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article:

systemic surgery: a new social contract for health care

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Modern health care presents challenges for science and technology that go well beyond surgical procedures and physiological monitoring. But although technology is making a rod for policymakers' backs, it may also be throwing them a lifeline. The research focus is increasingly on information and communications technologies, which are opening up new possibilities in preventive health, self-diagnosis and even remote surgery. For a public accustomed to paternalistic medicine, the redistribution of R&D resources may come as a shock – but Europe's overstretched health services need more than sticking plaster solutions.

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Health care systems in Europe are under mounting pressure for a number of reasons. These include increased life expectancy, rising standards of living, ageing of the population, changes in family structures, greater personal mobility, new health treatments and technological innovations, and further integration and enlargement of the EU.

At the same time, constraints on financial resources are demanding that health services become more efficient and effective, while at the same time retaining their responsiveness to citizens' needs and expectations. The European model of health care is heading for some major changes that will involve a rethink of the roles of the state and the private sector, decentralization of the system, and more active participation by citizens in the clinical and policy decisionmaking process.¹

The purpose of this paper is to identify science and technology research challenges and opportunities that are relevant for tackling future challenges for European health care systems. The analysis is based on the results of several recent national foresight studies and other relevant technical documents. The conclusions provide a number of research priorities for science and technology in this field.

State of the Union

In general terms the health of the European population has never been better. Infant mortality has fallen sharply in recent years. People are living longer: from 1970 to 1997, life expectancy at birth has increased by more than six years on average in the European Union, ranging from 75 years (in Portugal) to 79 years (in Sweden, France and Italy). Nevertheless, Europe faces continuing changes in the health status of its population that cannot be ignored.²

First, there is a high level of premature death (one fifth of all deaths are premature, ie before the age of 65) from diseases related to lifestyle that are, to varying degrees, preventable. Cardiovascular diseases (CVD) continue to be the leading cause of death, causing half of all deaths and one third of permanent disabilities, and being responsible for a large proportion of health care costs. Cancer is the second leading cause of death, accounting for 20% of the total. External causes, such as accidents, homicide and suicide, are the third largest cause of death. These affect particularly adults in their twenties and thirties, and thus have a disproportionate effect on families as well as in economic terms.

Second, although mortality from infectious diseases is less significant compared with that from non-communicable diseases, the emergence of new infectious diseases such as AIDS, Lyme disease or Creutzfeldt Jacob Disease, and the re-emergence of old ones such as tuberculosis, diphtheria and cholera, are particularly notable. Some of these diseases are made worse by the growing problem of resistance to anti-microbial drugs.

Third, there is a substantial level of morbidity and disability from mental illness, musculo-skeletal diseases, diabetes and CVD. In addition there is an increase in the

1 C. Paton *et al*, *The Impact of Market Forces on Health Systems – A Review of the Evidence in the 15 European Union Member States*, European Health Management Association, Dublin, 2000; R.B. Saltman *et al*, eds, *Regulating Entrepreneurial Behaviour in European Healthcare Systems*, Open University Press, Buckingham, 2001.

2 *European Healthcare Reform: Analysis of Current Strategies*, WHO Regional Office for Europe, Copenhagen, 1997; *Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the Health Strategy of the European Community*, European Commission, COM(2000) 285 final, European Commission, 2000.

3 WHO, *ibid*.

4 E. Jakubowski, M. Perleth and R. Busse, *Best Practice: State of the Art and Perspectives in the EU for Improving the Effectiveness and Efficiency of European Health Systems*, European Commission, Directorate-General for Employment, Industrial Relations and Social Affairs, Luxembourg, 1999.

5 *Foresight: Making the Future Work for You*, Healthcare and Ageing Population Panels, UK Foresight Programme, DTI, London, 2000.

6 *Social and Health Policies in OECD Countries: A Survey of Current Programmes and Recent Developments*, Labour Market and Social Policy occasional paper No 33, OECD, Paris, 1998.

incidence of diseases related to old age, such as cancers, stroke and the impairment of functional capacity through physical disabilities and mental disorders – all factors of our lengthening life expectancy.

A growing body of research raises questions about the effectiveness and/or cost-effectiveness of various clinical procedures, as well as the appropriateness of their use for specific patients. In fact, up to 30% of all delivered clinical services may be considered to be ineffective.³ Even generally effective services are often used inappropriately. A range of interrelated activities aim to change this situation, including Evidence-based Medicine, Clinical Practice Guidelines and Health Technology Assessment.⁴

Management aspects

There are also concerns about inefficient management – and hence performance – at the micro and institutional level. Some of the problems include poor co-ordination among providers and across sub-sectors, lack of incentives for efficient service provision, lack of adequate information about the costs and quality of services, inadequate management of capital resources, and insufficient or inappropriate management at the institutional level. However, the growing focus on micro-level institutional activities has generated increasing concern about the quality of services delivered, as reflected in several surveys of patient satisfaction.

Performance of health care systems differs among European Union member states. For example, between 1970 and 1996 life expectancy increased from 70.0 to 77.4 years in Austria, but only from 73.5 to 75.8 years in Denmark. Within member states, differences between social classes, occupational groups, genders, ethnic groups and regions are much larger. Substantial evidence exists that poorer people, the disadvantaged and socially excluded groups have significantly higher health risks and mortality. Even in countries where health system structures provide universal access to services, there are growing inequalities in terms of access to services and quality of care.

The costs of health systems are a major charge on national budgets and are continuing to grow as resources chase rising demand. In the last three decades, health care expenditure in the EU as a percentage of GDP has substantially increased, from 5.3% in 1970 to 7.2% in 1980, 7.8% in 1990 and 8.6% in 1998. This trend is the result of several factors combined. In particular, the ageing of the population, with an increase in chronic diseases and disability, has exerted new pressures on health services. The pace of technology development has quickened over the past decade, generating new diagnostic techniques and treatments, increasing the demand for services.

Leaving aside the significant ethical issues raised, technology has different impacts on health care costs. On one hand, it may have a positive effect – by, for example, reducing the length of stay in hospital, or avoiding the need for complicated and expensive surgeries. On the other hand, technology developments may increase overall costs because more conditions can be treated. For example, the case of the uncoupling of mortality and morbidity in coronary heart disease and stroke has achieved a better survival rate, but also a trend towards multiple episodes of intense usage of health care.⁵ Moreover, issues of affordability, and the justification of new techniques and products, inevitably arise and need to be properly addressed.

Future challenges

In the next few decades, due to several socio-economic factors, the structure and organization of the European health care system will be under even greater pressure. The success of the system will depend on its ability to adjust to these new conditions.⁶

An ageing population

The European population is ageing markedly, both because of falling birth rates and increasing life expectancy. Both as a percentage of the population and in absolute terms, the population over 65 years is increasing in all parts of Europe, with the increases likely to be particularly large in southern and western Europe. By 2020, there will be 40% more people aged 75 and above than in 1990. This will have a significant impact on the health needs of the population and on the patterns of disease contributing to it, owing to higher levels of chronic disease and disability. It is likely to increase, and certain to change, demand for health services – and hence their organization and structure.

With more people living over 80 and 90 years, more people will need long-term health care services and specialized social services. The growing importance of the older population will also call for a change in the profile of health care professionals, while equipment, information and facilities will need to be reorganized to achieve better results. This is giving rise to some of the greatest concerns about financial sustainability. As the ratio of dependants to workers (the so-called ‘total dependency ratio’) rises from its current levels, the burden of funding the system falls on fewer people.

Projections about health care utilization and costs are more difficult. On the one hand, current per capita expenditure on health care increases with age, and if this relationship remains unchanged, a larger proportion of aged people will substantially increase health care costs. On the other hand, older people are now healthier than they were previously, and are likely to be even healthier in the future. At any given age, being healthier than the previous generation might, therefore, actually decrease health care needs – or at least shift the ‘cost-by-age curve’ to the right.

Changing disease patterns

Demographic transition, higher mobility of people (from inside and outside Europe) and the adoption of new lifestyles (new food habits, new work conditions, etc) are effecting deep changes in disease patterns. A shift from curative to preventive care, and from secondary and tertiary care to primary care, is mandated by the emergence of new diseases such as stress, and the return of old ones such as tuberculosis and malaria. The mounting risks of food-related diseases such as Bovine Spongiform Encephalopathy (BSE) also call for shifting funds.

In this framework, education and nutrition have an important role as preventive tools, and must be taken into account when designing health policies. At the same time, the organization and management structure of health services needs to be modified to respond to these changes. Existing structures and incentives should be analysed to determine whether they are satisfactorily addressing new disease patterns.

Higher expectations

Health services also have to respond to public expectations and concerns. An encouraging trend in the EU is the growing attention being paid to the views of the public in the planning and provision of services and setting priorities. The situation has

7 E. Mossialos and D. King, ‘Citizens and rationing: analysis of a European survey’, *Health Policy* Vol 49, No 1/2, 1999, pp 75-135.

8 WHO, *op cit*, Ref 2.

9 DTI, *op cit*, Ref 5.

10 DTI, *op cit*, Ref 5; *Key Technologies 2005*, Ministry of Economics, Finance and Industry, Paris, 2000; *Technology Foresight Ireland*, Irish Council for Science, Technology and Innovation, Dublin, 1998; *Technology Foresight: Progress Through Partnership*, Health and Life Science Panel, UK, 1995.

11 Ministry of Economics, Finance and Industry, *op cit*, Ref 10; Health and Life Science Panel, *op cit*, Ref 10.

12 Health and Life Science Panel, *op cit*, Ref 10.

13 *The Foresighted Society*, Swedish Business Development Agency (NUTEK), Stockholm, 2000.

14 *The Sixth Technology Forecast Survey: Future Technology in Japan Toward the Year 2025*, National Institute of Science and Technology Policy (NISTEP), Tokyo, 1997; *Delphi 1998*, Institute of Technology Assessment of the Austrian Academy of Science, Vienna; *Delphi '98, Studie zur Globalen Entwicklung von Wissenschaft und Technik*, BMBF/Fraunhofer Institut, Karlsruhe, 1998; Ministry of Economics, Finance and Industry, *op cit*, Ref 10; Health and Life Science Panel, *op cit*, Ref 10.

15 Health and Life Science Panel, *op cit*, Ref 10; Austrian Academy of Science, *op cit*, Ref 14; NUTEK, *op cit*, Ref 13.

become more complex with the increasing availability of information, especially over the internet, about health risks, diseases and therapies. Information technology development will contribute to that process, increasing the availability of health information among citizens, and consequently the opportunities for self-diagnosis, self-care and self-treatment.

The result of increasing expectations and demands on health services is a growing pressure on structures and budgets, since people are reluctant to accept any rationing of services. A 1998 *Eurobarometer* survey showed that a majority of the population still prefers unlimited funding for health care to setting limits for services.⁷ Health systems are in fact strongly influenced by the underlying norms and values of the societies within which they function.⁸ These fundamental values, while generated outside the formal structure of the health system, nevertheless affect its overall character and capacity.

A key indicator of a society's normative values is the very nature of health care itself. In European societies it is viewed as a predominantly social or collective good, in which all citizens benefit when an individual receives needed curative as well as preventive care. A related value is that of solidarity, in which the cost of care is intentionally cross-subsidized from the young to the old, from the rich to the poor and from the healthy to the sick, to ensure that all members of society receive needed care.

Moreover, the expectations of patients regarding the range of treatments and quality of services available have also increased in many European countries, putting health care professionals under great pressure to adopt the latest medical techniques available.

Science and technology in European health care

Bio-medical technologies

The development of medical technologies will provide new and improved therapies, medical treatments, diagnosis methods and techniques. Important innovations include genetic engineering, cloning, the production of new classes of pharmaceuticals, and research on replacement tissues and organs. The following technologies in particular look set to have a strong impact on the future structure and organization of health care systems and services:

- Genomic and proteomic technologies, gene and antisense therapies. These will enable viral and other diseases to be targeted at gene level through highly specific vaccines, correcting aberrant gene expression, compensating for loss of gene function, or selectively blocking a specific gene. Human genome research will provide insights into the genetic contribution to ageing and age-related disease conditions.⁹ Gene screening will also identify those people who may be predisposed or at risk to certain conditions and improve drug targeting.¹⁰
- Technologies for preventive medicine and diagnosis. Greater concentration on preventive medicine will reduce the frequency of misdiagnosis and reduce societal costs for treatments based on such diagnoses.¹¹ Individual risk assessment, based on genetic screening and lifestyle measures, will be possible for some diseases,¹² as well as ultra-rapid analysis using high-throughput screening.¹³
- Implants of medical devices and tissue engineering. A growing diffusion of bio-artificial organs, smart prosthesis, xenotransplants and biosensors is expected.¹⁴ Eventually, tissue engineering may replace the implant of medical devices.

Information and communication technologies

Information and communication technologies (ICTs) will be an important enabler of diagnosis and preventive medicine, providing improved data storage and retrieval, and a range of other capabilities using sensors and imaging technology. These technologies will be especially relevant in the following areas:

- Telecare and telemedicine, including the remote delivery of health care and support services and information to people in their own homes over the new high-speed digital telecommunication infrastructure; the remote exchange and delivery of medical diagnosis, consultation and information (doctor-to-doctor and doctor-to-patient).¹⁵ Telecoms and sensors will also allow remote monitoring of patients' condition or behaviour from a centralized facility. Furthermore, telecare and telemedicine will be crucial for providing health care services to rural areas at reduced cost, with consequent benefits for social cohesion.
- Integrating information technology, medical imaging and robotics, including image-processing, virtual reality, storage analysis and interpretation, robot-assisted and image-guided surgery.¹⁶ In particular, the development of less invasive surgery techniques will have a positive impact, reducing both the risk of failure and the length of stay in hospital (with a consequent reduction in the total number of beds required). Techniques for non-invasive tissue microscopy and tissue architecture visualization will be particularly critical for diagnosing diseased tissues.¹⁷ Strong support will come from developments in 3D image technologies.
- Decision support systems, including systems to provide information and analysis, or options to assist in diagnostic, therapeutic and prescription decisions, and to assist in organizing treatment plans. This system will be an essential complement to evidence-based medicine and medical information systems, improving the use of available information in diagnosis, prognosis, prescriptions and treatment options.¹⁸ A growing diffusion of smart cards with the full health history of individual patients is expected in the near future.¹⁹
- Bio-informatics is the science that uses biological data and knowledge stored in computer databases. There will be diffusion of databases containing gene sequence data and protein sequence data.²⁰ Furthermore, connections of health care centres to national electronic information networks for patient records and information will provide accurate diagnosis, treatment and outcomes.²¹

Living environment technologies

Social and demographic changes also bring a growing need for innovative forms of long-term care services.²² Historically, long-term care has been under the responsibility of family members and friends, without the intervention of the public sector. This situation is changing rapidly for many reasons, in particular the increase in the life expectancy of the elderly, and changes in family and neighbourhood structures. The number of households with one or two elderly persons living alone is increasing, while family nursing care capabilities are in decline (mainly due to women's greater involvement in the labour market). These trends will promote the development of home-based nursing care technologies as well as injury/disease prevention and self-management techniques.²³

The development of services that support the autonomy and independence of the elderly range from alternative forms of institutions to visiting nurse services; from new forms of home and community care services (eg home help and day care centers) to a better housing environment. Old-age welfare will shift to services focusing on home visits, to support the elderly and enable them to remain independent in their own

16 Health and Life Science Panel, *op cit*, Ref 10; BMBF, *op cit*, Ref 14.

17 *New Forces at Work – Industry Views of Critical Technologies*, RAND Critical Technologies Institute, Washington DC, 1998; Ministry of Economics, Finance and Industry, *op cit*, Ref 10; DTI, *op cit*, Ref 5.

18 Health and Life Science Panel, *op cit*, Ref 11; Ministry of Economics, Finance and Industry, *op cit*, Ref 10.

19 Austrian Academy of Science, *op cit*, Ref 14.

20 BMBF, *op cit*, Ref 14; Irish Council for Science, Technology and Innovation, *op cit*, Ref 10.

21 Health and Life Science Panel, *op cit*, Ref 10.

22 *Long Term Care Services to Older People, a Perspective on Future Needs: the Impact of an Improving Health of Older Persons*, Ageing Working Paper 4.2, OECD, Paris, 1998.

23 NISTEP, *op cit*, Ref 14; Austrian Academy of Science, *op cit*, Ref 14; DTI, *op cit*, Ref 5.

24 NISTEP, *op cit*, Ref 14; DTI, *op cit*, Ref 5.

25 *Ibid.*

26 EC, *op cit*, Ref 2.

homes. Additionally, sensors and information technologies for remote care delivery (tele-medicine and tele-diagnostic) will be crucial in increasing functional independence among older people in their homes.²⁴

Nutrition and education technologies

Preventive medicine will also rely on technologies that improve nutrition quality. Increasing knowledge about the effect of natural compounds on the human metabolism will enable food producers to develop new products that have positive effects on health. The production of novel 'nutraceuticals', also referred to as 'functional foods', with specific medical or physiological benefits, may enable a nutrition-based approach to the long-term maintenance of health.²⁵

Science and technology research priorities

A number of promising avenues of scientific research are opened up by the challenges facing public health:

- First, a shift in research emphasis towards preventive health techniques and methods is needed. This will include developing technologies to maintain patients in the primary system, and techniques for screening and risk assessment. In addition, effective health promotion (education programmes) and disease prevention measures (healthier nutrition and lifestyles) need to be developed. Preventive research is also needed to tackle new unknown diseases and the re-emergence of old ones, sometimes in drug-resistant forms, due to increasing population mobility. Finally, research on the causes of age-related diseases and their related therapies needs special attention.
- Second, there is a need for better instruments for assessing the effectiveness, cost-effectiveness and appropriateness of health technologies, especially where they concern new technologies, and in their nexus with the needs of people (so-called 'horizon scanning'). New methods to analyse and evaluate health care systems, as well as the creation of databases with relevant indicators, are future priorities. The analysis and comparison of different experiences in Europe (benchmarking) will be necessary for identifying best practice in health service delivery.²⁶ These results should then be clustered in a comprehensive Europe-wide health information system, to provide policymakers, health professionals and the general public with the key health information they need.
- Third, bio-medical technologies are an important research area. These range from new monitoring and diagnosis techniques, such as a global monitoring programme (associated with higher population mobility and migration), the use of GMO-based diagnostic tools (eg antibiotic resistance marker gene), and advanced ICTs (allowing complex and expensive diagnostic services to be centralized).
- Fourth, the profile of health care staff (nurses, doctors and pharmacists) has to change in response to the future needs and structure of health care systems. Training for specialists in health informatics, for example, or knowledge and data management, will be needed.

A conclusive observation is that although health care services are fundamentally concerned with improving health, they can have only a limited impact. Overall, health status seems to be determined predominantly by socio-economic status, behavioural and lifestyle factors. This implies a research approach that addresses wider environmental factors influencing the cost and take-up of health care services – and the complex links between them.