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DOES THE UTTO MODEL OF TECHNOLOGY TRANSFER FIT PUBLIC SECTOR HEALTHCARE SERVICES?

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Public sector healthcare services are both large users and innovators of health technologies. In the UK's National Health Service (NHS) initiatives have been developed to manage the process of technological innovation more effectively. This has two main aims, to maximize potential commercial returns from innovations developed within the NHS; and to improve levels of patient care through appropriate diffusion of innovations. The initiatives have been devised using approaches and processes already used in other public sector organizations, in particular, universities. Central to the approach taken by many universities is the setting up of a university technology transfer office (UTTO) to provide innovation management services. This paper assesses the extent to which the UTTO-based approach to technology transfer matches the needs of the NHS. Several significant factors are identified that suggest that the two sectors merit different approaches to innovation management. An agenda for further research into health service innovation management processes is suggested that emphasises issues including: the relative roles of formal and informal innovation processes; contingent variables affecting design of innovation processes; limitations of technology-push approaches to managing practice-based innovation; and cultural fit of innovation management models.

Keywords: Technological innovation; technology transfer; innovation hub; Nation Health Service.

1. Introduction

One of the results of the drive to modernize the UK's National Health Service (NHS) has been efforts to support innovation, particularly in relation to improvements in patient services and care and the development of hard technologies such as medical devices [UK Government (2000)]. These innovations are often rooted in formal research projects but can also result from ideas, inventions and process changes produced by NHS employees in the course of their work.

From its position as the largest employer in the UK, the NHS recognizes the potential for innovation activities is massive and as a consequence has started to invest in mechanisms to manage innovation and facilitate technology transfer. The way it has chosen to do this is to set up a number of innovation hubs, some of which are an integral part of the NHS itself [NHS Innovations (2004)]. These hubs

have drawn staff from within the NHS, from private technology transfer companies and from University Technology Transfer Offices (UTTOs) and their structure and operation are modeled on UTTOs. The role of the hubs however is primarily to support technology transfer out of the NHS, based on a pipeline model of innovation where IP is exploited through first protection and commercialization. The main measures of success used for the hubs are numbers of patents and licensing deals brokered.

The role of universities within national innovation systems has been established as vital to innovative activities [Nelson (1990)]. The role is however not purely as a source of innovation but as a member of a network of relationships spanning government and industry [Etzkowitz and Leydesdorff (2000)]. UTTOs have existed in the US and the UK for several years and have played an important part in managing and capitalizing on intellectual property (IP) produced within universities. The defining purpose of the UTTO can be characterized as to "... facilitate technological diffusion through the licensing to industry of inventions or intellectual property resulting from university research" [Siegel *et al.* (2003)]. This emphasis on identifying and commercialising new technologies can be viewed as underpinning a purely "technology push" model of innovation [Howells (1997)]. Even within a university context this has not been seen by all writers as always beneficial [Colyvas *et al.* (2002)].

The author of this paper believes that the perceived success of the UTTO model of innovation in commercializing university research has resulted in its uncritical application to the NHS. Unfortunately, the purpose and structure of the NHS requires application of a more sophisticated model of innovation, to ensure that maximum value is gained from the inventions created by its employees. This paper questions the extent to which it is appropriate to model the operation of NHS innovation hubs on the operation of UTTOs. It suggests that the organizational aims and context of the NHS are sufficiently unique to suggest that innovation processes should be encouraged to operate very differently. After reviewing the background to the current NHS initiatives the paper sets out a research agenda that supports the development of a better understanding of the innovation management challenge in the NHS.

2. History of Government Policy

Innovation in the NHS has now held the serious attention of the UK government for over a decade. This is for three reasons. First, the potential commercial value of innovations in the global healthcare market leading to additional income streams for the NHS. Second, the potential offered by innovations to transform the services provided by the NHS and improve patient care. Finally, the sources of innovation in the NHS are not just those engaged in formal research projects; many innovations stem from everyday work situations.

In the 1990s, the UK government recognized that the inventions developed in the UK's public sector research establishments (PSRE) were often poorly commercialized. In his report to the UK government, Minister for Science John Baker

commented: "It is generally perceived in Government and in PSREs, ... that the Government sector taken as a whole is not as advanced in the knowledge transfer arena as the best of the university sector or as the Government sector in the US" [Baker (1999)]. This led to IP rights not being appropriately protected, limiting the extent to which their full commercial value was achieved. To counter this PSREs were encouraged to make the commercialization of IP a priority. This prompted PSREs to setup technology transfer companies to provide specific support services. These companies provide services such as: identifying important IP; legal advice on protection of IP; and support in commercializing the IP through licensing or the set up of spin-off companies.

It was not until the late 1990s that significant attention was drawn to the performance of innovation in the NHS. In 1994 the Culyer Report [Culyer (1994)] set out a new strategy for R&D in the NHS. This recognized that much research in the NHS was done outside of teaching hospitals. It recommended that all the money spent by the NHS on R&D should be brought together into a single funding stream with primary, secondary, and acute sectors all having equal access to R&D funding. In addition, there was a new requirement for research to be effectively managed in order to achieve best value for money. This gave NHS trusts explicit funding for R&D. While changing the basis on which NHS trusts were able to manage their research, there was still little centralized guidance or control of how any resulting intellectual property was protected or commercially exploited.

Teaching hospitals have traditionally had close partnerships with universities. In these cases it was usually existing UTTOs that provided support for commercializing IP. However, for other inventions developed by NHS staff there was no obvious route or mechanism for commercializing IP. In some cases, individuals would pursue the innovation through private agreements with external organizations. In other cases, the innovation would either remain in use on a localized basis or would simply be forgotten.

The Baker report [Baker (1999)] emphasized the potential for gaining economic benefits from public sector research establishments (PSRE). While the report made general comments on UK PSREs, it had particular relevance to the NHS. Its main recommendations were accepted by the UK government. This lead to the government's response [Office of Science and Technology (2000)] focusing around the need for PSREs to have: an explicit knowledge transfer mission; necessary financial freedom; control and ownership of IP; access to necessary skills and advice; personal incentives for staff. As a direct result of the report several high level changes occurred. In July 2000, changes were made to allow government scientists new incentives and rewards for participating in the exploitation of inventions. The report also triggered moves to reduce the risk-averse culture of PSREs. The National Audit office published a statement "... confirming that they will adopt an open-minded and supportive approach to commercialization by PSREs, focusing on their commitment to exploitation, the quality of their risk management, and the lessons that can be learned for PSREs as a whole" [Office of Science and Technology (2000)]. This represented high level support for PSREs adopting a forward looking innovative culture that recognised that a level of commercial risk was inherent in any

innovative activity; in contrast to the existing "culture of risk avoidance". This was to be achieved by ensuring that audit methodologies would incorporate a "positive approach to risk". For the NHS in particular the Baker report was to change the way NHS trusts were able to take ownership of IP and then exploit it.

Subsequent to the Baker report other initiatives were made that aimed to support innovation in the NHS. The development of the NHS innovation hubs was outlined in a Department of Health framework and guidance paper [DoH (2002)]. In this, the hubs were given the role of "advisor" organizations, providing IP services including: technology audits; training of NHS employees on IP issues; evaluating IP and initiating additional R&D to produce evidence of clinical application; registering IP; commissioning production of prototypes; advising on and exploiting IP through licensing or through the setting up of companies; collaborating with universities and other third parties in the exploitation of IP generated jointly with NHS trusts.

The position of the UK government to innovation in the NHS, made clear in the DoH paper, was that two distinct categories of innovation exist. The first of these are those that have some commercial value. For these types of innovation, there is opportunity to commercialize the IP and develop products suitable for the global healthcare market. These innovations include diagnostic and therapeutic devices. These types of innovations were the focus of attempts to improve technology transfer processes out of the NHS. The second category are innovations that have "... no commercial value but the potential to improve health and to save expenditure by the NHS" (p. 11). These are commonly service improvements. Service innovations were seen predominantly as "best practices" to be diffused freely through the NHS. The NHS Modernisation Agency, was established in 2001, as the preferred agency to deal with service innovations. The implicit assumption embodied in this view of innovation is that the innovation of hard technologies is a separate activity from innovation of services. This is an oversimplification as many innovations combine hard and soft technologies. The true value of the innovation is based on synergy gained from the synthesis of technologies. This binary view resulted in two separate agencies becoming responsible for dealing with NHS innovations: NHS Innovations for commercially viable innovation and the NHS Modernisation Agency for "best practices".

The Department of Health approach to NHS innovation was also heavily based on a technology push based model of innovation. The proposed hubs were expected to "search" the NHS for potentially valuable IP. This approach emphasized the "... commercialization of a pipeline of innovations coming from the NHS..." [HITF (2004)]. There was little emphasis placed on creating an environment for innovation or more importantly recognizing the role of users and their use of technology in the innovation process.

With the development of the NHS Institute for Innovation in 2005, there is scope for a co-ordinated approach to the innovation of hard and soft health technologies. There is however, some doubt about how such an innovation process should be structured. While models of technology transfer have been adopted from other sectors e.g. the university sector, it remains to be seen that they provide a complete

and holistic model of technological innovation appropriate to the NHS. The nature of the NHS makes it very distinct from other sectors, especially with respect to the range of cultures that exist within the organization. Any set of processes that support innovation in the NHS must therefore take account of the cultural context the NHS presents.

3. Technology Transfer Offices in the Public Sector

The focus of technology transfer studies and public policy up to 1980 was on technology transfer between countries [Reddy and Zhao (1990)]. The economic benefits of a nation's internal technology transfer from public sector bodies, has since in the 1980s, become a focus for technology policy. In the US, this shift has been seen through change to the basis on which public institutions own IP they produce. For example, the Bahr-Dohl Act 1980 has been cited as triggering an increase in the rate of patenting by US universities [Nelson (2001)]. Bozeman suggests that this is due to a change in economic perspective; from an assumption that a free market will be adequate to facilitate the transfer of technology, to one that recognizes that markets are not the most efficient mechanisms for innovation and economic growth [Bozeman (2000)]. It is now recognized that public sector R&D, especially in developing pre-competitive technology, can be an important complement to R&D carried out in the private sector. It is however not simply a choice between state run planned R&D and market led R&D; instead a path between the two is necessary [Lundvall (1999)]. The position taken in many nations and regions is that the role of public sector R&D is an important component of a regional or national innovation system e.g. Japan [Fujisue (1998)], UK [DTI (2004)].

While there is a range of different publicly funded research institutions, universities have been the focus of many technology transfer initiatives in Europe and the US. One of these initiatives has been the setting up of technology transfer offices within universities. The purpose of these offices is to act as an intermediary organization between the private sector and academia. The offices aim to commercialize a university's IP. The general commercialization process has been summarized as: "(a) evaluate and valuate disclosures of new discoveries; (b) seek legal protection for the technology, primarily through patenting; (c) sell licensing agreements to industry; and (d) collect royalty, oversee, and enforce contractual agreements with licensees" [Markman *et al.* (2005)]. UTTOs are also involved in new venture creation, such as creation of start-up companies.

Three archetypal structures have been suggested for the form taken by a UTTO. In a US study [Markman *et al.* (2005)] over half UTTOs were based within the formal structure of the university; a large minority were set up as non-profit research foundations; and a small number ($< 10\%$) were set up as for profit private ventures. The advantage of the UTTO being placed within the university is simplicity of management and higher level of control can be exerted by the university over its activity. In contrast the for-profit private venture limits the level of risk and liability by the associated university, while allowing greater autonomy. The results of the differing structures also make university based UTTO more likely to engage in

licensing for cash/revenues, while the for profit venture based UTTO is more able to aggressively create business start-ups. A key factor in the success of a UTTO seems to be that it is decentralised and responsibilities are placed close to research groups and individuals [Bercovitz *et al.* (2001)]. A reason for decentralization has also been cited as the need to provide a buffer against the potential conflict of interest between teaching and research within a university [Debackere and Veugelers (2005)].

4. Technological Innovation in the Healthcare Sector

NHS staff, in common with staff working in all types of organization, have novel ideas about new technologies and how they should be used. These ideas range from small "work arounds" conceived to solve an everyday problem; to a major new medical technology, that has a significant impact on how patients are cared for. These ideas constitute inventions that through a process of innovation become useable technologies. The number and range of inventions produced within the NHS itself is significant. Recent innovation competitions within the NHS attract hundreds of entries each year, many of which have commercial value [NHS Innovations (2004)]. For some inventions their value is only to a localized group of staff. For others, the invention can have applicability to the global healthcare market, making the intellectual property associated with the invention commercially valuable. For potentially valuable inventions it is important that appropriate commercial protection of the IP is obtained, so that its commercial value can be fully realized. This typically involves the filing of a patent. To develop an invention further into a commercially viable product requires an innovation process that adequately tests and develops the invention so that it can be produced as a reliable product. In the case of healthcare technologies this is expensive and time consuming, not least because of the need to fulfill rigorous regulatory requirements. Within Europe there is now a strong regulatory framework that regulates the medical device industry, for example the EU Medical Devices Directive (93/42/EC). Two major benefits exist for the NHS from investing in the technological innovation process. The first benefit of exploiting its IP is the potential income stream from commercial exploitation of inventions. The second benefit is the potential to transform itself through diffusing innovation within the service, resulting in improvements in efficiency, effectiveness and improved patient care.

Within the NHS a distinction is made between two categories of innovation, innovative technology and service improvement. This can be seen as a distinction between "hard technologies" based around physical, technological artifacts e.g. devices and software; and "soft technologies" based on technological knowledge or know-how. Within the EU medical devices directive medical technology has been defined that encompasses mainly hard technologies; thus a hard healthcare technology can be seen as an:

> *. . . instrument, apparatus, appliance, materials or other article, whether used alone in combination, including the software necessary for its proper application intended by the manufacturer to be*

used for human beings for the purpose of:

- *diagnosis, prevention, monitoring, treatment or alleviation of disease*
- *diagnosis, monitoring, treatment, or alleviation of or compensation for an injury or handicap*
- *investigation, replacement or modification of the anatomy or of a physiological process*
- *control of conception*

EU Medical Devices Directive (93/42/EC)

In contrast, soft technologies would include knowledge embodied in processes and procedures used to support patient care e.g. surgical procedures, care plans and protocols.

The NHS has tended to keep these two categories as separate types of invention. This is mistaken as for most hard technologies their effective implementation requires suitable soft technologies. For example in the case of cochlear implants, implanted devices used to give deaf patients the ability to hear, the hard technology of the device requires a complex mix of soft technologies to achieve maximum benefit from the implant. These soft technologies define the wrap around services that care for the patient before, during and after the implantation of the actual device. To treat the hard and soft technologies separately ignores their inter-relationships. For hard healthcare technologies there will inevitably be have a service wrap-around that embodies softer technologies.

5. Technological Innovation in the NHS

The nature of innovation in any organization is complex. In the case of the NHS and its hospitals, innovation can take place in many dimensions. This makes it a particularly complex context for innovation. The source of this complexity is the range and interrelations of specialist groups and the diversity of services that are provided. It is suggested that to understand innovation in hospitals it is best to treat hospitals as "... providers of complex services and healthcare system hubs". Treating a hospital as a production function; collections of technological and biopharmacological capacities; or information systems leads to a simplification of the complex interrelationships involved [Djellal and Gallouj (2005)]. It would be easy to see hospital innovation simply in terms of "medical innovation" of hard technologies including biomedical/bio-pharmacological substances and medical devices; or "soft" technologies such as care protocols, diagnostic or therapeutic strategies. Similarly, innovation goes beyond the application of information technologies to healthcare. Within their own model of hospital innovation, Djellal and Gallouj stress recognizing innovation of services as the main unit of analysis, rather than a specific technology. They suggest that innovation results in the extension, specialization, intensification or recombination of a service's constituent technologies. These changes to a service will result at the component and architectural levels of technology [Henderson and Clark (1990)]. By maintaining a focus on the service however, a link is maintained between the technology and its implemented use in the organization. The

implication of this is that while it is useful for pharmaceutical companies, medical device manufacturers and even universities to consider "medical innovations" from the perspective of specific hard and soft technologies, to understand innovation in hospitals it is imperative that a broader view is taken.

6. Does the UTTO Model Fit the Needs of the NHS?

The structure and function of UTTOs has been the target for much research. For most universities the UTTO draws together a wide range of skills and knowledge to support a range of processes. These include not just straightforward commercialization but also act as a focus for other university-industry relationships such as a contract research. It is perhaps because the UTTO encompasses a well developed and sophisticated range of business models with proven effectiveness, that it is the predominant model adopted for NHS innovation hubs. The context for technology transfer in the university sector differs to that in the NHS, is in terms of the aims of the respective organizations, their structural characteristics and the basis on which technology transfer performance is evaluated.

6.1. *Differences in the context for technology transfer*

The NHS is very distinct from the university sector in terms of its aims and underlying structures and culture. While there are links between the two sectors, particularly in teaching hospitals, it would be wrong to generalize between them. The functions of the two sectors are very different. In universities, the two priority activities are teaching and research. University teaching emphasises academic approaches to knowledge, while research spans both curiosity-driven and strategic applied research. The resulting outputs of universities are therefore educated adults and published research. While other outputs include patents, the key performance indicators for universities are numbers of students and number/quality of research publications. In contrast, for NHS hospitals the main purpose is provision of patient care. While research takes place within the NHS, it is primarily applied research. The result of these two differing purposes means that the respective organizations have distinct differences in structure and culture. A common structure to both is that of a professional bureaucracy [Mintzberg (1993)]. However the professional identities of staff in the two sectors are very different. In the university sector, staff value the academic freedom to carry out both "blue sky" or applied research, though research funding regimes can constrain this freedom. There is doubt however that the pursuit of commercially oriented research is consistent with the goal of creating reputation enhancing academic knowledge [Goldfarb and Henrekson (2003)]. University research can be experimental and is supported by a risk-tolerant environment, particularly where staff have tenure. The main motive for research is development of professional status based on the quality of published work, rather than financial incentives. In contrast, NHS research is predominantly applied and is carried out in an environment characterized as risk-adverse and highly regulated, both in terms of scientific and ethical standards. Innovations created by NHS staff

are often problem oriented and practice-based innovations, concerned with a specific health care service.

6.2. *Differences in the evaluation criteria for technology transfer*

While both sectors have been the focus of attempts to increase levels of technology transfer, the basis on which initiatives are evaluated will differ between the sectors. Bozeman suggests criteria on which technology transfer from universities is evaluated [Bozeman (2000)].

(1) The "Out the door" criteria is based on simply whether a technology transfer occurs, this is perhaps the crudest measure of success, though easiest to measure e.g. number of licenses granted in a year.
(2) Market impact/economic development is more concerned with the effect of a technology transfer, either on the competitiveness of the recipient organization or the macro economic impact of the transfer.
(3) Political reward emphasizes the political pay-off of a particular technology transfer.
(4) Opportunity cost of technology transfer activities, recognizing that the resources put into technology transfer activities absorb resources for other activities.
(5) Technology transfer can result in an increase in scientific and technical human capital that increases the university's research capacity.

Bozeman's criteria provide a rounded set of criteria for evaluating technology transfer. When reviewing the university sector Bozeman found that only a small number of criteria were used, usually those for which there were easily established metrics, for example number of licenses granted. Unfortunately, metrics based only on numbers of patents or licenses fail to reflect the true complexity of technology transfer. The establishment of a patent or license does not always unequivocally signal a successful technology transfer. In addition for "non-embryonic inventions" requiring little additional development, protection of IPR is only important with respect to allowing universities to collect revenues, rather than actually facilitating technology transfer [Colyvas *et al.* (2002)]. For policy makers there needs to be a distinction between processes that facilitate the generation of income from technology transfer; and those that facilitate technology transfer. While the UTTO can play an important part in supporting income generation, through the commercialization of inventions, it is unclear whether the wider benefits alluded to by Bozeman's criteria are supported by UTTOs.

6.3. *The NHS as a complex technology transfer problem*

UTTOs have played an important function in commercializing a large number and range of IP from the university sector. In specific areas such as biotechnology their function has gone beyond just providing services required to gain protection of IP, to strategic decision-making on how best to commercialize an idea by developing industry relationships and even triggering the creation of start-up companies. Existing links between the university sector and the NHS, focused in medical schools,

has meant that some UTTOs already serve both university and NHS organizations. A natural step in encouraging better management of IP in the NHS is to widen access to TTO services for NHS staff. There are three factors that complicate the issue of promoting technology transfer in the NHS.

(1) In the healthcare area UTTO have tended to focus on hard technologies. These technologies are more amenable to protection such as patents, than the wider procedures or processes within which they are used. So for an innovative surgical procedure, the only practical way of protecting the associated IPR, is to patent devices used in the procedure.
(2) The nature of UTTO commercialization processes leads to a separation between the hard and soft technologies supporting its use. Thus, a tight boundary is maintained between the technology and the context of its use, e.g. a service delivery process. This is particularly the case in universities (with the exception of medical schools), where R&D is likely to be carried out remotely from the final context of use.
(3) Evaluation of UTTO is commonly based on metrics concerned with efficiency of technology transfer, e.g. number of patents, licenses, start-ups. This can be appropriate in a university where emphasis is on increased quantities of technology transfer and maximizing resulting revenues. In the NHS however, effective technology transfer, and in particular the benefits gained through diffusion of NHS innovations within the service, are major concerns. While not providing major new revenue streams for the NHS, this internal technology transfer has the potential for improvements both in efficiency and effectiveness. Ultimately, improved patient care within the service can result from internal technology transfer. Evaluation of technology transfer activities must encompass both effective commercialization and enhanced patient care. Several of Bozeman's evaluation criteria have particular relevance to the NHS and suggest that any innovation management should value outcomes such as capacity building equally with improved income streams.

7. Cultural Context for NHS Innovation

Many organizations that are seen as innovative have been described as having a culture that is conducive to innovation. Many large organizations such as 3M, Microsoft and Hewlett Packard have their innovative cultures linked to charismatic and innovative leaders. These leaders have influenced values and practises supporting innovation over a long period [Deschamps (2003)]. The presence of an innovation culture can be a pre-requisite to encouraging technological innovation in the NHS. This raises the question of whether the NHS does have an innovative culture. An attempt at characterizing the culture of the NHS is prone to generalizations simply because of the size and diversity of the organization. Several observations can however be made.

The NHS is organized into strong functional specialisms, which are overlaid with strong professional roles. In turn these functions and roles have become

institutionalized into a tight bureaucratic structure that supports and co-ordinates its activities.

The primary base of power in the NHS has been medical knowledge and as such doctors in particular hold significant power [Worthington (2004)]. Other healthcare professionals such as nurses and paramedics hold lower levels of power and influence. The powerful position of doctors also leads to the organization having a predominantly positivist world view. This leads to scientific method being the primary process for validating knowledge. This has implications for technological innovation as evaluation of technology tends to be based on a search for "scientific fact". This can be limiting as epistemologies based in the social sciences carry less credence [Jones (2001)]. Thus despite the need to recognize the socio-technical dimension of technology, NHS decision-making underpinned by a knowledge validation process based on a positivist epistemology. Though alternative epistemologies have been used in clinical settings [Reason and Bradbury (2000)], they remain marginal. This strong positivist worldview is illustrated by a statement from a senior manager at the NHS Modernisation Agency when commenting on continuous improvement methodology applied to the NHS. They stated that "... data are presented in a format that is easily understood and *statistically valid, which appeals to doctors...*" [author's emphasis] [Rogers *et al.* (2004)]. It is revealing from this statement that in order to drive improvements to organizational rather than medical operations, NHS decision making requires scientific levels of proof. As increasingly recognized in the management literature this can lead to a myopia in which only the measurable is managed, or even believed.

The cultural propensity for scientific knowledge leads to initiatives being led by scientific method. For example, the NHS has since the early 1990s placed emphasis on "evidence based clinical practice". This approach to clinical practice is concerned that where research data is available it should drive clinical practice. There have also been moves to develop "evidence based policy" in the NHS. Both these initiatives are an attempt to transfer scientifically validated knowledge into clinical practice and policy making. There has been some criticism of evidence based policy on the grounds that research results are often too context specific to be widely generalized [Black (2001)]. Evidence based policy in the NHS has attracted specific criticism on the grounds that policy requires a more pluralist and diverse approach and to recognize that policy often requires compromises between competing view-points [Marmot (2004)]. Evidence based initiatives are an example of the predominantly positivist culture in the NHS rooted in the dominant views of the medical profession.

While emphasis on scientific knowledge and the division of the organization on functional specialisms has allowed the enhancement of patient care through practitioners gaining specialist skills; innovation has been impeded by rigidity; pecking orders; strict demarcation; tribalisism between staff; and departmental silos [Rushmer *et al.* (2004)]. While the source of many innovations are based in the novel combination of diverse disciplines; the NHSs predominantly functionally based structure acts against such innovation.

The NHS has a strong culture of professional autonomy because of the NHS's structure primarily being based on functional specialisms [Worthington (2004)].

This should provide an effective setting for innovation work to occur, as professional staff have some control and discretion in how they approach their work. There are however a number of factors that stop individuals pursuing certain innovations. There is increasing requirement for new practices to be rigorously tested prior to being approved by regulatory authorities at national and regional levels. This in itself carries with it a significant overhead that can potentially retard innovative activities. The role of NHS staff is primarily to deliver services to patients. The demand for such services is high and so for many staff there is little time to spend on innovative activities.

Since the 1980s there has been a gradual change in the role of professional managers in the NHS. Up to the 1980s the role of managers has been characterized as to support the work of professionals and nurses in carrying out their work. Their primary role was seen as ensuring that the necessary resources were available at the appropriate time [Worthington (2004)]. Only after the Griffiths inquiry of 1983 was the role of managers made more explicitly concerned with performance management or strategic change. This has led to a conflict between the work of clinical professionals and management.

In order to develop a thriving innovation context in the NHS, account needs to be taken of its culture. As outlined above however this is not simple as the NHS's culture is complex and heterogeneous; complex because of the web of power relationships; heterogeneous because of the diversity of disciplines and roles. In addition to its size the NHS also experiences a high rate of change. Significant change has been rooted in external pressures e.g. government initiatives. Perhaps the most acute driver of change is technology. The rate of technological change has implications for the organization in terms of both resourcing new technology and the development of skills to use it. The past twenty years has seen a succession of initiatives in the NHS, this has resulted in "change fatigue" becoming endemic in staff. For these reasons an approach to managing innovation in the NHS must be sensitive to the diverse cultures and recognize that for an organization experiencing rapid change any "solutions" are likely to be only transitory.

8. A Research Agenda

A number of potentially rich areas of research are raised by the recent initiatives aimed at generating and improving the management of innovation in the NHS. At a general level, an assessment of the approaches taken to innovation management, and their levels of success, is valuable in providing insights into how future initiatives are designed. The sheer size of the NHS as the largest healthcare provider in the world means that this has an intrinsic value in its potential to support continuous improvement and innovation. The insights gained can however be also relevant to other large, public-sector organizations. Operationally focused, yet technically dependent, public service organizations can benefit from understanding the problem of innovation management. Such sectors include: policing, education and social-care.

Table 1. Distinction between innovation in Universities/PSREs and NHS Organizations.

	University/PSRE	NHS Organization
Context	Research and invention is primary purpose	Operational focus with invention a byproduct of practice
	Development of published work improves professional status	Innovation is problem oriented
	Experimental and risk tolerant	Highly regulated and risk averse
Evaluation criteria for innovation	Quantity of patents and licenses	Improved operational efficiency
	Improved technical human capital	Improved quality of care
	Prestige and reputation	Value of income stream from technology licenses Political kudos
Technology	Hard technologies	Closely coupled hard and soft technologies
Proximity of R&D effort to context of use	Distant	Close to the context of use
	Multidisciplinary teams drawn from specialist research staff	Operationally focused individuals and teams
Mechanisms for diffusion and adoption of technology	Market mechanisms	Diffusion of soft technology

This paper has suggested that treating the NHS as simply another PSRE, without recognizing its unique characteristics and distinct differences from universities and research institutes (see Table 1), can lead to the application of a sub-optimal model of innovation management. For example, the un-critical application of a UTTO model, could undermine the development of a systemic approach to innovation management. A systemic model of innovation would allow the value of inventions to be assessed using multiple criteria, not just their potential as an income stream from commercial exploitation. Additional criteria are required to take into account the potential for internal efficiency and patient care improvement benefits. Such criteria would have to be sensitive to the synergies developed between hard and soft technologies. In addition, the incentives and disincentives for NHS staff engaging in innovative activities needs to be clearly understood and addressed. Finally, the diverse range of formal and informal innovation activities in the NHS requires a contingent approach to innovation process design; better understanding of the variables affecting the design of these processes is needed.

Further research would be beneficial to establish insights into effective innovation in the NHS. This suggests a research agenda based around five issues.

(1) The problem identified by government is not that innovation fails to occur in the NHS but that exploitation of inventions is not always as effective as it could be. This leads to a need to examine what actual innovation processes operate in the NHS. Research in this area has the potential to differentiate between the officially recognized and articulated innovation practices and those that occur on an informal and unofficial basis. A comparison of the official and un-official

innovation processes has potential to strengthen new initiatives by taking into account those informal processes that potentially support or retard innovation.

(2) The heterogeneity of NHS inventions suggests that a contingent approach to their innovation process is required. Further research has the potential to identify those contingent variables that influence the design of the innovation process applied to a specific invention.

(3) The implied model of innovation embodied in UTTO models is one of technology push. While the initiatives to manage NHS innovation have improvement of patient care as a primary objective, the emphasis on technology push results in the main objective becoming development of commercially successful healthcare products. It is possible that the development of commercially successful healthcare products benefits patient care, through making new technologies more widely available via market mechanisms. The involvement of the private sector in the development process can ensure that the technology developed satisfies regulatory requirements and also make products available at lower price due to competition in the global healthcare market. By establishing a product in the global market place, its diffusion and use back into the NHS can occur more readily. For many technologies this mechanism can be effective, on the basis of gaining royalties for the NHS and acting as an effective mechanism for technology diffusion. The assumption however that all inventions should have commercial viability in order to merit development through the innovation pipeline is flawed. Unfortunately tests for commercial viability carried out as part of a technology assessment must be based purely on forecast of potential income generated from the commercial product. This emphasis hides other potential benefits of an invention, such as improvements in effectiveness, quality of patient care or enabling better internal processes within the NHS. Research is needed to consider how assessment of inventions is best structured where the primary target of an invention is the NHSs internal market for technology rather than the global healthcare market. This is particularly the case where the advantages of the technology are based on synergy between a hard technology and a service wrapping provided by the NHS.

(4) The inventions produced within the NHS are rooted in a practice-based rather than a research-based culture. Further research is needed to examine how the innovation process must differ from that applied in PRSEs, including universities. A key factor to consider is the extent to which an invention is coupled to its original context. Within the NHS there will be cases where technologies that were invented to support specific procedures or ways or working, will be difficult to separate into distinct products. The tight coupling with organizational practices can be the crucial linkage in making a new technology usable and effective. For the NHS this implies that the innovation process must mange not just hard technologies but also any "service wrapping" that supports its effective use.

(5) The final area of research that the paper leads to is how the model of innovation management adopted in the NHS fits with its culture. As noted in the paper the shared values and attitudes of NHS staff are based around the organization's

purpose to deliver patient care. This is distinct from values held by staff in other PSREs, where the predominant values support a research focused culture. The implication of this is that models of innovation management taken from other sectors such as universities are incommensurate with the values of NHS staff. Technology transfer initiatives in particular that emphasise transfer out to commercial markets, can sit uncomfortably with the NHS, especially where the major market is within the NHS itself. This raises questions about whether the conventional process used for "protecting" IP, through secrecy and/or patenting are actually counter-productive to technology diffusion within the service.

Further research is planned that will build case studies of the actual processes followed by NHS staff in pursuing successful innovation. It is intended that these will provide insights into the contingent variables affecting design of the innovation processes including: the co-development of soft and hard technologies; the role of NHS staff as both innovators and users; and the impact of the values and beliefs about technology that shape innovation processes.

References

Baker, J. (1999). *Creating Knowledge Creating Wealth: Realising the Economic Potential of Public Sector Research Establishments*. A report by John Baker to the Minister for Science and the Financial Secretary to the Treasury. HM Treasury. London, UK.

Bercovitz, J., Feldman, M. *et al.* (2001). Organizational structure as a determinant of academic patent and licensing behavior: An exploratory study of Duke, Johns Hopkins, and Pennsylvania State Universities. *The Journal of Technology Transfer*, **26**, 1–2: 21–35.

Black, N. (2001). Evidence based policy: Proceed with care. *British Medical Journal*, **323**, 7307: 275–278.

Bozeman, B. (2000). Technology transfer and public policy: A review of research and theory. *Research Policy*, **29**, 4–5: 627–655.

Colyvas, J. and Crow, M. *et al.* (2002). How do university inventions get into practice? *Management Science*, **48**, 1: 61–72.

Culyer, A. (1994). *Supporting Research and Development in the NHS*. A report to the minister for health by a research and development task force chaired by Professor Anthony Culyer. HMSO. London, UK.

Debackere, K. and Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy*, **34**, 3: 321–342.

Deschamps, J. P. (2003). Innovation and Leadership. *The International Handbook on Innovation*. L. V. Shavinina. Amsterdam. Boston, Elsevier Science, **xxviii**: 1171.

Djellal, F. and Gallouj, F. (2005). Mapping innovation dynamics in hospitals. *Research Policy*, **34**, 6: 817–835.

DoH (2002). *The NHS as an Innovative Organisation, a Framework and Guidance on the Management of Intellectual Property*. Department of Health. Report No. 29030. London, UK.

DTI (2004). *Knowledge Transfer and Public Sector Research Establishments (PSREs)*. Department of Trade and Industry. London, UK.

Etzkowitz, H. and Leydesdorff, L. (2000). The dynamics of innovation: From National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy*, **29**, 2: 109–123.

Fujisue, K. (1998). Promotion of academia-industry cooperation in Japan — Establishing the "law of promoting technology transfer from university to industry" in Japan. *Technovation*, **18**, 6–7: 371–381.

Goldfarb, B. and Henrekson, M. (2003). Bottom-up versus top-down policies towards the commercialization of university intellectual property. *Research Policy*, **32**, 4: 639–658.

Henderson, R. M. and Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies. *Administrative Science Quarterly, Administrative Science Quarterly*, **35**: 9.

HITF (2004). *Better Health Through Partnership: A Programme for Action.* Health Industries Task Force, Department of Health, Report No. 265090. London, UK.

Howells, J. (1997). Rethinking the market-technology relationship for innovation. *Research Policy*, **25**, 8: 1209–1219.

Jones, M. (2001). An interpretive method for the formative evaluation of an electronic patient record system. *8th European Conference on IT Evaluation*, Oriel College, Oxford, UK, MCIL.

Lundvall, B.-A. (1999). Technology policy in the learning economy. *Innovation Policy in a Global Economy.* D. Archibugi, J. Howells and J. Michie, Cambridge, England, New York, Cambridge University Press, pp. 19–34.

Markman, G. D., Phan, P. H. *et al.* (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing*, **20**, 2: 241–263.

Marmot, M. G. (2004). Evidence based policy or policy based evidence? *British Medical Journal*, **328**, 7445: 906–907.

Mintzberg, H. (1993). *Structure in Fives: Designing Effective Organizations*, Englewood Cliffs; London, Prentice Hall, Prentice-Hall International.

Nelson, R. R. (1990). Capitalism as an engine of progress. *Research Policy*, **19**, 3: 193–214.

Nelson, R. R. (2001). Observations on the Post-Bayh-Dole rise of patenting at American Universities. *The Journal of Technology Transfer*, **26**, 1–2: 13–19.

NHS Innovations (2004). *NHS Innovations Annual Report 2003/2004.* NHS Innovations. London, UK.

Office of Science and Technology (2000). *The Government Response to the Baker Report: Creating Knowledge, Creating Wealth: Realising the Economic Potential of Public Sector Research Establishments.* HM Treasury. London, UK.

Reason, P. and Bradbury, H. (eds.) (2000). *Handbook of Action Research: Participative Inquiry and Practice*, Sage.

Reddy, N. M. and Zhao, L. M. (1990). International technology-transfer — A review. *Research Policy*, **19**, 4: 285–307.

Rogers, H., Silvestor, K. *et al.* (2004). NHS Modernisation Agency's way to improve health care. *British Medical Journal*, **328**: 463.

Rushmer, R., Kelly, D. *et al.* (2004). Introducing the learning practice — I. The characteristics of learning organizations in primary care. *Journal of Evaluation in Clinical Practice*, **10**, 3: 375–386.

Siegel, D. S., Waldman, D. *et al.* (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy*, **32**, 1: 27–48.

UK Government (2000). *The NHS Plan, A Plan for Investment, a Plan for Reform*, HMSO. London.

Worthington, F. (2004). Management, change and culture in the NHS: Rhetoric and reality. *Clinician in Management*, **12**, 2: 55–67.

Biography

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