

Foresight

Infectious Diseases: preparing for the future

OFFICE OF SCIENCE AND INNOVATION

D2: Introduction to the User Challenge Reviews

This paper has been commissioned as part of the UK Government's Foresight project, Infectious Diseases: preparing for the future. The views expressed do not represent the policy of any Government or organisation.

1 Introduction

The Foresight project, Infectious Diseases: preparing for the future, has considered how new systems for detection, identification and monitoring (DIM) could improve our ability to manage infectious diseases in the future. However, to simplify the analysis, the future DIM systems have been grouped into four broad classes - referred to as 'User Challenges' (UCs).

This document explains how the UCs were chosen, and describes the analysis that has been performed for each. In so doing, it introduces detailed reviews of the four UCs (reports D2.1 – D2.4), and also report D1, which provides a high-level overview of all of the User Challenge work. All of these documents may also be downloaded from www.foresight.gov.uk

2 How the User Challenges were chosen

The choice of the User Challenges was informed by three other parts of the project:

- Analysis of future disease threats (report T1) which identified eight important categories of diseases for which new DIM systems could play an important role. The DIM systems envisaged for each fell naturally into categories corresponding to the four User Challenges.
- Reviews of the state of natural science (S1). These were conducted in ten diverse fields – including intelligent sensor networks, non-invasive scanning, genomics and bioinformatics, biosensors and biomarkers, interrogation of natural signals and earth observation. The developments in science identified in these form the building blocks of future DIM systems. Again, it was found that certain of these areas of science fell into natural groupings, which also suggested the four User Challenges.
- The systems of governance and culture in which the User Challenges would need to operate. Such issues were considered to be particularly important, since they would play a large role in determining whether the systems would operate effectively within societies.

In March 2005, the science review authors and other technical experts and developers, met to explore future trends and begin the process of defining the UCs. The focus of the workshop was on technical capability and experts were encouraged to be creative and to think of 'blue sky' ideas as well as capabilities that have a high probability of being realised.

This process was continued in a 2-day international workshop, in which plant, animal and human infectious disease specialists were asked to identify diagnostic capabilities/tools that could make a significant impact on the management of infectious diseases and future threats. In particular, the workshop drew on African expertise to ensure that the capabilities identified would be appropriate for the DIM of infectious diseases in developing countries.

3 The User Challenges:

The four high-priority UCs that emerged from the above are set out below, together with the high-level stakeholder (User Challenge 'Champion') who agreed to oversee their analysis:

- **UC1:** Novel information technology for the capture, analysis and modelling of data for the early detection of infectious disease events. Champion: Professor Roy Anderson, Chief Scientific Adviser, MoD
- **UC2:** Early detection and characterisation of new or newly resistant/virulent pathogens using genomics and post genomics. This would require laboratory-based facilities (i.e. in contrast to UC3). Champion: Dr Debby Reynolds, Chief Veterinary Officer, Defra
- **UC3:** Taking technology for identification and characterisation of infectious diseases to individuals by designing smart swabs or hand held devices that particularly analyse fluids. Champion: Professor Sir Liam Donaldson, Chief Medical Officer, DoH
- **UC4:** High throughput screening for infectious diseases of people, animals and plants using surrogate, non-invasive markers (e.g. electromagnetic radiation, volatiles), for example in airports, containers and livestock markets. Champion: Angela Singh, Home Office

Two further UCs were identified:

- **UC5:** Surveillance to determine the distribution of vector-borne diseases involving sampling of vectors, diseased hosts or environmental parameters. In addition, analysis of this data and modelling to predict patterns of future disease risk and outbreak.
- **UC6:** Active environmental sampling of materials (e.g. food, water, rather than the host itself) which identifies pathogens for prevention and control.

Whilst UC5 and UC6 were not taken forward in their own right, it is noteworthy that the proposed 'requirements' could be realised through implementation of the other UCs. For example, the hand-held devices described by UC3 (especially if the output is linked into a UC1 network) could satisfy UC6 and aspects, if not all, of UC5. UC1, coupled with technologies described in UC3 and/or UC4 and UC2 sampling regimes, could be used to fully address UC5.

The table provided here was constructed to check that the high-priority UCs addressed the challenges of the eight exemplar disease categories. Each UC was awarded between 1 and 3 stars for each disease category – with 3 stars representing high potential of a particular UC to contribute to managing the disease. The table shows that every disease category received a three-star rating for at least one of the UCs, implying that future DIM systems could play a substantial role for each. Conversely, each UC received a three-star rating for at least one of the disease categories, implying that all of the UCs were potentially important.

Table: The extent to which each of the User Challenges could contribute to managing eight categories of infectious diseases that are likely to be important in the future.

Potential ranges from moderate () to high (***)*.

Categories of disease threat	Potential contribution to managing future risk			
	UC1	UC2	UC3	UC4
Novel pathogens	***	***	**	**
Pathogens acquiring resistance	***	**	***	*
Zoonoses	**	**	***	***
HIV/TB/Malaria	**	*	***	*
Epidemic plant diseases	***	*	***	***
Acute respiratory infections	***	**	***	***
Sexually transmitted infections	**	*	***	*
Trans-boundary animal diseases	***	**	***	***



4 The analysis of the User Challenges

Having selected the four high-priority User Challenges, these were then explored in detail through further workshops and specialist working groups. The analysis was also informed by papers that were commissioned to address the social, cultural and ethical issues associated with the implementation of the UCs. These papers considered the situation in both the UK and sub-Saharan Africa.

The aims of the analysis of the UCs were several. Firstly technology developments that might yield new DIM capabilities were considered. The analysis also considered the costs and benefits of the UCs in managing the future disease threats, from both a financial and socioeconomic perspective. It further analysed the barriers and enablers to achieving those future systems, and discussed the actions that could be considered - to maximise the public good, and to ensure effective development and implementation of the UCs. All of this is set out for each of the User Challenges in reports D2.1 – D2.4. These also include a roadmap which projects developments in technologies, applications and systems for the next 25 years against a background of drivers and trends.

Finally, it was considered important to consider issues affecting all the UCs, and their use in combination. In the future, the various UCs are expected to work together in integrated systems for disease management. These cross-User Challenge issues are detailed in report D1 which provides an overview of all the UC work, and also gives pen pictures of the use of the future DIM systems.

All the reports and papers produced within the Foresight project 'Infectious Diseases: preparing for the future,' may be downloaded from the Foresight website (www.foresight.gov.uk). Requests for hard copies may also be made through this website.

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