

Innovation in hospitals: a survey of the literature

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Received: 18 January 2006 / Accepted: 22 September 2006 / Published online: 21 December 2006
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Abstract The literature on innovation in hospitals is relatively extensive and varied. The purpose of this article is to conduct a critical survey, and in particular to highlight the functional and occupational bias that characterises it, whereby the sole object of innovation is medical care, and that innovation is essentially the work of doctors. In order to achieve this objective, four different (complementary or competing) concepts of the hospital are considered. In the first, the hospital is seen in terms of its production function, in the second, as a set of technical capacities, in the third, as an information system, and in the fourth, as a service provider and a hub in a wider system of healthcare. In the latter approach, hospitals are regarded as combi-native providers of diverse and dynamic services, able to go beyond their own institutional boundaries by becoming part of larger networks of healthcare provision, which are themselves diverse and dynamic. This approach makes it possible to extend the model of hospital innovation to incorporate new forms of innovation and new actors in the innovation process, in accordance with the Schumpeterian tradition of openness.

Keywords Innovation · Hospitals · Survey

JEL Classification O3 · I1

Introduction

Innovation in hospitals is in itself scarcely a new problem. Knowledge and innovation in the area of health are inextricable elements of universal human history. This heritage undoubtedly explains a certain general tendency, in both the humanities and the social sciences, to underestimate innovation in hospitals. After all, it is *medical innovation* (in the sense of technical care systems and biopharmacology) that usually lies at the heart of investigations in this area. This bias concerning the nature of innovation goes hand in hand with a biased approach to the actors involved in innovation. Thus, it is the medical profession that occupies centre stage in the hospital innovation system. However, hospitals are complex service organisations that provide an extensive and open-ended range of services that both support and influence the quality of care.

The purpose of this paper is to compile a survey of the literature on innovation in hospitals and to highlight the numerous possible reservoirs of innovation. This literature can be divided into four groups of uneven size. The first group includes those studies by economists in which hospitals are considered in terms of the notion of *production function* and are broadly likened to firms. The characteristic shared by the second group of studies, which adopt an approach in which hospitals are seen as a *set of technological and biopharmacological capacities*, is that they emphasise *medical innovation*, that is the various types of (tangible and intangible) technological and biopharmacological innovations in the healthcare field. The third group comprises an increasingly large number of studies that consider the question of innovation in

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hospitals in terms of the introduction of *information systems*. In the fourth and final group, which is the most recent and probably the least voluminous, hospitals are seen as *providers of complex services and healthcare system hubs*. Here, the functional approach, in which hospitals are reduced to their function of healthcare providers, gives way to an approach that is both institutional (hospitals as providers of a multiplicity of diverse services) and network-based (hospitals as parts of larger networks of healthcare provision).

Hospitals as production functions

Health economics was initially constructed around the notion of the hospital as a production function, in other words as a firm like any other. After all, the notion of production function developed as a universal tool capable of accounting for any economic activity. Thus, Phelps [1] does not see the slightest difference between the production of cars and the production of healthcare. In both cases, the fundamental objective is to mobilise and combine production factors in order to create a product. In the case of a car, the production factors will be, for example, steel, plastic, labour, etc., while in the case of health services, the production factors will be ‘medical care’, that is a set of activities intended to restore or increase patients’ health capital.

The production function can be written as follows: $H = g(m)$, where H denotes the product ‘health’ and m ‘medical care’. The marginal productivity of medical care is assumed to be positive or, in other words, an increase in ‘medical care’ increases the restoration of health. In addition, returns to scale are assumed to be decreasing.

The medical care (m) that is described here, for simplicity’s sake, as a homogeneous activity, actually comprises a large number of variables [1]: capital (beds, diagnostic and therapeutic equipment, operating theatres, etc.), supplies (bed sheets, more or less sophisticated drugs, etc.), various types of workers (nurses, doctors, secretaries, managers, etc.) and patients, since they are themselves participants in their own care (co-production). Similarly, the product (H) is not homogeneous, since hospitals and doctors’ surgeries are like multi-task workshops producing a range of different products, each of which is specially tailored to a specific patient [1]. This production model does not differ fundamentally, therefore, from that of organisations such as hairdressing salons, motor vehicle or electronic equipment repair shops or grocery stores.

The notion of technique, it should be remembered, lies at the heart of the concept of production function, to the extent that technique is defined as a given combination of production factors (in this case, ‘methods’ of providing healthcare). *Changes in technique* can be explained by changes in the relative prices of these production factors. They are reflected in a shift along the production function. *Technological change* is reflected in the shift in the production function and expresses the notion that more ‘health’ (H) is being produced with unchanged quantities of production factors, that is ‘medical care’ (m), or that the same amount of health is produced with less medical care. Thus, from a dynamic perspective, the health production function can be written as follows: $H_t = g_t(m_t)$.

The literature on the hospital as a production function, and more specifically on the microeconomics of technical change and innovation in hospitals, is relatively extensive [2–5]. As Béjean and Gadreau [6] note, this standard approach to hospitals (and the producer–consumer model associated with it) emphasises the search for the optimum by relying on the definition of the rules governing public enterprise pricing. When applied to service activities, this approach also comes up against the traditional hypotheses relating to nomenclature, product anonymity and non-interaction. Some studies have sought to critique or adapt the notion of the hospital as a firm or production function. These studies have drawn in particular on the economics of bureaucracy, agency theory, convention theory and the new industrial economics (for a survey, see [6, 7]).

Hospitals as a ‘set of technological and biopharmacological capacities’

The focus of this second group of studies is *medical innovation*. This term is used here to denote the introduction and/or development of tangible or intangible technological innovations, or of ‘medicinal’ innovations at the heart of a hospital’s core business, namely the provision of medical care. Within this generic category, three sub-groups can be identified: (1) biomedical or biopharmacological innovation (new drugs, new chemical or pharmaceutical substances, etc.); (2) tangible medical innovation, i.e. the introduction of technical systems, whether based on capital goods or various small items of equipment and whether used for diagnostic or therapeutic purposes; and (3) intangible medical innovation, which encompasses treatment protocols, diagnostic or therapeutic strategies, etc.

This second, very heterogeneous group of studies is undoubtedly the largest in terms of volume. Its heterogeneity manifests itself in various ways:

- The discipline involved: there have been contributions from economists, sociologists and management experts, as well as experts, practitioners and professionals in the medical sector.
- Within these disciplines, the theoretical framework adopted varies considerably. Thus to focus just on economics, some studies are clearly in the neoclassical tradition (and constitute an extension of the studies outlined under ‘Hospitals as production functions’), while others adopt a heterodox, particularly evolutionary approach.
- Intellectual status: sophisticated theoretical constructions, empirical studies, simple case studies.
- The range of medical innovations covered (cf. typology presented above).
- The diversity of roles hospitals play in this medical innovation: adoption, adaptation, participation in the design, experiments, etc.

The main studies in this second group focus on (1) the nature of medical innovation, (2) its dynamic, and (3) its impacts.

The nature of medical innovation

This is the subject with which the vast majority of studies by experts and practitioners, published regularly in the numerous specialist magazines, are concerned. These essentially descriptive articles constitute veritable case study databases that social science researchers, who generally ignore this literature, could use to their advantage. For example, Schrayner [8] identifies 18 categories or sectors, which can be divided into three groups: single-use equipment, capital goods and implants.

Although they are much fewer in number, this group also includes some more theoretical inquiries into the nature of technologies. The classification developed by Thomas [9], for example, identifies three types of medical technologies:

- ‘Non-technologies’, which are applied to little-known and poorly understood diseases; these generally involve the provision of assistance and support for patients in situations in which remission is more or less inconceivable. This category would include the treatment of tuberculosis until the 1920s and of infections until the 1950s, and the treatment of AIDS until the introduction of combination therapy.

- ‘Halfway technologies’, which lead to a remission of the disease or enable patients’ lives to be adapted to their illnesses, albeit at relatively high cost. These technologies help to slow down the development of diseases, but have no real effect on the causes. They would include the treatment of tuberculosis in the 1930s by artificial pneumothorax and sending patients to sanatoriums. More recent examples would include organ transplantations, anti-cancer treatments (radiotherapy and chemotherapy), dialysis and combination therapies for AIDS patients.
- ‘High technologies’ (or ‘effective technologies’), which result from real understanding of the pathological mechanisms of the diseases in question. These high technologies can be used to prevent and cure diseases at low marginal cost. Immunisation programmes, antibiotics and vaccines would fall into this category.

The dynamic of medical innovation

All the humanities and social science disciplines have been concerned with this second general theme, but economics occupies a central position. The main theoretical problems addressed are the diffusion of medical innovation, its life cycle and its decreasing returns.

The diffusion of medical innovation

Numerous studies have revealed differentiated diffusion patterns, depending on the type of innovation in question [10–12]. Thus, according to Majnoni D’Intignano and Ulmann [13], innovations can be classified as follows by decreasing rapidity of diffusion: drugs and heavy equipment, complex procedures, and innovations requiring a coordinated network of out-patient and in-patient facilities. Moreover, the diffusion of innovation depends on many other factors, such as the existence of specialist teams with specific training, the degree of acceptance of the innovation within the population at large and even within the medical profession itself, government standards and controls and even the pricing system.

Although a wide range of themes is addressed in the literature on the diffusion of innovation, Paraponaris et al. [14] take the view that this question can be considered from three different perspectives, which they denote by the terms normative, analytical/descriptive and prescriptive. Normative studies seek to define the optimal configurations for the use and diffusion (rates and scale of diffusion) of medical innovation and its various elements. In order to achieve

their objective, the authors apply the traditional evaluation tools used by public economists, e.g. cost–benefit and cost–effectiveness analyses, to healthcare services [15]. Evans [16], for example, takes the view that the rush to innovate affects expenditure drift in health services, because medical innovations are introduced and diffused in haste without any prior economic evaluation such as cost–benefit analyses. Analytical/descriptive studies are given over essentially to examining the cognitive, socio-demographic and organisational factors that encourage or hinder the diffusion of medical innovations. Finally, prescriptive studies seek to identify the financial and organisational constraints and incentives that encourage and promote more rational (use) of the resources allocated to the healthcare system.

The life cycle of medical innovation

Some studies have revealed that medical innovations have relatively short life cycles or, in other words, that they are renewed or replaced very rapidly. Thus, Weisbrod [17] notes that, of the 200 drugs and substances most widely used 20 years ago, only 50 or so are still widely used today. He also notes that most of the diagnostic techniques and treatment protocols and techniques currently in use did not exist less than 50 years ago. More recent studies [18] describe in particular certain trends towards the replacement of invasive investigations with non-invasive procedures, of irradiating methods with non-irradiating methods and of standard surgical procedures with therapeutic techniques based on interventional radiology.

However, many studies [19–21] suggest that genuine substitutions are rare and that the life cycles of medical innovations can in fact be relatively long. In most cases, medical innovations are added to the panoply of existing diagnostic and therapeutic methods. Thus, for example, endoscopy has not supplanted radiological methods among gastroenterologists, despite its real effectiveness. And in the sphere of medical imaging, the widespread use of scanners has not led to any significant reduction in the number of standard radiological examinations, while MRI has not significantly reduced the number of scans carried out.

The decreasing returns to medical innovations

A number of studies have investigated the decreasing returns to medical innovations and the consequences thereof. These decreasing returns become evident as the innovation in question is diffused, whether as a result of its being repeated in the treatment of the same

patient or being applied to other patients or to other therapeutic indications [22–25].

For any given pathology, the diffusion of medical innovations contributes to a deterioration in the cost–effectiveness ratio. According to Paraponaris et al. [14], patient survival, or the quality of that survival (an indicator of the effectiveness of treatments), is increasingly less elastic to R&D expenditure, to investment in innovative technological equipment or to the introduction of new therapeutic strategies. However, the deterioration in the cost–effectiveness ratio is all the more rapid when the technique in question is applied to new indications. Thus, according to Majnoni D’Intignano and Ulmann [13], while hormone therapy and adjuvant combination chemotherapies are major innovations in the treatment of breast cancers, since they significantly extend life expectancy at a relatively low costs (€7,500 per year of life gained), one application of these therapies outside of the group in question multiplies costs by a factor of 10 or 15.

The impacts of medical innovation

This question can be considered in relation to a number of potential targets: quality of health, productivity, work organisation, the nature of that work, health expenditure, externalities, etc. We will confine ourselves here to examining these last three targets and, in particular, the question of the impacts of innovation on health expenditure and externalities, which seem to figure prominently in the literature. One additional, cross-cutting theme is evaluation (of medical technologies), the aim of which is both to verify the performance of the technologies in their practical applications and to assess their positive or negative consequences for individuals and the wider society [19, 25–27].

Medical innovation and health expenditure

Economists frequently tackle the question of medical innovation from the perspective of health costs: medical innovation is, after all, often regarded as the main factor in explaining the rise in health expenditure [28–32]. According to Newhouse [30], medical innovation explains half of the increase in medical expenditure in the USA over half a century. In France, L’horthy et al. [33] estimate that technical advances in medicine explain more than a quarter of the increase in health expenditure between 1970 and 1995. For his part, Weisbrod [17], who draws on Thomas’s typology, takes the view that the sharp increase in health expenditure is linked to the fact that the collective treatment of

many diseases has moved from stage 1 (non-technologies) to stage 2 (halfway technologies), with its associated higher costs.

However, the direction of causality between medical innovation and health expenditure is far from obvious. Some authors wonder whether the causality might not in fact be reversed, with technological innovation being the result rather than the cause of increased health expenditure [19]. It should be noted, furthermore, that what is problematic is less the absolute level of health expenditure than the increasing ineffectiveness of this expenditure relative to the results achieved [13, 34]. Thus, for example, the development of vaccines and antibiotics in the 1950s led to significant improvements in health at relatively low cost. On the other hand, the technical progress achieved in the 1970s and 1980s (in spheres such as organ transplants, chemotherapy and medical imaging) led to a greater increase in expenditure, but a relatively smaller gain in terms of collective health. Finally, in the 1990s, the cost of treatments for cancer and cardiovascular diseases increased rapidly but the health effects were modest.

Medical innovation, healthcare quality and well-being

A certain number of studies have focussed on the relationship between medical innovation and healthcare quality and, more generally, on the impacts of medical innovation on well-being, whether individual or collective. These studies assess quality on the basis of criteria such as technical effectiveness, safety and comfort, accessibility (physical and moral) and the cost savings achieved [19].

Technical effectiveness is essentially a measure of the impact of medical innovation on the reduction of mortality, morbidity or infirmity. De Kervasdoué and Lacroque [19] note that any evaluation of technical effectiveness is concerned primarily with 'medicinal' innovations and, to a lesser extent, with instrumental innovation, but never with organisational innovation, for which there are no reliable evaluation methods.

Safety and patient comfort are the quality characteristics associated with the non-invasive technological trajectories, analyses and examinations based on simple automatic manipulation techniques. These innovations are associated with a considerable reduction in the undesirable effects and possible problems likely to damage a patient's quality of life.

The (physical and moral) accessibility of healthcare is a quality characteristic that relates both to organisational innovations (e.g. day-units or the 'hospital at

home', which provide access to care while at the same time avoiding hospitalisation in the conventional sense) and technological innovations linked in particular to telecommunications, which facilitate access to health services (e.g. computerised appointment management systems, telemedicine).

Finally, the economic criterion describes innovation trajectories based on the reduction of the unit cost of healthcare and thus on the careful use of resources.

Any improvement in one or other of these variables is regarded as a contribution to healthcare quality and increased well-being, even if it has no effect on technical effectiveness (in the sense of reduced mortality, morbidity or infirmity).

There are also a number of studies given over to the general theme of evaluating the effects of technological progress and innovative procedures on the quality of patients' (extended) lives [21, 35]. Thus, Weinstein and Stason [36] and Williams [37] develop a synthetic indicator of the 'quantity and quality of survival' (QALY: 'quality-adjusted life years'), which can be used as a basis for analysing a treatment in terms of both life expectancy and survival quality.

Medical innovation and the nature of work

Medical innovation fundamentally alters the nature of medical care. The relational aspect of providing healthcare tends to be replaced by a logistical process whereby the patient is transferred from one technical system to the other [38]. In consequence, technical acts increasingly replace relational acts and technical time is increasingly substituted for relational time, which also gives rise to changes in management and monitoring systems, since it is easier to measure technical time than relational time.

The new medical technologies are also contributing to the break-up of the traditional notion of a profession and to the emergence of new professions. The medical professions are increasingly entering a period of integration characterised by a blurring of the traditional boundaries between, for example, biology and clinical practice (development of predictive medicine) and between medicine and surgery (development of interventional techniques), as well as between research and clinical practice and between health and social services [39]. The use of new technologies leads to the emergence of new competences. For example, the development of non-invasive techniques means that surgeons and their teams work with conscious patients, whereas they used to operate on patients under anaesthetic. The need to manage this new service

relationship gives rise to changes in behaviour and competences for all operating theatre personnel.

Hospitals as information systems

In the literature, innovation in services is very often reduced to the introduction of new information and communication technologies (NICTs) [40]. It is true that, for several decades, services have been the main users of this type of technology. Hospitals are not, of course, immune to the pervasive diffusion of NICTs. Consequently, a significant number of studies have taken as their starting point the notion of the *hospital as an information system* and examined innovation in hospitals in terms of its relations with the informational paradigm. There has even been talk of a trend towards so-called digital hospitals, in which the use of paper is greatly reduced and fully integrated IT systems are a ubiquitous presence, with computer terminals even located at patients' bedsides.

In surveying the literature on innovation in hospitals considered from this point of view, a distinction has to be made—albeit an artificial one in some cases—between *information technology applied to administration (informational and material flows)* and *information technology applied to medical care itself*.

NICTs and the management of informational and material flows

Information technology swept through hospital administrative departments as early as the mid-1960s. It was only later that it was applied, first, in logistical departments (management of material flows) and then in medico-technical departments [41–44].

A number of studies [45, 46] are given over to the development of more or less sophisticated typologies of NICT applications or of the various hospital management systems. Sachot [46], for example, identifies four separate management systems: a patient management system (comprising an administrative and a medical component); a production input management system (i.e. pharmacy and other supplies, as well as personnel); a system for managing production units; and a system for managing production itself (which extends from patient reception to discharge and billing).

There is nothing to separate this literature from that devoted to other types of service activities. The analyses focus primarily on the impacts of NICTs on various economic variables: quality, work organisation and, in particular, productivity and employment. These

last two variables will be examined in '[The effects of NICTs on employment and productivity](#)' below.

NICTs applied to medical care

We are dealing here with medical technologies, that is with technologies applied to patient care, in whatever form that care may take, whether diagnosis, treatment or monitoring. These technologies have emerged much more recently than those deployed for administrative purposes [47].

It is useful, in investigating the nature of these technological innovations, to make a distinction between two major groups of technologies: (1) hybrid medical technologies that have an NICT component added to other technological elements (robotics, transport, etc.); and (2) NICTs that facilitate the delivery of healthcare remotely (principally telemedicine).

Hybrid medical technologies (i.e. those that combine NICTs with more traditional, material processing technologies) have been the subject of numerous studies [48, 49] that are essentially analytical/descriptive in nature (description of the technology, analysis of its impact in organisational terms). The examples most frequently investigated include computer-assisted diagnosis, medical monitoring, automatic diagnostic equipment and video surgery. Imaging (MRI, scanography, video endoscopy, etc.) is often regarded as the medical technology that has benefited most from progress in IT, automatics and video. The principal themes of studies devoted to these hybrid medical technologies are generally the same as those already mentioned in '[Hospitals as a “set of technological and biopharmaceutical capacities”](#)' above that deal with medical innovation from the point of view of the hospital as a 'set of technological and biopharmaceutical capacities' (diffusion and impact on the quality of care and well-being, for example).

Telemedicine already has its particular spheres of application, such as obstetrics and, more generally, perinatality, but other areas are also affected, including emergency services, out-patient clinics and treatment centres, prisons and retirement homes [50]. In each of these sectors, there are many possible spheres of application, including remote consultations, visio-communication, teleconferencing, telemonitoring [51]. Over and above the sometimes very detailed description of the possible uses and the (sometimes unfulfilled) promises of the application of NICTs to remote medicine, two major research concerns can be identified. Firstly, investigations of telemedicine are often associated with more general enquiries into the

development of care networks [52]. The other major preoccupation is with hospital treatment provided in the home [53–55]. Studies in this second group focus in particular on the social and ethical implications of home care, the economic impact of high-tech home care and the effects of NICTs on patients and their families. These two groups of studies are sometimes accompanied by economic or sociological analyses of access to healthcare, particularly in areas with low levels of provision [56] or among certain social groups (the elderly in particular).

The effects of NICTs on employment and productivity

Studies that approach innovation from the perspective of NICTs, on the one hand, and from that of the hospital as a set of technological and biopharmacological capacities, on the other, share a number of concerns (diffusion, impacts on quality of healthcare and well-being, for example). However, one important differentiating characteristic is the focus, in the first group, on the effects of NICTs on jobs and productivity. These last two questions are essentially, though not exclusively, associated with the administrative applications of NICTs.

NICTs and the question of employment and skills

A very large number of studies have investigated the effects of NICTs on employment, in both its quantitative and qualitative aspects [45, 57–59]. The following are some of the main concerns of these studies: the volume of jobs, the nature of work and employment, the demarcation lines between tasks, the new professions, payment systems, monitoring of work, internal mobility (career opportunities), etc. This is not of course an exhaustive list, nor can the individual themes be considered independently of each other.

Paradoxically, the finding on which there seems to be unanimity is that the introduction of NICTs seems to have had relatively little impact in terms of reducing the volume of hospital jobs. It would appear that new technologies are supplementing rather than replacing existing functions and procedures. As far as the more qualitative aspects of employment are concerned, the findings also tend to show that the impact of NICTs has been positive rather than negative. In his studies of the American hospital system, Stanback [45] found that the work done by administrative staff and nurses had widened in scope and that their responsibilities had increased; there were also new career opportunities,

which reflected the increased need for professionals and specialists to operate and maintain the technical tools (isotope technicians, IT specialists, electronics experts, etc.). This is leading to the emergence within hospitals of new scientific/administrative elites [41, 60, 61, 47]. Similarly, according to Vendramin and Valenduc [59], NICTs have not generally had much of a negative influence on the qualifications, competences and occupational status of workers in the hospital sector. Contrary to what has been observed in other service sectors (banking and insurance, distribution, etc.), the pressures on workers and working conditions following the introduction of NICTs seem to be relatively weak. Little evidence has been found of stressful monitoring, increased labour turnover, increased involuntary part-time working or any increase in low levels of qualifications and skills.

Mention should also be made of some interesting studies on the shifts in occupational boundaries resulting from the introduction of NICTs. For example, according to Silver [57], the increasing computerisation of medical and administrative records is forcing nurses to act as secretaries when it comes to certain administrative tasks, while hospital IT services currently play very little part in their strictly medical duties. The number of bedside computers is still very small indeed.

New information and communication technologies have led to a number of certain changes in the structure and composition of occupational categories. Thus, a high proportion of the NICTs used in hospitals (although this is also true of all the new technical systems introduced in hospitals) now depend on specialists, who generally benefit from continuing training programmes provided by the manufacturers of the medical equipment themselves.

NICTs and the productivity question

The productivity question cannot be dissociated from that of employment. However, the question of productivity, which is a particularly sensitive one when it comes to the impact of NICTs, is less frequently the focus of studies of ‘medical innovation’ (cf. ‘Hospitals as a “set of technological and biopharmacological capacities”’). After all, the main purpose of medical innovation (in the sense of the ‘hospital as set of technical and biopharmacological capacities’ approach) is to help improve patient health rather than reduce employment levels.

As in other service sectors, the basic question running through the literature on this subject is that of Solow’s paradox, which concerns the difficulties of

generating productivity gains through the use of all-pervasive information technology. Here again, attempts to explain this paradox occupy an important place. Some interpretations are specific to hospitals. For example, according to Fuchs [62], the increase in litigation for alleged professional negligence explains the inadequacy of the productivity gains. And indeed, health professionals have tended to increase the volume of records, reports and other documentation they produce in the course of treating patients as a precautionary measure should they become involved in litigation. This increases the volume of work done by doctors and other health professionals, but has absolutely no effect on output. Doctors are also conducting more examinations and devoting more time to each patient, without there being any corresponding change in pricing practices. Finally, they have a tendency to request increasing numbers of tests and analyses of various kinds for each patient.

Other explanations of Solow's paradox are more general and can be applied to all services or even to all economic activities. This is the case with hysteresis phenomena, which reflect the notion that a certain time has to elapse before the use of NICTs in hospital activities has a real and measurable impact on productivity [45, 63]. It also applies to criticisms of the methods used to measure productivity, which are said to be ill-suited to services [64].

Hospitals as service providers and healthcare system hubs

This concept of the hospital reflects a change of approach, one that marks a shift away from the technicist perspective towards one that places greater emphasis on service and the (internal and external) service relationship. The patient is not simply a patient in need of treatment but also a consumer of a complex set of services, and efforts have to be made to satisfy this customer's needs, as well as those of his family.

Thus, innovation in hospitals is not a black box, as in the production function approach. It is no longer simply the sum of the more or less highly developed and spectacular medical technologies designed and/or used by a medical aristocracy, as in the approach that sees the hospital as a set of technical and biopharmacological capacities. Nor does it come down simply to a sophisticated and all-pervasive information system, as in the hospital-as-information-system approach. If innovation in hospitals is to be apprehended in its totality, it is necessary to break into the black box of the organisation. Penetrating the

black box in this way puts the spotlight on the actors in innovation and on support functions (accommodation, catering, laundering, transport, etc.), which are also neglected.

In our experience, the specialist professional literature is less resistant to adopting an approach that is open to the multiple aspects of innovation in hospitals. A survey of this literature is facilitated by dividing it into two groups. The first comprises analytical studies that seek to develop broad, open typologies of innovation or focus on forms of innovation that are generally neglected. The few academic studies concerned with the same issues will be allocated to this group. The second comprises more descriptive studies that confine themselves to 'technical' presentations of case studies of innovation in hospitals. These case studies cover a very wide range of innovations.

The typological and analytical/descriptive studies

This first group includes the studies by Anatole-Touzot and Souffir [39], who describe a veritable hospital 'innovation system' encompassing the following types of innovation:

- Technological innovations in the strict sense of the term: biotechnologies, IT, new equipment, etc.
- Service innovations linked to changes in the way hospitals go about their work, that is the introduction of new activities such as out-patient services, medical and social services for the destitute and the development of networks with doctors in private practice and/or voluntary organisations.
- Organisational innovations: reorganisation of administrative and logistical departments, evaluation of healthcare quality, development of treatment protocols, organisation of working time, etc.
- Social and cultural innovations: development of problem-based training schemes, programmes for improving working conditions, etc.

This typology, which has the merit of acknowledging the multiplicity of different forms of innovation that exist in hospitals and therefore belongs to what might be called the Schumpeterian tradition, suffers from a lack of any explicit definition of each of the categories and from a certain degree of overlap between them. Thus, as the examples listed above show, the boundaries between service, organisational and social innovations are not clearly defined.

This group also includes the studies of Arbus and Debrosse [65], which concentrate more on 'non-technological' innovation. These authors criticise other studies for their excessive concentration on 'innovation

in terms of medical equipment and practices', which leads to serious underestimation of the important role played by the modernisation of other activities, in particular the general running of hospitals and working conditions.

The academic studies that tackle the question of organisational innovation in hospitals can be characterised in different ways. Firstly, there are relatively fewer of them than of the others. Secondly, they tend to emphasise innovations in the organisation of healthcare or of treatment units. Thirdly, an increasing number of them are concerned with issues related to healthcare networks [65, 67]. Finally, a (relatively) large number of them tackle the question of organisational innovation as a secondary matter, that is, in most cases, as a consequence of the introduction of medical technologies or new information systems. Thus, for example, De Kervasdoué [63] argues that the diffusion of technological innovations is reflected, firstly, in increased costs before giving rise to organisational innovations introduced with a view to fully exploiting the new potential for increased productivity. This approach to organisational innovation as a matter of secondary importance is even more explicit in the studies by Lamarque [68], who makes a distinction between key and peripheral innovations. Key innovations, which are strictly medical, are those involving technologies used for diagnostic or investigative purposes, for treatment or rehabilitation and for prevention, in other words the triad of drugs, material resources (products and equipment) and techniques (procedures). Peripheral innovations are structural or organisational innovations introduced in order to bring about changes in the organisation of healthcare provision.

The case studies

Most of the available studies belong to this second group. They include examples, case studies, monographs and accounts of experiments. One example in France is the journal *Gestions Hospitalières* which, every two years since 1987, has published the results of the 'awards for innovations in hospitals'. The various award winners listed here constitute a very rich database of innovations in French hospitals. Examination of these case study databases, and of other sources as well, shows that the range of innovations listed is extremely wide, covering a multiplicity of areas and specialities within hospitals.

If strictly technological innovations (medical, IT-related and logistical) are excluded, the hundreds of

innovations listed can be divided into the following five categories¹:

Organisational innovations

These include, firstly, all attempts to modernise the organisation and functioning of non-medical hospital departments: breaking down departmental boundaries, organisational 'flattening' [69], establishment of new units in order to develop or take responsibility for new functions in spheres such as catering, accommodation, shops, maintenance, management, etc. They also include all innovations in the organisation of healthcare provision. Examples would include the establishment of new types of clinics within certain hospitals, 'the hospital at home', 'day-units' [60, 70–74]. Organisational innovations may be secondary to technological innovations or separate innovations in their own right, as already noted.

Managerial innovations

This category comprises new management techniques and methods, e.g. new accounting and financial techniques and procedures, new management practices, such as the development of strategic approaches, client segmentation, the introduction of total quality management approaches [75–78]. The Programme de Médicalisation du Système d'Information, a management tool that seeks to measure hospital activity by means of a typology of patients or diseases, also falls into this category [79].

Relational or service innovations

This category includes all innovations affecting the nature of the interface between service providers and service users and their families, such as improvements in the quality of patient facilities, management of patient flows, reductions in waiting times, accommodation for patients' families, etc. [80, 81].

Social innovations

Barreau [82] defines social innovation as a process based on social bargaining and formal and informal compromises leading to changes in the rules governing coordination and incentives. Thus, these innovations take shape through the development of new attitudes

¹ The categories in question may overlap with each other. After all, the definitions adopted in the literature often vary depending on the studies and authors in question.

to work organisation, the exercise of power and decision-making processes. Examples would include experiments with internal communications [83] or even with voluntary working hours in excess of the standard (in France) 35-h week or flexible time management [84, 85].

Innovations in external relations

This type of innovation involves the establishment (in new and original forms) of particular relations with customers, suppliers, the public authorities, other businesses, etc. For some years, hospitals have after all been increasingly opening up to their environments. The purpose of this opening up is control expenditure, as well as to facilitate the detection of change and to anticipate changes in demand and the nature of the new needs that have to be satisfied [86]. Innovations in external relations can take a number of different, more or less complex forms (depending on the number of actors involved in the new relationship, the purpose of that relationship, etc.). Thus, the simplest innovations in external relations are those involving bilateral relations. The following examples can be cited: agreements on the shared use of heavy equipment (whether medical or logistical equipment), agreements on the joint acquisition of such equipment, mergers between hospitals and the sale of services to other hospitals or to firms or organisations in other sectors. A range of different service activities might be involved here: catering, laundry services and logistics, as well as training, consultancy, renting out of premises for conferences or cultural activities, etc. The more complex innovations in external relations involve healthcare networks. Increasingly diverse networks are being built up, whether formal or informal, integrated or otherwise and dependent (or not) on the use of NICTs. It might be said that the 'hospital as service provider' is increasingly also part of a network of healthcare and other services.

Conclusion

The question of innovation in hospitals can be investigated from several interdependent theoretical perspectives: hospitals viewed in terms of their production functions, as sets of technical and biopharmacological capacities, as information systems or as service providers and healthcare system hubs. In the literature, the first three perspectives predominate. The main focus of attention is, on the one hand, those innovation processes involving a hospital's 'operational centre',

that is the individual treatment units, and, on the other, the implementation of medical and/or IT innovations. As a consequence, the literature largely ignores certain aspects of innovation in hospitals and consequently fails to investigate either the form or nature of that innovation or the departments (i.e. the actors) involved in such innovation.

This technological 'bias' can be interpreted in various ways by drawing on various economic and sociological arguments. Firstly, economic theory, through the notion of the production function, favours a technologist approach to innovation, which is usually reduced to process innovations. Secondly, medical and IT innovations are tangible and often spectacular. They can be described as pervasive when they are no longer concentrated in clearly identified areas of 'cutting-edge' specialist hospitals (operating theatres, radiology departments, laboratories, etc.), but have spread to all hospitals (including general or basic hospitals) and other areas of hospitals, particularly in-patient areas [38]. These technologies constitute a hospital's 'shop window' and testify to its degree of modernism and technicity and its practitioners' level of competence. A hospital's technical capacities enable it to attract not only (good) doctors but also patients. It is hardly surprising, therefore, that hospital managers and medical staff should combine to highlight this aspect of innovation. Furthermore, hospitals are healthcare providers dominated by the medical profession. This being so, the concentration on innovations involving this 'learned profession' can scarcely be regarded as illegitimate.

However, hospitals are increasingly complex organisations producing a wide range of outputs and services. Consequently, they have many other sources of innovation available for exploitation, whether by researchers, actors in the hospitals themselves or the public authorities. These new sources contain an abundance of technological innovations, as well as organisational innovations, service innovations, etc. They bring into play actors other than medical personnel, including administrators and workers in services such as catering, cleaning and so on.

The forms and the modes of innovation in such an organisation are therefore diverse. Our assumption is that *medical innovation is not synonymous with hospital innovation*, in other words that hospital innovation is a category much broader than medical innovation. It is thus necessary for the actors in hospitals, the public authorities and researchers in the social sciences to take into account these various reservoirs of innovation and the actors involved in them, both individually and in terms of the interactions between them (reciprocal effects, conflicts).

The view of innovation as a technical system is fundamental. There is no question of rejecting it. On the contrary, this perspective should be broadened, particularly in those areas of hospitals where it is neglected (logistics, catering, cleaning, etc.). In the same way, it is not our intention to devalue the role of doctors. It is quite simply a question of not neglecting any form or any actor in the innovation process, insofar as they contribute to a better quality of service, to improved economic efficiency and more generally to improved hospital performance. In other words, as much as scanners or MRI, account should be taken, for example, of improvements in the reception of patients, the introduction of new organisational forms and new services in non-medical sectors and the development of new types of cooperations and innovative network structures.

The four approaches to innovation outlined here provide a general analytical framework and survey of the literature on innovation in hospitals. We do not claim to have included in this survey all the studies devoted to innovation in hospitals—far from it. We take the view, quite simply, that most of the existing studies could be incorporated into this relatively simple general framework. We also think that the fourth approach outlined here, which is still adopted by only a minority of theoretical studies, is the one most able, in accordance with the Schumpeterian tradition of openness, to take account of the wide diversity of forms of hospital innovation and of actors in the innovation process. However, this approach lacks the analytical and theoretical foundations that would unify the diversity of studies that adopt this approach. Some of the paths towards a unifying model of this kind are outlined in Djellal and Gallouj [87].

Acknowledgement We gratefully acknowledge the comments and suggestions by the three anonymous referees appointed by the journal.

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