SOURCES OF TECHNOLOGICAL INNOVATION IN HEALTH CARE SERVICES

José Figueiredo
Instituto Politécnico de Santarém, Portugal
Vasco Eiriz
University of Minho, Portugal

ABSTRACT

Technological innovation is an important source of competitiveness in major sub-sectors of the services. In terms of health care services, evidence is much more diffuse. Additionally, the concept of technological innovation is very wide if we consider new medical equipment, new pharmaceutical products, new forms of contact with patients and new work processes. This paper intends to define a broad theoretical approach to the different sources of innovation technology that could develop competitiveness in health care services. Another important field explored suggests the evaluation of the impact of technological innovation in different sectors of the health care industry. The identification of sources of technological innovation and their relationship with different types of health care services may allow us to know more about the relationship between technological innovation and competitiveness in different areas of the health care service industry.

INTRODUCTION

The importance of the health care service industry is increasing. Like other service industries, health care relies heavily on technological development. The European Union has devoted increased attention to public health since the Maastricht Treaty of 1991. Banta and Oortwijn (2000) stated that "while health care has become increasingly effective during last decades, evidence has gradually emerged of substantial ineffective technology, as well as overuse and inappropriate use of health technology".

If we try to analyse the impact of technology on some service industries, there is probably a positive relationship between technology investments and competitiveness. In terms of health care services, this relationship is difficult to establish, because this sector is not seen as a business. Yasin and Yavas (1994) recognised the lack of business orientation in hospitals, even in the United States.

Another aspect that could bring additional problems when attempting to relate technological innovation and competitiveness in health care services is the ownership of the organisation. There are several types of ownership: private, public (government-owned) and mutual organisations (profit or non-profit oriented).

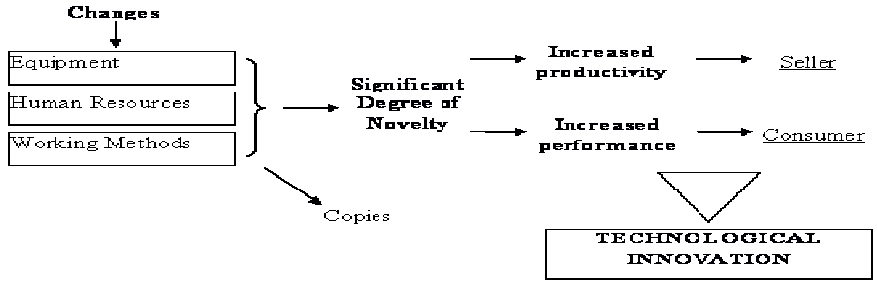
In this article, we identify sources of technological innovation and their meaning in terms of health care services, aiming to establish a relationship between technological innovation and competitiveness.

TECHNOLOGICAL INNOVATION

Innovation is more than just an invention, and relies particularly on new knowledge that will be developed on a technological basis. These developments may be led by customer needs, which will ultimately support the future commercialisation of new products, services or processes. Common sense tries to explain

innovation using the words, “big idea” or “great invention”, which does not perhaps represent a large part of innovation, such as like the small ones that affect our lives almost every day. In other words, "some of the most famous inventions of the nineteenth century were invented by men whose names are forgotten; the names which we associate with them are the entrepreneurs who brought them into commercial use” (Tidd et al, 2001, p. 39).

Figure 1: Technological innovation dynamics



Source: Authors, based on OECD, 1996.

For many authors, innovation is the development and initial commercialisation of a new technology; in terms of diffusion, it is the application of readily available and transferable technologies. Nevertheless, diffusion includes also a process of continuing incremental change after the initial acquisition of technology. Sometimes, diffusion bears some similarity to innovation, because incremental change in second stage development for an acquired technology could be seen as a pure innovation. In service industries, changes can come from different processes, knowledge, information technology, equipment, human resources, working methods or a combination of two or several sources. In any case, it is important that these changes should bring a significant degree of novelty. Finally, it is important to analyse the opinion from the viewpoint of the seller and from that of the consumer (Figure 1).

Porter (1990, p. 45) included improvements in technology and better methods or ways of doing things in the innovation concept. In his view, innovations could be product changes, process changes, new approaches to marketing, or new forms of distribution. He also stated that “much innovation, in practice, is rather mundane and incremental rather than radical”.

Technological development and innovation can also be seen in a network view. Ford (2002, p. 137) stated that “these processes (invention and innovation) occur between firms and not solely within them”, which enables us to envisage the complexity of networks within and around health care organisations.

The impact of technological innovation in health care services, particularly the new role of the internet and the development of clinical information systems, is huge. Andrew Grove, cited by Coddington et al (2000, p. 146), said that “we are in a period of major change that is dictated by the fact that consumers of health care services are ahead of the profession in their embrace of electronic means of getting information”. Processes in health care services will be recreated with tremendous speed and impact, sometimes without human touch. The Institute for the Future (1999, p. 5) saw the future in the following terms: “Overall, the future of the internet in medical care is that of a venue for real care management of many varied types, mostly achieved remotely”.

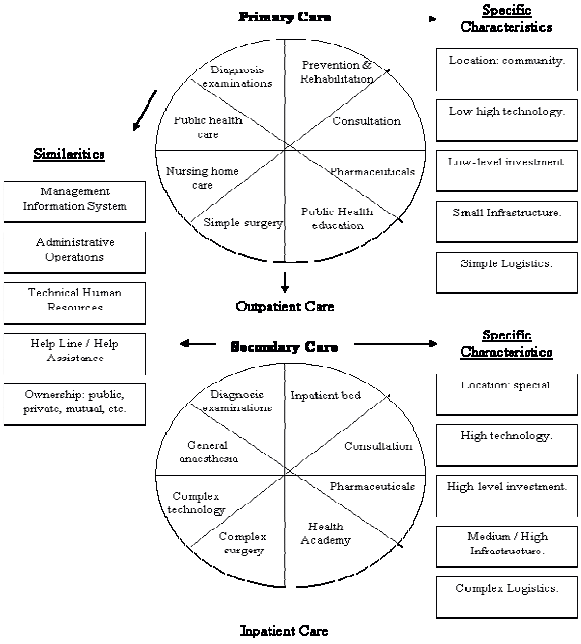
Finally, Jonsson et al (2002, p. 218) established their concept of technology when connected with health care as “broadly defined to include the drugs, devices, medical and surgical procedures used in health care, as well as measures for prevention and rehabilitation of disease, and the organisational and support systems in which health care is provided”.

HEALTH CARE SERVICES

Trying to define clear boundaries of health care services may be not an easy task. As Coddington et al (2000, p. 60) said, “the sectors of health care showing the most growth in recent years have been drugs, nursing

home care, home health, and other services (for example, personal care, administration)". Therefore, there is a large-scale mixture of services under the umbrella-term of health care services.

Figure 2: Health care service boundaries



Source: Authors

Lovelock et al (1999, p. 314), analysed the core product of health care insurance as "the core service, (…) includes a personal advisory team, health information line and immediate access to private healthcare treatment". Health insurance coverage includes inpatient and outpatient treatment.

Hospital, surgery centre, HMO (Health Maintenance Organisations), CT (computerized axial tomography), MRI (magnetic resonance imagers), X-rays, regional anaesthesia, coronary angioplasty, prevention, pharmaceuticals, etc. are common words that represent parts of health care services. Some of them are new, while others will lose their importance due to technological obsolescence.

A traditional way to analyse health care services, comes from the simple idea of primary care and secondary care (Figure 2). The role of primary care becomes more important, especially in prevention, aid in the community and immediate help. Secondary care is much more connected with surgery centres and specialized clinical care, normally located in hospitals. We also identify specialised care, like long-term care (connected with elderly and injured people), rehabilitation care, centres for drug treatment, etc.

Health care providers are associated to several outsourcing suppliers or contractors for service such as laundries, food services or housekeeping. Nevertheless, these are supplementary services of the health care service, with high importance in terms of patients' perception of quality, which means it requires a high level of control from the management of the health care provider.

The Baldridge National Quality Program (2002) defined health care services as "all services delivered by the organisation that involve professional clinical / medical judgment, including those delivered to the community".

Health care services can be seen also from the viewpoint of ownership. A state-owned hospital possibly has a different concept of quality of health care provided to patients than that of a private, a mutual or a religious hospital. This different view of the same concept could be the trigger to determine a different relationship between technological innovation and competitiveness. Possibly, it will be more difficult for a private hospital

to invest in high-tech solutions without the necessary economic view than it is for a non-profit health care organisation, despite the fact that both have patient satisfaction as their main objective.

HEALTH TECHNOLOGIES

The importance of health technologies in terms of health care effectiveness and costs is expressed by the support given by the European Commission to the creation of the EUR – ASSESS project, which intends to establish a co-ordinated European policy for health technology assessment in order to accomplish the following objectives (Banta and Oortwijn, 2000, p. 300): 1) to contribute to the effectiveness and cost-effectiveness of health care in Europe through improved HTA (health technological assessment); 2) to contribute to the development of institutions for healthcare technology assessment in Europe; 3) to strengthen the co-ordination of healthcare technology assessment in Europe; 4) to contribute to the development of methods of information transfer between European countries; 5) to guide the European Commission on how to strengthen and aid co-ordination of HTA activities in Europe.

Jonsson et al (2002, p. 213) said that "health technology is an indispensable part of any nation's healthcare system", noting that "during the past 50 years, all member states that comprise the European Union have increased their technological base for health care, both in terms of knowledge and by investments in equipment, devices, and pharmaceuticals". Woof and Henshall (2000, p. 598) focused on costs: "a major contributor to rising costs is the rapid emergence of new and expensive technologies (e.g. medical imaging, gene testing and therapy, and new drugs)". One of the latest developments in health technology within the European Union was the creation of ECHTA/ ECAHI in 2000. This broadly intends: 1) to disseminate information on health technology issues across European countries; 2) to develop and promote best practices in technological assessments; 3) to identify and share successful approaches to technological assessment and health indicators and the connection with healthcare decision-making.

Hagenfeldt et al (2002, p. 305) expressed the need for a HTA network organisation: "The development and diffusion of new pharmaceuticals, diagnostics, clinical procedures, and medical equipment are advancing at an accelerating speed. The supply of fragmented scientific information about medical innovations, and increasing public awareness of that subject, puts pressure on policy makers and health planning systems, especially where restrictions on healthcare funding are in place".

Medical technologies

Medical technologies probably represent one of the most innovative areas of health care services. It is also the most representative in terms of increased cost (Herzlinger, 1997, p. 204). In contrast to other industries, innovation technology in health care services is not reducing relative cost or increasing revenues more than costs. As mentioned before, medical devices, drugs or pharmaceuticals, as well as the procedures used in medical and surgical operations can be included in the category of medical technologies.

According to Siebert et al, (2002, p. 735), European Directive 93/42/EEC defines a medical device as "any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of: i) diagnosis, prevention, monitoring, treatment or alleviation of disease; ii) diagnosis, monitoring, treatment or alleviation of or compensation for an injury or handicap; iii) investigation, replacement or modification of the anatomy or of a physiological process; iv) control of conception, and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its functions by such means". Medical devices are the subject of constant incremental product innovation, which means their product life cycle is very short, between 18 to 24 months (Siebert et al, 2002, p. 736). This incremental improvement brings a serious problem in evaluating the efficiency of constantly innovated medical devices, because people that work with these devices must have a period of learning and training in order to make full use of their features and potential. Then, when the technical staff have learned enough to use the new medical device efficiently, the manufacturer launches a "new" and improved version of that device, which means the "older" device can be abandoned.

It is difficult for technical staff and patients to evaluate new devices and new technologies. Moreover, the manufacturer will use the first step usage of the new devices to make some adaptations and corrections according to the first trials, which means that the treatments – even for the same patient – will not have a constant "output". The process of evaluating new devices is complex because it has at least four different entities that decide on its efficiency and efficacy: the government, which normally pays for the new technology; the technical staff that actively work with the new technologies; manufacturers, who are the main risk investor in the entire process and will possibly be the main financial beneficiary of the process; and the patient, who has a difficult dual position – first, as the object of the new innovation product, secondly as the ultimate payer for the new technology (either as a taxpayer or as a normal client).

Siebert et al (2002, p. 740) concluded that "failure to reward innovative medical technologies will inhibit the further development of new life-enhancing and lifesaving technologies that patients need". This means that the public authorities in particular are always faced by a complex decision, because they need to combine medical effectiveness and benefits to patients with cost benefits.

Herzlinger (1997, p.206) describes several types of new technologies that have brought enormous advantages to the patient, reducing pain and adding comfort. Herzlinger assumes that "the key innovation came from a most unexpected source – the plastic industry" explaining that "Plastics revolutionized surgery with small plastic rods that are inserted through catheters (tubes) into natural body cavities – such as the mouth, penis, vagina, and nose – or into small holes punched into the body. These rods are fiberoptic light sources that illuminate the surgical site for the miniature cameras (endoscopes) and small surgical instruments that are also inserted through catheters. When these lights and cameras reach the surgical site, the surgeon can spring into action, using small instruments to operate, while watching the image of the site on a screen".

Coddington et al (2000, p. 16) are enthusiastic supporters of the use of new technologies in health care, establishing "… technology as one of the two or three most important factors influencing health care costs and quality over the past two decades". They explained the idea through the experience of a physician, "These new technologies (computerized tomography scanning (CT), magnetic resonance image (MRI) and ultrasound) cut down on the need for explanatory surgeries and enable physicians to do a better diagnostic job", which gives the idea of a better quality of life for the patient and possibly lower costs for the payers.

Nevertheless, Coddington et al (2000, p. 17) referred to pharmaceuticals as another high-level factor to impact on health care, mentioning the case of a doctor of internal medicine who said "the most important development in medicine in his years of practice – thirty-five years – has been effective drugs for treating hypertension". But these authors (2000, p. 87) see pharmaceuticals in the same way as medical devices, in terms of the cost impact on health care, when they say "New drugs. This has to be near the top of any list of factors pushing up health care expenditure, and there is no slow-down in sight".

We have also seen great innovations from genetics and biotechnology. Lemonick, cited by Coddington et al (2000, p. 176), said "Gene therapy and gene-based drugs are two ways we could benefit from our growing mastery of genetic science. But there will be others as well, including new kinds of vaccines, new sources of transplant tissue, even techniques doctors may someday use to stave off the aging process".

A report by the Boston Consulting Group (BCG), cited by Coddington et al (2000, p. 176), reveals "drug products reaching the market today often experience only 50% to 80% average efficacy, and experts estimate that as many as 20% to 50% of prescriptions written today are either ineffective or only marginally effective for the person taking the drug". This opens the door to new research. According to the BCG's study, "Genomics could help eliminate the estimated 20% to 50% of prescriptions that are ineffective".

Coddington et al (2000, p. 259) produced a study of different scenarios for future developments in health care services, placing a constant focus in each of the four different scenarios on two major change drivers: consumers and technologies. Consumers will demand more efficiency from health providers, and technologies will be a major source of change (radical or incremental) in improving quality of life and life expectancy. Helping to see the importance of new drugs innovativeness, the authors noted that "Advances in medications would reduce the need for some types of surgery (for example, open-heart surgery)".

Another area that has undergone major technological development in the last decades is medical procedures. Laparoscopic surgery was one of the most revolutionary changes, particularly because of popular use of the procedure and its immediate impact on quantitative figures, as expressed by Coddington et al (2000,

p. 17), “by 1993 more than a half million laparoscopic gallbladder surgeries had been performed (just in the USA)”. The laparoscopic procedure also started being used in different parts of the human body, as mentioned by Eubanks and Schauer (1996, p. 791), “other surgical applications for laparoscopic technology include thoracic, pediatric, gynaecological, urological, orthopedic, plastic, and ear, nose and throat surgery”. The new procedures made it possible to increase the quality of life of patients and allowed a different usage of infrastructures, as explained by Herzlinger (1997, p. 209), “an increasing number of these out-of-the-hospital surgeries are conducted in doctors’ offices”.

Prevention and rehabilitation

The simple idea of preventive care, in terms of eating less fat, not smoking and taking regular exercise, are part of public health education programs. These programs may be able to expand more through new ways of communication (electronic kiosks and the internet). Public and private health care services are investing more in new incentives to encourage the use of preventive care, mainly because it is a simple truth that early intervention is beneficial, bringing cost savings and better quality of life. In developed countries, it is now possible to have some special medical devices at home so as to control some basic, but fundamental, information on self-care.

Another important technological issue is the potential to use systems to manage available data on personal preventive care in order to acquire more updated information and to store larger amounts of data. Nevertheless, the use of information systems on primary care, and particularly on prevention, is not so widespread (Coddington et al, 2000).

Increased life expectancy is creating generations of elderly people all over the world. This leads to new needs and new knowledge in prevention, self-care and self-diagnosis. People know that prevention is beneficial, but general medical expenses are increasing, leading patients to use knowledge and some simple procedures and devices as the first step in creating a better quality of life.

The increasing power of patients also introduces more variables to health care. People are demanding more information on health, a fact that offers new opportunities to launch new communication media. The number of media for health care issues will exceed those from the late 1990s (Coddington et al, 2000, p. 263).

Like prevention, rehabilitation is part of primary care, even though it is closely connected with secondary care. Rehabilitation is also the subject of a high level of technological innovation, not only regarding medical equipment and devices (such as those related with orthopedics), but also in relation to some human functions as listening and seeing, and even the psychological side of the human being. Rehabilitation is becoming more important and expensive because people invest more in the quality of life.

Organizational and support systems

“Companies operating information-based services (…) are seeing the nature and scope of their businesses totally transformed by the advent of national (or even global) electronic delivery systems, including the internet and its best-known component, the World Wide Web”, Lovelock et al (1999, p. 12). Information systems are vital for every health care service organisation, not only because of general business requirements, but also because health care services are subject to many external interventions, such as regulatory authorities, insurance companies, consumers and legal organisations, and from every type of media. This information requires two types of reports. First, regular business information: number of patients; breakdown of patients by type of medical treatment received; breakdown of costs by type of expenses (medical fees, drugs, medical equipment, etc.); level of patient satisfaction and dissatisfaction; etc. Second, requests by external bodies, which could be very wide-ranging and in part unexpected information. This category can include databases covering the history of every patient’s object of assistance; records of all staff, technical and non-technical, in terms of professional and public liability; usage of medical equipment, devices and drugs; etc.

CONCLUSION AND FURTHER RESEARCH

Analysis of technological innovation in the different parts of the health care services industry reveals real and significant impacts in all areas. Magnetic resonance imagers, laparoscopic surgery, selective painkillers, computerised axial tomography, complex information systems and the internet represent some of the greatest recent technological innovations in the entire health care system, with real increased value for patients, in terms of quality of life and life expectancy.

While some of the best-known technological innovations are related with inpatient care, we can also find dramatic innovations in outpatient care. The increased importance of prevention, self-care, self-diagnosis, rehabilitation and long-term care have been made possible because technological advances make knowledge available everywhere, and common people also have access to some devices in a very user-friendly way.

It may also be concluded that major research into medical technologies happens in inpatient care situations, particularly in terms of major investments in new medical devices and new medical procedures. Nevertheless, some of the most innovative technologies appear at in outpatient care, where it is possible to mass market the innovative product or process.

Future research is required to support these findings through empirical research and to evaluate the real impact of technological innovation on health care services. In particular, this must focus on the relationship between technological innovation and competitiveness, which requires a detailed definition of competitiveness.

The research needs a clear focus and must define one specific part of the health care service. Otherwise, it may be difficult to extract conclusions properly, mainly due to the different type of health networks.

This delimitation should also apply to organisations with similar types of ownership. The first stage will be to select exclusively private health care organisations with inpatient and outpatient care operations, in order to avoid unacceptable comparisons with state-owned institutions. Secondly, it will focus on technological innovations related to medical technologies. This area of health care services nay be rather complex to evaluate, mainly due to the higher level of investment required and the high risk connected with new technologies. However, medical technologies possibly represent the most challenging part of the health care business, in terms of investment and also in terms of the networks involved.

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