can access and compare images at the touch of a button.	Hospital or GP surgery (medical environment)
Clinician PDAs	Portable computers specifically designed for health care professionals, these would include basic diagnostic testing equipment as well as decision support systems and access to online medical records, etc. They would also include technology for video and imagery. They would act as a portable clinician-specific personal computer so that clinicians could access patient details at any time, regardless of their location within the hospital.	Hospital or GP surgery (medical environment)
Vital-sign monitoring at the bedside	This application would consist of sensors that would wirelessly transmit vital signs to a computer or PDA. Clinicians would receive real-time information and would therefore be able to monitor patients from other locations if necessary. Any important changes in the vital signs would sound an alarm, and clinicians could also be alerted if they were not in the direct vicinity.	Hospital or GP surgery (medical environment)
Room-clean sensors	These would be sensors that can tell whether a room has been thoroughly cleaned by detecting antibacterial agents within the cleaning agent. This application is likely to be linked into the central map, so that staff could easily see which rooms were free, have been cleaned and when. This would also be a good way of ensuring that all rooms were cleaned at regular intervals.	Hospital or GP surgery (medical environment)
Smart cards	Smart cards are already in use in the NHS. They are similar in size and shape to a credit card, and contain a chip that records personal, contractual and health clearance information about clinicians. Additionally, smart cards could be extended to store information that could be used to regulate entry into certain areas in hospitals. Smart cards obviate the need for personal identification numbers (PINs) to be used on doors, the card simply being 'swiped' through or against a reader without the user touching anything but the smart card.	Hospital or GP surgery (medical environment)
Patient video displays	Patients would have a screen from which they could access a webcam at their home, if available, or a choice of webcams showing, for example, attractive views to make them feel less isolated in hospital.	Hospital or GP surgery (medical environment)

Application	Description	Location
Internet connectivity for patients	Patients and visitors would be able to access a public wireless network within the hospital to give them access to information and communication tools, and to make them feel less isolated.	Hospital or GP surgery (medical environment)

Table B5 Technology to meet the need for monitoring in the ideal scenario

Application	Description	Location
Infectious disease sensors	Sensors would measure levels of indicators that suggest ill health, such as body temperature. These sensors would be placed in public areas, such as airports, and would alert the system or a clinician if someone's body temperature were outside the normal range. Devices such as this could be used in an influenza pandemic, for example.	Individual applications located anywhere
Alarms/falls monitors (from patient to hub)	These alarms could either be triggered by patients themselves after they have fallen, or be triggered automatically using an accelerometer or some other technology that can detect a fall. The alarm itself would include a microphone and speaker to allow the wearer to talk to someone in a call centre (if they were able to speak). This would usually be in the home, but could also be deployed in care homes, hospitals at night, etc.	Individual applications located anywhere
Alarms/falls monitors (from hub to call centre)	Once a message is received from a patient's alarm, this would automatically activate a call to the call centre, or, in an emergency, would call the emergency services directly.	Individual applications located anywhere
In-body monitoring	Sensors could either be implanted to measure vital signs, or could be swallowed for a particular diagnostic test. The sensor would wirelessly transmit the results to a transceiver outside the body. There is a number of different applications for in-body monitoring. One example would be continuous measurement of vital signs, such as heart rate, blood pressure, etc, with the advantage to the patient that he or she would not need to be attached to anything. In addition, information from within the body could be the most accurate way of gauging vital signs. In-body sensors could be wirelessly recalibrated to adjust to changes in the patients' physiology/ morbidity, removing the need for surgical removal and reinstallation.	Individual applications located anywhere
In-body drug delivery	A sensor would be implanted in the body to measure levels of particular chemicals in the bloodstream. It would wirelessly transmit the results to a transceiver outside the body. There is a number of different applications for in-body drug delivery. For example, a sensor could continuously measure the blood glucose levels of a diabetic patient, sending this information to a terminal outside the body, which in turn would send a message to an insulin pump telling it exactly how much insulin should be released into the system. The terminal could also raise an alarm if the glucose level became dangerously high or low.	Individual applications located anywhere
On-body monitoring	This would consist of a pack that would monitor vital signs or, for example, the amount of vapour emitted from the skin. It would then transfer the information either to a wearable device (such as a watch or mobile telephone) or, if in the home, to the home hub.	Individual applications located anywhere

Application	Description	Location
Interface between body area network (BAN) and hub	The transceiver worn by the patient that collects data from the sensor inside the body will be able to store only a limited amount of data. The best solution to this problem is for the transceiver to download the data to a central hub. For ease of use, the transceiver will communicate with this hub whenever possible, either using wireless technology or, perhaps, mobile networks (if the data were collected on a mobile telephone).	Individual applications located anywhere
Home hub and sensors	Telecare and telehealth sensors (for example, vital-signs monitoring) would connect to a central hub, wirelessly (using a personal area network or local area network) or by wired communication, which would in turn then send the information to the clinician. Many would also interact with patients, asking questions or notifying them when their vital signs were out of range. There is currently a number of slightly different lifestyle monitors/sensors, but they are all aimed at monitoring ill or elderly people in their homes. They can be set up to suit the requirements of the individual, but typically they will monitor a person's daily routine and alert a call centre or relative if there is a major deviation from the norm. Environment monitors, such as sensors on fridges or taps, intruder sensors, and inactivity alarms could also have a role to play.	In the home

Appendix C

Workshop participants and interviewees

Workshop participants

An interactive, multi-stakeholder event took place at The King's Fund on 26 March 2008. It was attended by the following participants.

Stephen Adshead	?What If!
James Barlow	Imperial College
Ellen Burgess	?What If!
Anna Dixon	The King's Fund
Melissa Frewin	Intellect
Richard Hamerton-Stove	NHS Choices
Harry Hobson	Fathom Partners
Paul Hodgkin	Patient Opinion
Russell Jones	UK eHealth Association
Tamora Langley	Medical Technology Group
Alasdair Liddell	The King's Fund
Charles Lowe	London Borough of Newham Primary Care Trust
Ronnette Lucraft	NHS Direct
Eddy Peers	Mentis Management Consultants
Mark Platt	Long-term Conditions Alliance
Justin Whatling	BT

Interviewees

Interviews were conducted between 19 February and 9 May 2008. The following people participated:

Eileen Askham	Fold Group
James Barlow	Imperial College
Angela Coulter	Picker Institute
Adrian Flowerday	Docobo Ltd
Melissa Frewin	Intellect
Bob Gann	NHS Choices
Ross Good	Hawthorn Medical Practice, Lincolnshire
Sneh Khemka	BUPA
Katherine Leach	British Lung Foundation
David McCarron	Intel Corporation
Kevin McSorley	Fold Group
Sean Riddell	EMIS
Geoff Royston	Department of Health
Bridget Turner	Diabetes UK
Christoph Westerteicher	Philips Medical
Murray Bain	NHS Direct

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