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Engineering the future

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Dr Nick Green
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Dear Dr Green

THE IMPACT OF ICT ON HEALTH AND HEALTHCARE

The IEE is pleased to respond to the Royal Society's call for evidence on the impact of ICT on health and healthcare in the next ten to fifteen years.

The IEE membership was consulted in preparing this response which was lead by the IT Sector Panel, on behalf of the IEE Trustees.

The IEE's 120,000 members are drawn from a broad range of engineering and ICT disciplines including members directly concerned with the technology of healthcare. The membership represents a wide range of functions from technical experts to business leaders. Many of the most experienced members of the IEE voluntarily participate in a variety of IEE policy guidance groups and there is also a Professional Network devoted to providing world class events, publications and networking on Healthcare Technologies. (See http://www.iee.org/oncomms/pn/healthtech/)

The IEE's response follows the questions posed in the call for evidence, with further information from the UK Computing Research Committee (UKCRC) at Annex A. The UKCRC is an Expert Group of the IEE, the BCS and the Council of Professors and Heads of Computing.

If you require further information or amplification of any aspect of this response, please do not hesitate to contact me.

Yours sincerely

p.p.
Graham Paterson
Head of Policy

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IMPACT OF ICT ON HEALTH AND HEALTHCARE
Evidence to the Royal Society from the Institution of Electrical Engineers (IEE)

IDENTIFYING RELEVANT FUTURE TECHNOLOGICAL DEVELOPMENTS

1 What relevant technology trends are likely to impact on health and healthcare in the next ten to fifteen years?

IT and communications applications are expected to develop rapidly . Likely innovations include:

- Methodologies for remote sensing and addressing individuals non-intrusively
- Ubiquitous connectivity: enabling patients to be monitored and interacted with 100% of the time.
- Integrated sensors and micro-machines: these will lead to a much improved ability to monitor biometrics and deliver drugs in a more continuous way.
- RFID: potential applications include hospital patient identification and treatment, security, and medication logging.
- Advanced Robotics: advances in robotics will provide support for surgeons and anaesthetists in their duties.
- Connectivity to international experts: a GP, for example, could have access to world experts on a particular disease sourcing papers, photos etc to help with their diagnosis.

Computing applications include:

- The Integrated Patient Record
- Security and Identity: reducing identity fraud and fraudulent use of medical insurance and facilities.
- Expert/knowledge-based systems for signal interpretation, image analysis and knowledge management.
- Methodologies for extracting relevant information from complex data for monitoring purposes and research.
- Information processing based on multi-cellular neural recordings used to interpret and control body movement.
- Computer modelling of human biology, accelerating drug discovery and making possible more personalised medicine.

Most of the healthcare opportunities result from the combination of two or more of these technologies.

Further information on developments in computing that will affect healthcare may be found at Annex A in evidence from the UK Computing Research Committee, an Expert Panel of the IEE, BCS and CPHC.

As the Human Genome Project, which is underpinned by huge computer processing power, is outside the scope of the enquiry, we have not addressed this in our evidence but would be pleased to provide further comment if required.

The IEE is holding a Forum on Medical Electronics on 14 September 2005. For further details please see http://conferences.iee.org/cti2005/medical_electronics.html

ASSESSING THE POTENTIAL POSITIVE AND NEGATIVE IMPACTS OF RELEVANT FUTURE TECHNOLOGICAL DEVELOPMENTS

2 What areas in the provision of health and healthcare could be positively or negatively affected by these developments?

Positive effects:

a) Advances in condition assessment, daily prognosis and avoidance of the development of critical situations requiring costly emergency actions, including:

- Remote testing of blood sugars or other blood chemistry; remote monitoring of pulse rates, blood pressure; heart monitors and foetal monitoring.
- Better diabetic care with improved reliability of readings and possible alerts / direct action for hyper or hypo-glycaemic incidents. Direct access to blood sugar readings by medical staff may improve patients' own behaviour with respect to maintaining good levels. Monitoring, and its associated actions, should reduce the long term effects of diabetes with great benefit to the patient and reduced load on the NHS.
- Improved monitoring of the frail/elderly in their own homes, for example using remote detection of movement sensors/access to domestic devices and generation of alerts on abnormal patterns.
- Monitoring persons in detention prone to self harm or suicide .

b) Reduced need to hospitalise patients to observe them. This could result in the separation of 'physical care' (other than pre-and post operative care, and emergency care) and 'medical treatment'. The possibility of picking up infections in hospital would be reduced. However, it would require an increase of nursing support at home or in nursing homes.

c) Cost-effective air quality monitoring for wide scale use could reduce health threatening effects for vulnerable groups.

d) Early indication of fatigue could reduce accident potential and loss of life, for example in the case of long distance vehicle drivers.

e) The use of optical sensor arrays / monitors and information extraction techniques for remote, non-intrusive monitoring of physiological conditions will provide cost effective opportunities whilst minimising trauma. For example:

- Stroke affects the lives of thousands of people with an annual cost of over £2.3 billion to the NHS. Assessing swallowing dysfunctions, a clinically common problem often associated with stroke, will have a high impact on rehabilitation, care, mortality rates and costs.
- Gait analysis is of paramount importance to a multitude of pathologies (diabetes, stroke, cerebral palsy, paralysis, etc.). Gait-lab, an expensive and laborious facility is the gold standard for acquiring data for clinical gait analysis. The construction of portable, intelligent and cheaper sensors is critical to the future development of diagnosis and treatment, e.g. electrical stimulation of spastic paralysis patients, etc.

f) True data reported on a regular basis: Information gained in real-life situations will be much more informative and accurate.

g) Better data for studies – with greater volumes of input, the capability to produce accurate and anonymous data for studies improves.

Negative effects:

The Hypochondriac effect will escalate as a result of ubiquitous connectivity. The more well-off members of society will tend towards a "Preventative Maintenance" approach to health. This will lead to them requiring treatments before symptoms are visible, or even before a condition has established itself. This will mean a huge increase in diagnostic work, much of which will be wasted. In theory this in-field monitoring and control will result in more people classing themselves as patients, however it should result in fewer patients needing to be hospitalised, so the net result may well not be as strongly negative as implied.

The ‘interventionalist’ effect is likely to escalate. People will learn that by monitoring a body parameter they can control something else. Perhaps the most obvious example is obesity and using Insulin to control weight, but there will be other cause/effect pairings. However, the body is a complex machine, and ‘corrective’ action will usually result in some other effect - which will need another corrective action, and so on. Instability of the body system will result and medical intervention will be necessary to return stability, or prevent death.

3 What actions should be undertaken now to maximise positive impacts, or to prevent or minimise adverse effects?

- A sizeable live trial of remote monitoring could gain real insight into the potential benefits and costs.
- International collaboration and standardisation could greatly reduce the costs of the necessary devices.
- The Government should initiate timely public debate on the ethical issues arising, including how to tackle the possibility of costs rising because more advanced and earlier treatment options will exist.

EVALUATING THE WIDER IMPLICATIONS OF RELEVANT FUTURE TECHNOLOGICAL DEVELOPMENTS

4 Do you have any concerns associated with the generation, release and subsequent use of personal data?

The main justifiable problem that people have about releasing data about themselves is the precautionary principle: once data is released there is nothing you can do to get it back.

At present the disjointed nature of governmental databases protects anonymity. Steps towards greater integration of any of this data must be supported by high-strength protection against misuse, particularly where commercial organisations are involved in providing services.

Advances in information and communication technologies need not lead to a reduction in privacy. On the contrary, advances in computer security technologies and in their mathematical bases can do much to empower the individual to make informed decisions and control access to their personal information, so long as these requirements are considered early enough in designing the systems architecture.

5 What medico-legal and ethical issues merit consideration when introducing new technologies, such as the responsibilities, processes and liabilities for decision making?

Liability issues are complex, and injuries caused by automation are generally less tolerable to society than injuries caused by an individual doctor. It may be desirable to introduce fault-free compensation and a statutory scale of damages, to reduce the expense and delays of litigation.

6 What regulations or other mechanisms (including standards) would facilitate the responsible development of relevant technologies?

Standards should be introduced to cover:

- Transmission of data from medical devices to the local communication devices
- Transmission of data from local communication devices to servers
- Processing and storage from servers to patient records or medical data repositories
- Facilities for patient-controlled encryption of personal data

Global harmonisation of standards and the advent of the third edition to IEC 60601-1 and associated particular standards, will have a significant impact on the design of medical devices, particularly with reference to those devices that contain programmable electronic systems This is currently an area of intense international standards activity. For example, the FDA's 510(k) regulation needs to be improved upon because it certifies equipment on the basis of equivalence of function to previous versions, without due regard for the internal design changes that have been made, making it inadequate to assure dependability of devices involving software.

As private companies can enter and leave the healthcare product market, a product's composition must be held securely on-file, to enable its independent replication if necessary. De-personalised product test results must be made public unless there is substantial reason why they should not; and personalised information must be held in secure file, with appropriate penalties for non-compliance.

7 What infrastructure would be required to allow any new technologies to be used effectively?

<u>IT Infrastructure</u>: Several levels of IT infrastructure would be required:

- Medical monitoring devices capable of transmitting data to a wireless device or downloading to an internet connected device. Such devices might also provide any local alerts
- Communication devices, local to a patient, to transmit to healthcare servers or to transmit alerts to other responsible parties. Here the existing widespread use of mobile devices should be tapped.
- Healthcare servers processing data. These would be responsible for:
  - data transformation, this may include filtering / sampling data before storing
  - transmitting data onwards to patient records
  - optionally providing the data in anonymous form to medical data repositories for the purpose of medical studies
  - alerting medical staff to untoward trends or immediate problems

  These servers do not have to be part of a national system; local IT systems for supporting alert mechanisms could be responsive to the local provision of such care. They must however be capable of feeding data into the national systems and this is where the standards become important.
- Communication devices local to parties responsible for taking action when alerted to any untoward events. It should be possible to use existing devices in this context as such alerts would not require any special protocol.

<u>Dependability of systems and software:</u>
Many applications in the health service will involve safety-critical systems and software. Such complex software systems need to be developed using appropriately rigorous engineering techniques, and shown to be adequately dependable through safety-cases. Users need to be

consulted from the outset in order to ensure that such systems meet the needs of clinicians and are practical for use as intended.

Availability of systems and software:
The more ICT is integrated into the healthcare system, the more attention needs to be given to minimising down-time (for whatever reason) and the availability of emergency power supplies and other reliable fall-back systems.

Medical profession and role of family or carers: The IT infrastructure is only one part of the requirement to support remote monitoring. The collected data must be reviewed and more particularly there must be a capability to handle alerts as they are raised. Alerts may not always require action to be taken by medical staff but responsibilities for taking action must always be clearly assigned. This may require co-operation between medical staff initiating a monitoring regime and family or carers who will receive the less urgent alerts.

Trials and demonstrators: There is a need to focus on building strong bridges between the computational / conceptual aspects of technology and the real life situations encountered by health practitioners via clearly meaningful demonstrators. For example, a small number of National Centres should be charged with testing and evaluating developments not produced internally but as a focus for exterior developers of systems. These might incorporate aspects of teaching hospitals blended with Industrial type test laboratories of a computational nature.

Legal Framework: The liability issues need to be examined and resolved as described earlier.

8 What are the most likely promoters and barriers to the take up of new ICT devices and systems?

Barriers:

a) Funding for genuine multidisciplinary demonstrator projects.
b) Cost
c) Inappropriate regulation
d) Resistance to change
e) Acceptability to providers and end users in the health sector, including security concerns

Promoters:

a) Political and economic pressures / needs
b) Commercial opportunities
c) Health threat awareness by the general public and the manner in which technology can alleviate it.

9 What education and training would need to accompany the introduction of any technologies, and who would need to be involved?

Patients: User interfaces should be kept as simple as possible and be usable without any specific training or background. The design would need to take into account patients with physical or mental disability. It should be possible to minimise, or eliminate, the training required by patients using remote monitoring. Device failures should be detected by servers and action taken rather than relying on patients to understand failures.

Medical staff should be able to review the patient data through the infrastructure which supports the electronic patient record. In this way the data is available to either hospital staff dealing with acute care or general practitioners.

Designers of the systems will need in depth technical skills. Increasingly these will be IT and Software skills, supplemented by a level of formal analysis and test which is uncommon today. Designers will increasingly need to work in multidisciplinary teams of life scientists, healthcare professionals and computer scientists. Specialists in Human Factors engineering will play an important part in these teams. Scientific societies and professional institutions could have a major role in providing interdisciplinary events and workshops.

Installers of the system will increasingly need no technical skills. In their case they will need to have an understanding of the configuration of the possible systems, and how the particular system is configured.

Bodies such as the IEE could have a role in providing vacation schools for multidisciplinary groups comprising healthcare operators, provider funders, technology developers and technology "bridge builders" to demonstrate and debate the technology, the healthcare problems, the fusion of technology and health care etc.

10 How are professional roles and responsibilities likely to be affected by the increasing use of ICT?

The availability of more data, and more accurate data, through the use of IT will lead to increased specialisation in medical staff. The shift towards greater outpatient care through remote monitoring and assistive technologies will lead to greater need for all disciplines to work effectively as part of a team. These changes are already under way, and increasing use of IT will accelerate them.

Research is being undertaken (for example the University of Cambridge CareGrid Project) into the development of "Trust Domains" to enable automated and secure trust-based decision making within large-scale real-time healthcare systems. Large-scale applications cannot rely on the traditional person in the trust decision loop, but must make use of automated trust decisions. See for example the CareGrid project based at the University of Cambridge Computing Laboratory. http://www.cl.cam.ac.uk/users/jmb/CareGrid.html

11 How can the development of technologies that meet patients and informal carers needs and are practically useable be best facilitated?

- By funding a number of real life demonstrator projects involving all necessary technology sectors, healthcare professionals, patients and carers.
- By investment in further research at the ICT/life sciences boundary.

12 What are the potential impacts of the costs of any of these new technologies?

The increased capabilities are likely to lead to increased demand for healthcare. However, earlier detection and intervention should reduce the need for more costly intervention later. The IEE is not in a position to weigh these two effects but the evidence indicates that the volume of follow up work generated by improved capabilities will be hugely expensive.

It is important that the impact is addressed systemically involving both professional staff and equipment. We already have examples of long waiting lists for Computer Assisted Tomography

(CAT) scanners because of a shortage of NHS radiographers and digital hearing aids due to a shortage of audiologists.

The UK is currently a world leader in aspects of medical ICT. By staying in the vanguard of developments in the responsible use of health informatics, we can ensure that the UK industry remains strong and contributes taxes, which in turn help fund the healthcare system.

13 What are the implications of the international use of future technological developments, such as global use of health data, variability of ICT-enabled support, and interoperability?

Assessment and monitoring of the type advocated opens possibility for trans-national processing of information of a non private nature which is already occurring in the domiciliary care sector (e.g. between the UK and the USA).

Annex A to IEE evidence

The IEE endorses the evidence of the UK Computing Research Committee, which is an expert Panel of the BCS, the IEE and the CPHC.

Please refer to accompanying pdf file.