EPSRC Response to RS Call for Evidence: Future Developments in ICT for Healthcare

Introduction

1. The Engineering and Physical Sciences Research Council (EPSRC) is responsible for promoting and supporting basic, strategic and applied research within its remit for the benefit of the UK. The EPSRC mission is:

- to promote and support, by any means, high quality basic, strategic and applied research and related postgraduate training in engineering and the physical sciences;
- to advance knowledge and technology, and provide trained engineers and scientists, to meet the needs of users and beneficiaries thereby contributing to the economic competitiveness of the United Kingdom and the quality of life of its citizens; and
- to provide advice, disseminate knowledge, and promote public understanding in the fields of engineering and the physical sciences.

2. The EPSRC currently invests approaching £500 million a year in the science base for research and training in engineering and physical sciences with a view to ensuring that the UK will be prepared for the next generation of technological change. Further details are available at http://www.epsrc.ac.uk.

3. The EPSRC welcomes the opportunity to respond to this call for evidence from the Royal Society in order to demonstrate its commitment to a healthy research base and to the knowledge economy.

Executive Summary

4. Health is a top priority for the UK, and will remain so in the context of an ageing society. However the dividing point between the working and ageing population is rapidly becoming blurred as people are 'required', and many may wish, to work longer. As a result the priority towards health should really be about a global investment since it will lead automatically to maintaining a sustainable workforce and thereby contributing to improved competitiveness of the UK economy. Moreover current standards of living and demographics lead to greater expectations of the quality of healthcare systems, and major

technological breakthroughs will contribute towards significant improvements in the healthcare sector. Current visions of innovation of healthcare systems converge in identifying the need for a systemic approach to tackling technological issues across various sectors and point towards the need for more of a system based approach possibly through the concept of technological platforms. This could be delivered through, for example, large focused integrated projects or programmes with a carefully defined agenda determined by consensus with some level of generic application. Such an approach is an important challenge and implies strong R&D policy commitments.

5. Within its remit, EPSRC supports a broad range of grants that are of relevance to the healthcare sector with a current total value of approximately £177 million. Along with research focused on finding solutions to disease-oriented problems, preventative medicine and engineering/physical sciences research which underpins basic medical research is also supported. This broad spectrum of research grants includes medical engineering, healthcare informatics, physics, photonics, mathematical sciences, systems architectures, materials, rehabilitation engineering, systems integration, imaging, Information and Communications Technology (ICT) and instrumentation. Among those, research in ICT with an impact on healthcare has become a growing part of EPSRC grants portfolio. EPSRC has recently carried out specific strategic investments, covering some aspects of ICT for healthcare, including a new cross-council programme entitled "New Dynamics of ageing"[1] (with ESRC, BBSRC and MRC), two Interdisciplinary Research Collaborations (IRC) in the areas of medical imaging[2] and tissue engineering[3] as well as a Multidisciplinary Assessment of Technology Centre for Healthcare (MATCH)[4]. Consequently, both via its responsive mode and managed activities, EPSRC has an increasing portfolio of active developing knowledge and expertise in the area of ICT for Healthcare.

6. Furthermore, in the context of the ten year Science and Innovation Investment Framework[5], EPSRC is keen to keep working in partnership with Universities, businesses and relevant healthcare sector organisations to support research that meets the needs of

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[1] http://www.epsrc.ac.uk/ResearchFunding/Programmes/InfrastructureAndEnvironment/Initiatives/ExtendingQualityLife(EQUAL)/TheNewDynamicsOfAgeing.htm
[2] http://www.mias-irc.org
[3] http://www.ukcte.org/
[4] http://www.nottingham.ac.uk/match/
[5] http://www.hm-treasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm

government, industry and society. EPSRC' main goals highlighted in the current delivery plan are to contribute towards a healthy UK science, technology and engineering base as well as to promote better exploitation[6]. Consequently, the role of EPSRC is complementary to that of other research investors, which include sister research councils, government agencies, the private sector and the EU (e.g. ERA-NET on ehealth) and, as a result, EPSRC seeks to take account of their priorities and of new developments in Europe and elsewhere[7]. It is highly appropriate therefore for EPSRC to provide information in response to the Royal Society's call for evidence. The information provided here relates to all categories of interest of the RS inquiry, current technological advances and future trends on the area of ICT for Healthcare in particular.

About this report

7. On EPSRC research funding, the information provided in this report relates mainly to the current technological advances and future trends in the area of ICT for Healthcare. This document is divided into seven sections. Each section represents both a technological challenge and a technological trend in which EPSRC has provided and/or is currently providing funding for the top-quality UK research in ICT solutions for healthcare. Those sections are as follows: Bio-medical implants, Standards and Interoperability, Trust and Security, Interfaces, Knowledge Management, Modeling and Simulation of Complex Systems, Mobile Health and Medical Administration Systems. Note that, except for the sections on mobile health and medical administration systems, the structure of this report follows closely that chosen by M. Cabrera and co-authors [8] in their recent European technical report on e-health.

8. In order to validate this report, a panel of experts (see acknowledgments section), whose role was to provide constructive input and feedback to the team that put together the evidence described below, was consulted during the preparation of this document.

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[6] EPSRC delivery plan 2005
[7] EPSRC annual report 2004-5 (http://www.epsrc.ac.uk/Publications/Corporate/AnnualReportAndAccounts2004-2005.htm)
[8] eHealth in 2010: Realising a Knowledge-based Approach to Healthcare in the EU, Institute for Prospective Technological Studies, p.53, 2004.

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Section 1: Bio-Medical Implants

9. Most breakthroughs in bio-medical implants are expected to come from the convergence of ICT, nanotechnologies and biology. Bio-medical implants and components should enable seamless and mobile care such as intelligent implantable drug dispensers. Key enabling technologies include:

- Bioinformatics
- DNA/protein sensors
- Self-powered micro- and nano- systems

10. One area which should be specifically mentioned is with regard to diagnostic biomarkers. Drug/biomarker combinations and profiling assays will be an important part of emerging healthcare as the transition towards more personalised medicine takes place. As more assays are developed, more molecular information will become available which might allow stratification of responder/non-responder profiles (with regard to administering a therapeutic). The ICT considerations are vast here. A good example of this is the recent Roche Diagnostics CYP450 amplichip[9], which focus on metabolism rates of the herceptin biomarker[10] for breast cancer treatment profiling.

11. Analysis of EPSRC's grant portfolio in the area of novel bio-materials, prosthetics, microsystems and nanotechnology shows that it currently supports 55 grants in this area for a total value reaching approximately £17 million.

12. One example is Professor Ian Bennion's research group at Aston University, funded via an EPSRC platform grant[11]. The group is carrying out a programme which seeks to advance and apply state-of-art photonic device and systems technologies to a spectrum of activities in biological science and medicine, with the purpose of creating a number of new diagnostic and therapeutic aids for medicine and surgery, and contributing novel investigative tools to advance understanding of cell behaviour. It proposes to conceive and deploy advanced optical fibre and planar waveguide components and techniques, using established and new materials and fabrication processes, to address areas of need in respiratory medicine, cancer

[9] http://www.roche-diagnostics.com/products_services/amplichip_cyp450.html
[10] http://www.herceptin.com/herceptin/
[11] EPSRC grant GR/S96432/01

therapies, cardiology, orthopaedics, ophthalmology, and other areas of human biomedicine. By close multidisciplinary collaborations, the programme aims to utilise powerful photonic sensing and measurement concepts to serve the development of new biocompatible materials and investigate the properties and motions of living cells, as an aid to tissue engineering. Many aspects of the programme take advantage of the biologically innocuous nature of optical fibres to target in-vivo applications, as microsurgical or therapeutic tools; ultimate goals in this direction reside in the realisation of optically activated actuators, in concert with new biomaterials, with numerous potential prosthetic applications[11]. This is an excellent example of how one specific area of ICT research i.e. photonics can have a tremendous impact on healthcare as a whole.

Section 2: Standards and Operability

13. Standards and interoperability are recognised to be important enabling factors e.g. the Electronic Health Record (EHR). Common references, vocabularies and ontologies are currently being developed but a lot more research needs to be done to reach the level of "Ambient Care"[12], as defined by the Information Society Technology Advisory Group (ISTAG), not only to facilitate cooperation across specialities, but also with respect to the "knowledgeable participating citizen". The main challenge is perhaps in ensuring sufficient interest and funding to create the infrastructures needed to make "Ambient Care" usable and deployable. Key players have so far been more focused on optimising their own processes rather than taking the whole system into consideration. As a result the sharing of data is perceived as being very facile but extracting sense out of the broad range of information available often proves extremely difficult since there is still no accepted set of concepts as common vocabulary. Solutions built on research projects have seldom transferred well to other real-life environments partly due to the fact that those are rarely fully evaluated.

14. EPSRC has recently started to fund research within this specific theme. Professor James Barlow of Imperial College, London was recently awarded an EPSRC grant for a total value approaching £700,000 to study the potential deployment of telecare/telemedicine within the homes of older people[13]. Working with housing and care

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[12] The Information Society Technology Advisory Group, see http://www.cordis.lu/ist/stag.htm, ISTAG-Scenarios of Ambient Intelligence in 2010 (ISTAG 2001)

[13] EPSRC grant GR/S29058/01

providers, his research team is looking at evaluating the deployment of a variety of telecare technologies in three contrasting housing settings - a large-scale care village, an extra-care facility and the mainstream private sector housing stock. Information from user-centred studies focusing on housing, health and social care needs will help to inform the type of telecare interventions that are made. Continuous data gathered through lifestyle monitoring and modelling will be integrated with expressed user needs and observed changes in the quality of life of users and carers to help identify where the intervention has made a difference. In parallel to the user-centred research, the team will also explore the impact of the interventions on the organisational processes of care delivery, drawing conclusions on the potential system-wide impact of telecare. The success of this project will certainly go some way in instigating the path for deployment of "Ambient care" in the UK and it also demonstrates the need for more research in this area. Another very relevant example is the work carried out by Dr Christine McLean of Manchester Business School, also supported by EPSRC[14]. Dr McLean is examining the role of information technology in the provision of an effectively managed and organised mental health service, with specific reference to the Care Programme Approach (CPA), the Health Electronic Record (HER) and the assessment of patients and mental health work. This involves examining the attempts to implement national programmes such as the CPA and the HER at a local level and the implications of these processes in terms of the different information requirements of the various user groups. Additionally, this project seeks to assess the ways in which technologies of assessment may support, undermine and interfere with each other in complex ways and become attached to alternative notions of objectivity, validity and truth. This involves investigating the manner in which the complex networks of humans, technologies, practices and beliefs may be presupposed and constituted in relation to the implementation of the CPA, the HER and with regard to notions such as accountability, participation, empowerment and control.

15. Like Barlow *et al.*, Dr McLean's research aims to further our understanding of the difficulties associated in implementing national programmes such as the CPA and the HER and it is likely to provide some solutions to very complex problems.

Section 3: Trust and Security

16. Considerable research is already underway into trust and security technologies such as encryption, identity management systems,

[14] EPSRC grant GR/R05864/01

biometrics, privacy enhancing technologies (PETs) etc. Some secure short-term applications are already being implemented for electronic health records. Based on PETs, modular access to medical records is often seen as a suitable conceptual model. Indeed the functions of different stakeholders (e.g. doctors, nurses, health administrations, social security systems etc.) are seen as the basis for access policies in combination with authorisation by citizens. User-friendly identification keys and management systems will then be required. Other conceptual models have also been proposed, for example splitting medical databases into two parts: one for identification data and one for other actual medical data. The latter would be available to healthcare professionals for research or statistical purposes. The link between a citizen's ID data and his/her medical data would be encrypted and only the citizen concerned would be able to grant access. However, in the case of an emergency, a specific and traceable procedure could be triggered, allowing access to clinicians[15].

17. EPSRC, through its ICT and e-science programmes, funds research in the broad area of trust and security and took part recently, in collaboration with the Office of Science and Technology (OST), the Department of Trade and industry (DTI) and the Economics and Social sciences Research Council (ESRC) in the launch of the Cybertrust & Crime Prevention Foresight Project[16]. There a number of research projects currently funded by EPSRC within the area of trust and security for healthcare applications. One recent EPSRC project[17], jointly awarded to Dr Jean Bacon of the University of Cambridge and Dr Naranker Dulay of Imperial College, London is for around £1 million; this project will investigate the interdependencies between trust, privacy, and security in the area of healthcare. Future large-scale healthcare will involve many different organisations cooperating in patient care, for example, hospitals, GPs, dentists, pharmacies, drug companies, and insurance companies. With the advent of new wireless healthcare products, it is becoming feasible to contemplate new applications that offer real-time healthcare to patients, and involve complex interactions between many services in many organisations. This scenario is ideal for investigating near-future pervasive computing environments in general. They will use healthcare as their application. In this project, they will investigate techniques for the organisation, management, and interoperation of trust domains as the basis for building large-scale trust-based applications. There is a need to collect and share evidence for use in making decisions based on trust but

[15] eHealth in 2010: Realising a Knowledge-based Approach to Healthcare in the EU, Institute for Prospective Technological Studies, p.54, 2004.
[16] http://www.foresight.gov.uk/Cyber_Trust_and_Crime_Prevention/
[17] EPSRC grant EP/C53719X/01

there is an inevitable tension between this information sharing and meeting personal and legal requirements for privacy[17] and this is an important issue in the area of healthcare.

Section 4: Interfaces

18. Future technological developments should make it possible to provide unobtrusive, and often invisible, interfaces in the context of a new knowledge based healthcare or "*Health-fare*"[18]. However, the real challenge remains in the inclusion of disabled people which has so far been little more than wishful thinking. However the government's recent long-term radical strategy for transforming the life chances of disabled people is a step in the right direction[19].

19. Advanced interfaces will have to be user-friendly, multimodal, multilingual and possibly even vocal (e.g. vocal internet browsers). Contextual awareness will represent a qualitative step towards efficient monitoring (e.g. intelligent and context sensitive monitoring systems). Answers to simple questions should be possible through context-oriented systems (e.g. where are you?, who are you with? etc.)[18]. Realistic context awareness should also consider context in its sociological sense (i.e. people's class, gender, ethnicity, family history etc.). Evidently this adds complication hence its incorporation into the design of interactive systems will be further away in the future than using location and identification for context aware services[20].

20. New personalised services will provide the required individualisation of information of personal health status and health self-promotion. In this focus, the ability of new services to offer configurable profiles is seen by many as one of the most advantageous features for UK citizens; interfaces will have to be adaptable, self-learning and self-monitoring. This is being explicitly recognised by companies (e.g. Philips) as they become lifestyle businesses hence there is now a real closeness between personal care and the healthcare market places.

21. It is worth pointing out that there is tremendous amount of research devoted to augmented reality displays which are likely to have a significant impact on assistive technologies. Direct brain-

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[18] Riva, 2003, *Ambient Intelligence in Healthcare*

[19] Improving the life chances of disabled people. Prime Minster's Strategy Unit. Office of the Deputy Prime Minister 2005

[20] A social and technological view of Ambient Intelligence in Everyday Life: What bends the tend?, Yves Punie, 2003

machine-network interfaces are also very promising new applications but research in this area is still some way from actual working prototypes.

22. To illustrate this, it is worth noting that EPSRC currently supports 75 research projects in the areas of user interface technologies and human-computer interaction for a total value of £22 million. Several of those research projects are likely to impact directly on healthcare in the future. For instance, Professor Ann Blandford's research group at the University College, London Interaction Centre (UCLIC), which is supported by EPSRC via a Platform Grant[21], is carrying out research in furthering our understanding of the use of complex information systems in a variety of contexts of use, as well as developing and testing novel design solutions that are tailored to those contexts, e.g. exploiting appropriate visualisation and multimodal interaction techniques. Professor Blandford's research also includes developing, testing and making available formally-based user interface design and evaluation tools, tailored to the demands of complex information systems[21]. This research is likely to impact directly on novel medical informatics and system development.

Section 5: Knowledge Management

23. One could be forgiven for thinking of every medical treatment/operation as a unique event/experience which could contain potentially valuable information especially when treated as part of a body of knowledge. However, only a very small amount of this information is actually fed back into the knowledge creation and sharing process. If all data were collected, processed, codified, stored and then fed back into medical practices, the benefits would be immense. Knowledge management is a crucial discipline for nearly all information technology services and the barriers to its implementation are specific to each sector. Moreover, with the growth of personalised medicine, there is an increased need to manage an increasing two-way knowledge flow rather than the one way system still considered at present and this creates some very strong challenges for future knowledge management.

24. Several tools have been developed to validate, aggregate, meta-analyse and synthesise the overload of medical information available; nevertheless the level of implementation of the most advanced current knowledge management tools in the health service remains low. This

[21] EPSRC Platform Grant GR/S73723/01 "The Design and Use of Complex Information Spaces"

results from the absence of suitable elicitation systems which will have to be created to extract all the knowledge available. As a result, specific research is required as well as advanced data mining tools and high standards of quality for data and information systems. Moreover the complexity of the healthcare systems available on the UK market will demand specific technologies for expert systems e.g. decision-support systems, workflow and knowledge management systems, equal management of clinical workflows, GRID-based applications and other specific applications such as Geographical information Systems (GIS), in order to keep patients informed of the location of medical service providers.

25. EPSRC, through its ICT programme, already funds research in this area. For example, Professor Mike Brady of the University of Oxford leads the eDiamond project[22] which aims to build a national database of mammographic images for use in the clinical management of breast disease. This is to be achieved by building the necessary Grid infrastructure through a partnership between the Oxford e-Science Centre, the MIAS IRC (From Medical ImAges and Signals to clinical information), IBM and Mirada Solutions. Working closely with clinical partners in four leading UK hospitals, Professor Brady and his team will use Grid technologies to develop tools that will allow this database to be used in clinical diagnoses, epidemiological studies, and in training and education of radiologists and clinicians. The project will take advantage of a key technology developed within the University of Oxford which allows the standardisation of images as they enter the database. This overcomes the major obstacle of confounding of information about breast tissue properties due to the major differences that can be introduced into image properties by different equipment and centres. This process is based on a mathematical model of the passage of x-ray photons through breast tissue, and is currently the only such standardisation process. This facility will provide a unique advantage for UK breast imaging. eDiamond brings together world-class medical image analysis expertise, computer science expertise, and clinical expertise, and will prototype and greatly aid the Government's electronic delivery of healthcare by providing an exemplar of the dynamic, best-evidence based approach to diagnosis and treatment made possible through the Grid. The potential problems of implementation of the research described in this example can be solved through coordination of research efforts between the different stakeholders i.e. research funding organisations e.g. EPSRC and MRC, healthcare companies, DH and NHS (through it modernisation agency).

[22] EPSRC grant GR/S20956/01

Section 6: Modelling and Simulation of Complex Systems

26. Modelling of complex systems (e.g. the human body) is a growing area of interest especially the study of the interactions between various sub-systems. One particular field of technologies with high potential impact on the training of healthcare professionals is that of virtual reality (VR). However, although a number of current robotic applications can help curing patients, a considerable push in research is required to provide efficient interfaces that can link the real world on one hand and the information systems and VR on the other.

27. EPSRC currently funds a number of projects focused on VR and its interface with robotic/information systems, several of which have a direct application on the healthcare sector. For example, Professor Guang Yang of Imperial College, London was recently awarded a research grant from EPSRC of £220k[23] for a project which addresses a new framework for extracting matched structural and surface properties for minimal access surgery. In this project, Professor Yang and his research group propose to define structural information from tomographic images and match that with visual surface properties from direct endoscopic images of the same patient. Registration of the taro data sets will allow the construction of highly realistic simulators for surgical training. The proposed research is a collaborative venture between the Visual Information Processing (VIP) Group of the Department of Computing, Imperial College, London, the National Heart and Lung Institute at the Brompton Hospital, and the Minimal Access Surgical Unit of Imperial College School of Medicine at St Mary's Hospital. The project aims to develop and validate a robust camera pose estimation method for structural based image registration, to establish a novel temporal correspondence scheme that exploits video frame-to-frame coherence for accelerating image registration and resolving 3D positional ambiguity of locally registered structures, to construct a photo-realistic texture rendering environment that is suitable for interactive viewing and navigation of virtual bronchoscopes, and eventually to develop a prototype real-patient case database and perform preliminary validation to assess its visual realism. The success of such a project may definitely impact on the future training of surgeons.

28. Another holistic approach to the human being in close connection with the social environment might require a virtual representation of

[23] EPSRC grant GR/R56822/01

the individual. The main advantage would be an increasing of the self-awareness of one's own body. This concept of a "virtual patient"[24] may serve this objective, as it is a holistic view of oneself (from a genetic, cellular, metabolic, skeletal, physiological, etc. point of view). The "virtual patient" would resemble the "avatar" in some respect by involving a sublimation of the perception and understanding of oneself or, in other words, a communication interface with oneself. The "virtual patient" would allow, for instance, the testing of a particular diet, drug or medical treatment before it is actually administered to the real patient.

29. In this section the association between innovative technology and the training of healthcare professionals is clearly highlighted. It is essential to point out that such association can only occur when engaging with the heads of leading schools of medicine, nursing, midwifery and professions allied to medicine, together with the professional bodies for example the Nursing and Midwifery Council, the General Medical Council and the Royal Societies.

Section 7: Mobile Health

30. One of several grand challenges in global ubiquitous computing is that of healthcare. It can be envisaged that by 2015 the entire UK population could be instrumented for systematic monitoring of metrics such as heart rate, skin conductivity, glycaemia level etc. and that this data is to be logged using secure wireless communications[25]. In the short-term, this would only be done for people really at risk thus allowing medical staff to take prompt remedial action. In the long-term, such technologies could benefit everyone regardless of their state of health. A second stage would be synchronisation of the information by making sure it is both up-to-date and consistent between patients, family members, carers, nurses, doctors, hospitals and emergency services. In a third stage, intervention could be implemented, at first via remote human advice and diagnostics, and possibly later via automatic responses. Risk management would be required at all stages of the process to ensure that quality of care comes first.

31. EPSRC has recently awarded a grant to Professor Morris Sloman of Imperial College, London through its Wired and wIreless NEtworkS

[24] eHealth in 2010: Realising a Knowledge-based Approach to Healthcare in the EU, Institute for Prospective Technological Studies, p.55, 2004.
[25] Grand challenge GC2/4
http://www.ukcrc.org.uk/grand_challenges/current/index.cfm

(WINES) initiative[26] for around £1 million. In this cutting-edge research project, Professor Sloman *et al.* aim to develop a new generation of intelligent biosensing networks that can combine information from multiple sources such as ECG, blood oxygenation level, temperature as well as current physical activity of the patient and report this to a remote monitoring service. This allows more accurate monitoring of patient conditions which can be analysed for predicting the occurrence of further adverse events. In addition, the collection of monitored information from many patients can be used in medical research to determine the general pattern and trend of certain chronic disease. Wireless based biosensors are more practical for monitoring patients as they maintain their normal activities as well as for combining information from multiple sensors. The intelligent sensors will be able to detect and recover from faulty components. The biosensor networks will be self-configuring so the network will automatically detect what sensors are available and how to communicate with a remote monitoring service - thus no technical skill will be needed to set up a sensor network. The demonstrator will be based on monitoring patients in a hospital who have had major surgery. There are many technical issues that need to be resolved. Some of the sensors may potentially be implanted, but even for on-body sensors, it is not practical to frequently change batteries. Technology requiring very low power for both signal processing and wireless communication is needed. Techniques of conserving power by switching off parts of the intelligent sensor, such as the wireless communications, when not needed, must be developed. New miniaturised techniques of generating power such as from heart or body movement must also be developed. Finally new types of sensing based on protein engineering are needed to determine what is actually happening within the body.

32. These biosensor networks have many medical applications including the monitoring of post-operative patients and those on complex therapeutic drug regimes (e.g. chemotherapy); patients with chronic disease (e.g. diabetes, heart or lung disease); and mental health patients whose behaviour in the community is dependent on their compliance with their drug treatment. This proposal will also address the long-term research issues of intelligent miniaturised biosensors. There is little doubt that such a project will yield exciting results and trigger further technological advances in this promising and reasonably recent area of research.

[26] EPSRC grant EP/C547586/01

33. Within mobile health it is essential to take into consideration the structure and organisation of healthcare, crucially the ability of the professionals on the ground to receive, interpret and process data generated through advanced technologies in a timely manner on a twenty-four hour a day, seven days a week basis. For example, it is rather obvious that information coming through of an alarming change in the white cell count of a patient at home receiving high dose chemotherapy needs to be received, accurately and quickly interpreted, and acted on to prevent the patient from succumbing to a life threatening status. However, the context of health service delivery and the knowledge, skills and skill mix of staff, together with the need for integrated, maintained and continually up dated hardware and software are but a few of the substantive components of infrastructure that are crucial to the uptake and use of computing technologies. This requires true co-operation between government, policy makers, research funders, research leads, health services and end-users.

Section 8: Medical Administration Systems

34. A high level of medical healthcare requires a high level of administrative efficiency. The procedures and systems that are in place have a significant impact on the quality of service. For example, the equipment used in radiotherapy is very expensive, and the expertise required by staff is very high. Therefore it is essential that the resources are used as efficiently as possible in order to treat as many patients as possible to as high a standard of effectiveness as possible. The scheduling of resources is a demanding, difficult and time consuming task. Recent years have witnessed a growing need to automate the management of the resources involved. However, this intelligent automation represents an extremely challenging and demanding scientific problem.

35. EPSRC are supporting a range of research projects which are investigating innovative new computational methodologies to facilitate the development of intelligent automated decision support software across a variety of decision making environments in medical administration. For example, Professor Burke is leading a project[27] which is developing new computational methodologies to effectively and efficiently generate healthcare personnel rosters. Such methodologies will underpin the development of systems to enable better rosters to be produced much more quickly than at present. The potential resource savings and the potential improvement of the quality of service are very high. Dr Petrovic and Professor Reeves are

[27] EPSRC grant GR/S31150/01

also working with hospitals to explore state of the art methodologies at the interface of Operational Research and Artificial Intelligence to build decision support systems to address the radiotherapy clinic scheduling problem discussed above[28].

Conclusions

36. From this report, it is apparent that there is already considerable research and innovation within the UK physical sciences and engineering base contributing to the development and implementation of ICT in healthcare applications. New technological trends are emerging all the time and the UK is at the forefront of innovative progress in this area. The real challenge remains in the implementation of those technologies within the health sector.

37. The recent meeting for the launch for the call for evidence at the Royal Society (14/07/05) highlighted this problem and sent a warning signal to the various stakeholders (technology providers, academic researchers, DH, NHS, funding bodies, medical staff, carers and patients). Unless communication between the stakeholders improves significantly, the language barriers that currently exist will not subside. Training of the new generations of researchers who are going to cross those barriers is therefore crucial; EPSRC schemes such as Doctoral Training Centres (DTC)[29] and the concept of "discipline hopping" have already gone some way in demonstrating how such training and experiences can be structured, but further work needs to be done. The research also needs to be made relevant to all end-users and its benefits should be highlighted more widely. RFID is an excellent example of a technology which is already being implemented in almost every sector including healthcare partly because of its simplicity of implementation. This ease of use and wide applicability will have to apply to other technologies if their implementation is to succeed within the healthcare sector. In the end, patients will hold the ultimate choice of taking up the new technologies or ignoring them altogether if the issues that matter to them are ignored e.g. privacy, design etc.

38. Simplification of processes in the health service will only be achieved through the take-up of the relevant technologies but this will

[28] EPSRC grant EP/C549511/1

[29] http://www.epsrc.ac.uk/ResearchFunding/Programmes/LifeSciencesInterface/DoctoralTrainingCentres/default.htm

have to be done while keeping humans in the loop and understanding the social aspects of telecare.

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