

# Engineering Challenges towards Personalised Medicine

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## Introduction

Advances in medical science, biomedical engineering and molecular biology, coupled with social attitudes centred on consumer choice, point towards tailoring medical care to the specific needs of individual patients. The agenda of personalised medicine is further driven by growing economic, social and technological pressures, including:

- Cost of healthcare provision, in particular for the ageing population such as the management of chronic diseases and cancer. This has generated a growing demand for ambulatory care, autonomous monitoring and control, and intelligent decision support for clinicians and patients alike.
- Litigation, which diminishes margins for human error thus spurring greater reliance on technological assistance.
- The accelerating pace of science and technology which is opening up new and compelling possibilities for healthcare development with a concomitant growth in public expectations.
- Personalised medicine is at the cusp of a very considerable worldwide market, where the UK is well placed to assume a position of leadership. Success in exploiting this industrial base will impact on the balance of trade with our main economic competitors.

## Implications for policy on Science, Engineering and Technology (SET)

Sustainability of healthcare delivery and competitiveness of the UK industrial base must link three complementary strands:

- distributed research across a significant range of priority areas and providers in SET
- tailored specific clinical need through the Department of Health, and

- substantial improvements in regulatory and procurement practices to promote uptake by medical industry.

## Priority areas for Science, Engineering and Technology (SET)

Leadership in radically new models of healthcare delivery will in the future be even more dependent on rapid advances in SET. While there already are significant interdisciplinary funding initiatives with a healthcare focus, this review has identified the following priority areas for further consideration:

- Translational research – metabolic phenotyping can form the basis for targeted large-scale lifestyle interventions as well as mapping disease progression and response to therapy. Moreover, identification of disease sub-types and elucidation of phenotypic pathways open the way to personalised therapy including drug discovery, maximising response to therapy and minimising adverse effects. There is a considerable way to go in developing mathematical science and informatics for accurate and reliable modelling of these very large and complex biological networks.
- Multi-modal data fusion – integration of multiscale measurement from molecular biology through histology, electrophysiological measurement, morphological and functional imaging, to clinical signs and indeed population based hospital episode statistics, still has vast potential for delivery of decision support. This includes tailoring patient specific physiological models to clinical data, but extends to integration of electronic health records in large federated databases that are distributed, yet reliable and secure. Further exploration of the electromagnetic spectrum is still needed to devise novel minimally invasive analytical imaging modalities capable of operating at low cost.

- Convergent platforms – interoperability of clinical measurement platforms of different commercial sources and operating in different modalities and their integration into workable data management systems with multimedia patient records requires wide ranging research covering, among others, harmonised standards, wireless technologies that are reliable, efficient and effective, data fusion and information management with formal semantic ontologies.
- Decision support – objective measurement is still lacking in key areas of clinical management, including cytology. It is also recognised that best practice needs to be more consistent across healthcare providers, while failure reporting must become more systematic with systemic filters put in place using better decision support. Moreover, patient information needs to embrace the electronic age to cater for widely different levels of intended involvement in informed consent to treatment. This requires novel approaches to patient information. Considerable potential exists also for interactive models for self-care, in particular for younger age groups where chronic diseases can take a heavy toll casting a long shadow. Furthermore, autonomous, privacy protecting activity monitoring can enable independent living to a later age, especially in the face of episodic need for health or social care support.

In addition, public engagement is crucial in enabling the development of pre-emptive medicine to pre-empt high cost care. This is not just to ensure acceptance of novel forms of healthcare delivery, but also to expedite efficiency and effectiveness in design and deployment, the more so as models of care evolve from curative to preventive and so from passive to participatory.